IDENTIFICATION OF SOME CAUSES OF DEMOTIVATION AMONGST KEY STAGE 4 PUPILS STUDYING DESIGN AND TECHNOLOGY

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This thesis is submitted in fulfilment of the requirements for the Degree of Doctor of Philosophy

UNIVERSITY OF
NEWCASTLE

Department of Education
May 1997

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ıbstract

This research project set out to identify some of the causes of demotivation amongst Key Stage 4 pupils studying design and technology for their GCSE examinations and to propose strategies that teachers could adopt in order to overcome the situation.

Design and technology in schools requires pupils to apply a complex integration of processes, concepts, knowledge and skills in order to develop solutions to practical problems. As the subject area has developed, so has the use of the design process as a method of delivering and examining subject content. Initial research indicated that the investigation of pupils engaged in long term pieces of project work could provide tangible indicators in the identification concerning the causes of pupil demotivation.

The research project was divided into three sections: the Initial Survey; Phase One; and Phase Two.

The purpose of the Initial Survey was to select a representative and yet manageable sample of schools from which the researcher could collect quantitative and qualitative data pertinent to the project. Eight schools were chosen from an original sample of one hundred and fifty schools located in seven Local Education Authorities in the North East of England.

Questionnaires and interviews during Phase One enabled the researcher to develop an understanding of pupil (n = 179) and teacher (n = 8) perceptions regarding pupils' enjoyment and their ability to perform in design and technology project work. Analysis of the data collected identified several key internal and external factors that affected pupil motivation. It also indicated that there was a large proportion of demotivated pupils within the sample.

Phase Two was conducted throughout the duration of the pupils engagement with design and technology examination project work. Observation of a new sample of pupils (n = 50) enabled the researcher to add to and clarify the list of selected factors. Educational issues that were seen to affect a teacher's level of motivation were also identified. An exploration of the relationship between all the targeted factors was carried out. This phase of the reasearch also supported the findings of Phase One, in that a large proportion of this new sample were found to be demotivated.

The effect of performance upon motivation and motivation upon performance was shown to be an important relationship in the context of the study. Internal attributes such as creativity, goal orientation and cognitive style were each seen to have a marked effect upon a pupils' motivation. A pupil's knowledge, skills and understanding of concepts, particularly regarding the design process, were also found to affect their performance and hence their motivation. Significant gender differences were noted. However influential the internal factors on their own or in various combinations were seen to be, the influence of the identified external factors was found to be substantial. In particular, the analysis indicated the importance of those factors that affected the teachers' own levels of motivation. The relationship between motivated teachers and motivated pupils and demotivated teachers and demotivated pupils was seen to be particularly important.

From the analysis of the evidence obtained throughout each stage of the project, three lists of advice for teachers of Key Stage 4 design and technology pupils were devised. The lists were written with the intention of providing teachers with suggestions that could help to improve pupil motivation. The lists were in three categories : general advice applicable to all pupils of design and technology; advice targeted at demotivated low achievers; advice principally for demotivated high achievers.

AUTHOR DECLARATIONS

1 During the period of registered study in which this thesis was prepared the author has not been registered for any other academic award or qualification.

2 The material included in this thesis has not been submitted wholly or in part for any academic award or qualification other then that for which it is now submitted.

E Stephanie Atkinson.

E. Stephanie Atkinson.
May, 1997

ACKNOWLEDGEMENTS

I am grateful to the many people who have contributed to my understanding of the activity of designing. I wish to give special thanks for support and advice throughout the past four and a half years to: Dr. Douglas Newton and Clive Mockford. I am also most grateful to all the pupils and teachers who have willingly taken part in the data collection procedures for the duration of my study.

Contents

List of Tables

List of Figures

Chapter One Literature Review

Chapter Two Methodology Overview

Chapter Three Aims of the Research Project

Chapter Four Initial Survey

Appendices

Introduction

Introduction

The importance of design and technology education[1] and the failure to involve a larger proportion of young people, including the more able and girls, at a time of considerable technological change in society has been the concern of educationalists and others in the United Kingdom (UK) throughout the second half of this century (Department of Education and Science (DES), 1988).

During this period of time in other European countries, such as Scandinavia, the Netherlands and Germany there has been sympathy for a philosophy of technological appreciation and understanding which has not been paralleled in the UK (Hopken 1993). In fact, it has been generally viewed in the UK that there was, and still is an attitude of indifference, even contempt for technology amongst the general public (Budgett-Meakin 1990, Riggs & Dillon 1992).

The attitude of young people towards technology has been recognised as an important pivotal feature in preparing young people for life in the coming century. In the UK Layton (1992) referred to the importance of values as a central theme within design and technology education.

"There is nothing inevitable about the form which a technology takes; it is shaped by the value decisions of those in control" (Layton, 1992).

Whaler and Tulley (1991) raised concerns felt in Germany when they summarised the results of periodic polls carried out in Germany during the 1980's which revealed that there was clearly developing a more sceptical attitude amongst young people towards technology. Their research suggested that young people's attitudes to technology was based primarily on an interest in technical processes and developments on the one hand, and on reflective and quite critical considerations of the consequences of technology for mankind and nature, on the other.

In the UK a TRIST report *"Moral issues in a technological society"* reported similar negative attitudes towards technology in society amongst young people reflected in a rejection of technological activities in school. It referred to a *"... climate of despair amongst many of our young people" (TRIST 1987c).*

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[1] *In order to avoid confusion and assist the reader the terms 'design and technology' and 'design and technology education' have been adopted to describe the area of the curriculum associated with this research project. The term 'technology' has been used to describe technology in the widest sense of the word. With regard to terminology associated with the National Curriculum (NC) 'NC Technology' has been used when reference is made specifically to the early orders and NC Design and Technology if reference is made to the most recent documentation. At the appropriate place within the historical overview the plethora of nomenclature that has been used to describe this subject area within the school curriculum has been referred to and explained.*

Bame and Dugger (1990) gave additional support to the importance of the role of design and technology education in their recent research in the United Sates of America regarding pupils' attitudes and concepts of technology.

"... students who had exposure to technology education classes had a more positive attitude toward, and displayed greater knowledge of, technology, as compared with students not having exposure to the classes" (Bame and Dugger, 1990).

Their findings also supported the belief that there is a need to strengthen efforts to achieve true gender equality in the curriculum and teaching methods as they believed that exposure to design and technology education in schools might have reinforced the image of technology as a male dominated area of the school curriculum.

Given the importance of design and technology education, it is vital that the design and technology curriculum offered to pupils motivates them to participate fully. Capability in design and technology involves a complex integration of processes, concepts, knowledge and skills.

"The possession or otherwise of individual bits of knowledge or skill is not in itself any indication of design and technology capability. There is a complex relationship between the 'content' of design and technology, the procedural demands of the activity, and the individual learning activities in which pupils become involved" (Assessment of Performance Unit (APU), 1987).

In 1990, Technology was referred to in the National Curriculum as a new subject (DES, 1990). In the first Orders it comprised two profile components, Design and Technology and Information Technology. Technology has developed from work undertaken in the past in Craft, Design and Technology (CDT), Home Economics, Art and Design, Business Education and Information Technology.

Design and technology as it is experienced in schools today requires pupils to apply skills and knowledge to develop solutions to practical problems. It is considered that pupils should be engaged in purposeful and comprehensive activities (APU, 1991).

"... it is concerned with identifying needs, generating ideas, planning, making and testing to find the best solutions" (DES, 1990).

Over the past few years, as a teacher of design and technology, an examiner at GCSE and A level, and as a lecturer/supervisor of ITT students, a lack of enthusiasm amongst a growing number of key stage 4 pupils for project based design and technology education was observed. Through analysis of a questionnaire used in a field study carried out in ten local schools it became obvious that there was clear evidence to support this concern, albeit from a very small sample. Grieve (1993) in on-going research into pupil/teacher experiences of project work at key stage 4 added support to this concern when she referred to an " *... anti-technology ethos developing in schools".*

The results of the field study stimulated this research project which is focussed upon pupil demotivation in design and technology at Key Stage 4, pupils in years 10 and 11. The intention is to identify the causes and suggest strategies which could remedy the situation.

The relevance of the use of a design process that included designing, making and evaluating as a method of delivering and examining subject content had been identified by some schools and examination boards as early as the mid 1960's. The work tended to be carried out as long term pieces of course work in the form of design and realisation projects. As the subject area of design and technology has developed so has the use of project work throughout secondary education (Down, 1986a).

The words 'project work', 'course work' and 'topic work' have been used by educationalists in a variety of educational contexts to denote an integrated approach to learning (Belham, 1966; Ferguson, 1967; the Teachers Handbook, 1972; Scott, 1983; Harland, 1988; and the National Curriculum Documentation for Art, English and Science 1989-91).

In primary education child-centred activities in the form of integrated studies, object work, centres of interest, free activity, topics, and projects have been well established modes of delivery for many years, Kent (1968) provided a clear informative guide to the whole field of child-centred activities and in particular an insight into primary 'project work'.

"It is based on the simple principle that a child will work more readily at something that interests him, and that in order to do this he will often acquire the necessary skills because he now sees a reason for possessing them" (Kent 1968).

In the case of design and technology the use of the term 'project' has meant a single piece of course work that has taken a fixed time, the number of hours of study having been stipulated by the teacher, or at GCSE level by the individual examination board (Aitchison, 1974; Medway, 1988; SEC, 1985 & 1986).

Throughout the various consultations, proposals and changes to the Orders (e.g. DFE, 1989; NCC, 1989; DFE, 1992; NCC, 1993; SCAA, 1994; DFE, 1995) there has prevailed a consensus of opinion regarding the use of long term pieces of course work. This mode of working was highlighted as a fundamental means of delivering design and technology (Department for Education (DFE), 1992).

Based upon personal professional experience and from initial fieldwork it was identified that in-depth analysis of the long term pieces of course work that are completed during years 10 and 11 may well be a tangible indicator of the causes of pupil dissatisfaction with this area of the school curriculum.

Chapter One

Literature Review

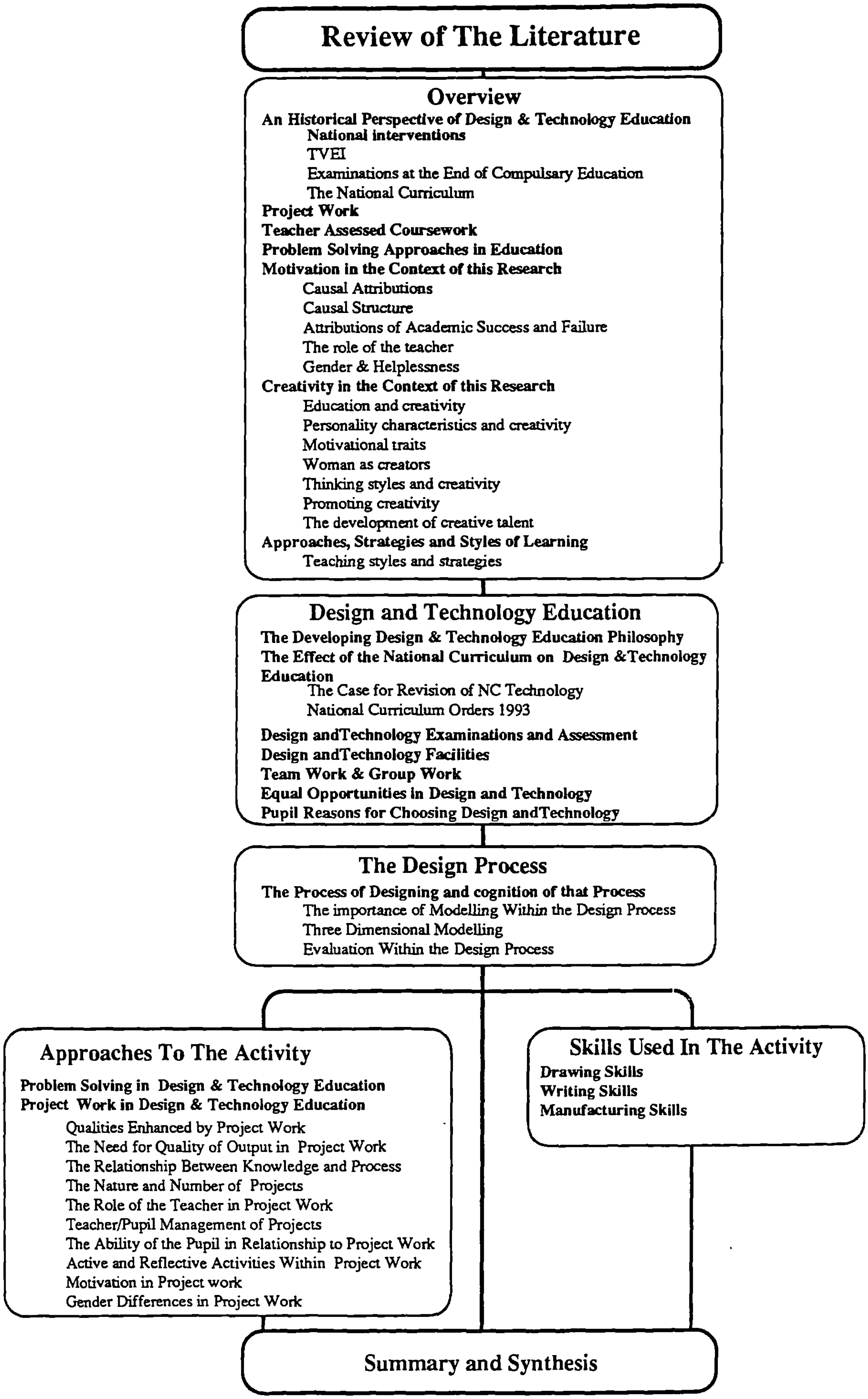


Figure 1.1 Diagram of the Review of the Literature

Literature Review

Overview

An Historical Perspective of Technology Education

'Handicraft' was a recognised subject in the national education system of the United Kingdom (UK) almost a century ago. However, it is only in the past sixty years that the curriculum area, now called design and technology has progressed from single material, craft-skill based courses for the less able to a thinking, feeling, doing activity drawing on and linking with a wide range of subject bases for all pupils of compulsory school age. In comparison to many subjects in the current school curriculum, design and technology is still in its infancy.

Unfortunately, the English language has no single word like 'literacy' or 'numeracy' that might denote the activities that go on in design and technology. Over the years, this has had unfortunate consequences for those trying to establish and build upon this important aspect of the curriculum (Archer, 1986; Archer & Roberts 1992).

The subject that started out as Handicraft, has over the years, developed and evolved to encompass a growing range of activities. Early Handicraft teachers were usually classroom teachers who utilised personal craft skills, or practicing craftsmen, who, by taking a short course, obtained a qualification to teach only that subject. The name has altered from 'Handicraft', to 'Woodwork', 'Metalwork', 'Manual Training', 'Craft', 'Technical Subjects', 'Design', 'Craft, Design and Technology', 'Design and Technology', 'Technology' and now back to 'Design and Technology'. This feature is a real indicator of the changing conception of this area of the curriculum. The status and place of the subject in the overall school curriculum has also changed as a result of these developments.

To many, the pace of development has appeared to be slow. For the first fifty years, courses in manual training were provided in certain schools for less academically able boys, while girls were allowed to study Domestic Science and Sewing, with little or no alteration as to how or what was delivered.

The changes that took place in the UK economy after the Second World War required a substantial increase in the labour force. This, in turn, led to an increase in the craft and technical training that was provided for the less academic in secondary schools, albeit essentially for male pupils.

The lack of curriculum development in school based Craft Education was recognised in 1959 by C.P. Snow, who argued that the traditional values of literary culture were dominating education at the expense of Science and Technology. He argued that the UK would decline as a world power if the balance was not redressed (Snow,1964; Weiner, 1986; McCulloch, Jenkins and Layton, 1986).

It was not until the 1970's that changes in society became so marked that they brought inescapable pressure upon those responsible for the pattern of education in the UK to develop a new philosophy with regard to the education of future generations. One of the main thrusts of those taking an interest in education at that time was towards the need for pupils to possess a greater understanding and awareness of technology, its future implications, its potential, and its exploitation. Therefore, it was not surprising that the technical subjects were among the curriculum areas to be scrutinised nationally by government.

It became increasingly understood by Her Majesty's Inspectorate (HMI), industrialists, the Design Council, educationalists and forward thinking teachers that a change in what was provided in technical subjects was essential (e.g. Aylward,1973; Arnold 1975; Design Council,1980). There was also considerable agreement amongst them that this aspect of education should be accessible to all pupils.

" We consider that design should be an essential part of the education of all children at all stages of secondary education up to the age of sixteen, and that it should be taught and examined in that light" (Design Council 1980).

It was at this time that changes to this area of the curriculum at last became apparent (Hargreaves, 1984). The name of the subject changed. Instead of being called Woodwork, Metalwork, Engineering Practice, etc., there was a merger of all the more resistant materials (wood, metal and plastics) into Craft, Design and Technology (Breckon and Prest,1983). The content of the courses changed too (Kimbell, 1986; DES,1980; Inspectorate of Schools, Craft Design and Technology,1983). No longer were pupils taught only craft skills; they were also encouraged to design whatever they made (Harahan,1978). At the same time, access to the subject at lower secondary age (ages 11-14) was improved. Pupils of all abilities were timetabled to participate in the new courses (Royal College of Art, Department of Design Research 1976; Kimbell, 1982). In many instances these courses were organised into modules that pupils took on a rotational basis. These courses were commonly referred to as 'roundabouts' or 'circuses'. As well as allowing each pupil to experience as wide a variety of materials and skills as the school could provide, these courses forced girls to have access to 'boys' subjects and boys to have access to 'girls' subjects. It was hoped that this would have the effect of encouraging more girls to study technological subjects at the option stage when pupils were allowed to choose between subjects (Kimbell, 1986).

The pity was that two different camps formed among educationalists (Baynes, 1976; Cross, Naughton, and Walker, 1986; Cross 1986). Those who saw creative designing as the necessary route forward, and those who believed in a need for what might be termed 'hard' technology based on a defined area of knowledge such as electronics, mechanics and fluidics. The two polarised factions were not ready to cope with the concept of these two important facets of the curriculum being amalgamated into one. Nor could they easily accept that what went on in Home Economics and Dressmaking areas of the curriculum might have a part to play in design and technology education. As CDT was not representing 'the whole' of design and technology in this sense, it failed to present the united front necessary to persuade academics, educationalists, or industrialists that it was essential to have this area of the curriculum as a core subject for all pupils.

During the 1970s and early part of the 1980s, this lack of clarity in the message, communicated by HMI and prominent educationalists continued to prevent CDT from securing a major role in the academic core of the school curriculum. This was further accentuated at grass roots level by the teaching staff of CDT, Technology, Art, and Design, who attempted to protect what they perceived to be their individual subject boundaries. Conflicting pictures of the rank importance of CDT, 'hard' technology, craft skills, design skills, the place of scientific knowledge (Black & Harrison, 1985; Harrison, 1990; Layton, 1990; Sage, 1992; and Sage & Steeg 1993), etc., prevented development of the subject (Cross, 1986).

"The need for technology in the schools, as part of the education of tomorrow's citizen, has now become a truism. However (like creativity, equality and love), whilst all agree that it is a 'good thing', there is little agreement as to the precise meaning of the term or how to implement it in practice" (Woolnough, 1986).

There continued to be educational opposition from senior members of staff in schools towards CDT; it was still equated with vocational training for the academically less able. Senior management teams within the schools, who were mainly made up of academics, with beliefs based upon their own school experience, still saw intellectual work as of high status and manual work as of low status. Science departments also expressed reservations concerning CDT's aspirations towards acquisition of equal status (McCulloch et al, 1986). At this time, activities in many CDT departments were rightly seen as secondary to, and dependent upon basic technology (Woolnough, 1986).

Other factors that affected this area of the curriculum were costs for necessary hardware, materials, and the staff and pupil related costs. Difficulties with assessment, low accreditation value, shortage of well trained teachers, and the fact that this area of the curriculum was offered under more labels at examination level than any other subject in the curriculum were additional aspects that caused concern. Yet it was against this backcloth that a positive change in attitude towards design and technology education started to emerge (APU, 1981).

A debate regarding education in general was beginning to come to the fore; up to this moment in time, education within schools had not been related to the outside world (DES 1980; TRIST, 1987a; TRIST, 1987b). In fact, despite attempts, it appeared that there had been a failure to recognise the necessity to do so. Many believed that the UK lived by trade and therefore they must succeed by trade. The continuing economic decline of the UK, linked closely to manufacturing industry, added strength to the educational movement, that supported curriculum development. Additional impetus came from industrialists with influence and/or the ability to inject money into the system. The Technical and Vocational Educational Initiative (TVEI), new examination systems, equal opportunities, local financial management (DES 1988), and the National Curriculum were just a few of the more recent initiatives that demonstrated that, although *ad hoc* subject based curriculum models developed by grass root teachers formed an important part of the process, large scale national intervention could cause mountains to be moved quickly.

From this evidence, whilst the changes to design and technology education have been considerable the researcher believes that the majority of recent changes have been based on sound educational philosophy. Given time, they will have a beneficial effect upon the education of our children. It has been the plethora of changes, the speed at which they have occurred and the ensuing, increased work load that have left teachers in an almost continual state of change, with little by way of continuity. Add to this the general undermining of confidence and competence caused by the moving goal posts of NC Technology/ Design and Technology and it is possible to see the background against which teachers are trying to make sense of design and technology in schools, and against which this research is set.

National Interventions

TVEI

TVEI, as one of its aims, sought to promote flexible approaches to teaching and learning that were compatible with the changing educational environment (Simmonds,1988). Their central premise was that students would learn most effectively and that their motivation to learn would be greatest when the work was grounded in personal and first-hand experience (Davis et al 1992). One effect of TVEI upon design and technology education was the injection of money from industry enabling change to take place. TVEI promoted a holistic approach to the design process carried out by pupils, encouraging business awareness and industrial links. This, in turn, brought its rewards to the schools concerned, often in the form of much needed expertise and equipment (Yeomans, 1987).

Examinations at the End of Compulsory Education

Entwistle and Ramsden (1983) in a piece of research regarding the approaches to learning adopted by Higher Education students suggested that their attitudes and orientations towards learning were powerfully shaped by experiences in school, in particular those associated with external examinations such as the General Certificate of Secondary Education (GCSE) and Advanced Level General Certificates of Education.

The recent need for accountability has lead to more and more objective methods of assessment being utilised during external examinations. In an attempt to make assessment more reliable short answers, multiple-choice questions and the introduction of constricting detailed marking schemes have been developed. Marking schemes for these new style examinations have tended to reward the regurgitation of correct pieces of information rather than to expect evidence of a pupil's integration and personal understanding (Entwistle & Ramsden, 1983). These moves in examination format are set against evidence from employers and the government that the requirements of formal education should be to develop certain general qualities of mind, foremost of which is the ability to think critically, objectively, flexibly, and quickly, and to be able to apply that thinking to a wide range of problem situations (Entwistle & Ramsden, 1983). In order that this might occur research has indicated that assessment methods need to be developed which genuinely test a pupil's ability to think critically and to understand the connection between activities in the real world and the material that has been learnt (e.g. Entwistle & Ramsden, 1983).

In the last ten years a number of changes have been made in an attempt to improve the formal examination of pupils in schools at the end of compulsory education. Until 1987, pupils were examined using two separate systems at the age of sixteen: the General Certificate of Education (GCE) and the Certificate of Secondary Education (CSE). GCE was for the top twenty percent of pupils, whilst CSE was designed to cater for the next sixty percent of pupils. In fact, CSE was usually attempted by the majority of the pupils who did not take examinations at GCE level (SCUE,SCDC,SEC and CNA,1987; DES 1985).

In 1988, these two examination systems were replaced by the GCSE, operated as a single system and open to all. It was introduced after many trials by the examination boards into new approaches that began as early as 1972 with the notion of a common examination at 16+ and feasibility studies that began the following year. Their success led to the setting up of the Waddell Committee that recommended a single system for examinations to tackle the weaknesses in the GCE/CSE two tiered system (DES 1978).

In the spring of 1979 the Secretary of State for Education, Mark Carlisle, announced the idea of a common replacement for GCE and CSE that would incorporate three new elements: subject criteria, differentiated examinations; a measure of teacher assessed work. At a speech to the Northern Education Association in January 1984, Sir Keith Joseph, one of Mark Carlisle's successors announced that a working party would be set up to develop subject criteria. In addition candidates would be awarded grades in terms of positive achievement and that the examination would essentially be criterion-referenced (Joseph, 1984). The final versions of the National and Subject Criteria were published in 1985, with the first cohort of pupils examined in their GCSE examinations in June 1988.

In addition to academic discrimination, there had been many other inadequacies in the old two-tier examination system. These included: the difficulty in changing from one system to another; the fact that two years work was assessed in one or two examination papers that gave a bias towards teaching that could be examined in timed written papers; and, as already stated, existing syllabuses called for learning facts at the expense of understanding or using information. GCSE aimed to assess positive achievement. It was felt that in the past, examinations had tended to record what pupils could not do rather than what they could do. It was also envisaged that, during the examination years, GCSE would allow schools to continue to develop the type of work done by pupils between the ages of eleven and fourteen.

The National Curriculum

One of the most important changes in education brought about by the Government's Education Reform Act of 1988 was the introduction of the National Curriculum (NC) for children aged five to sixteen in all state schools in England and Wales (National Curriculum Council (NCC), 1989; DES, 1985,1987a, 1987b). The purpose of the National Curriculum was to ensure that all children studied essential subjects, thus providing a better all-round, balanced education. It was designed to ensure that children could not opt out of subjects too early, and thereby close doors to future job opportunities and personal development.

The NC was not seen as the total curriculum for the child, but rather a fundamental framework. *"It is for each school to decide mechanisms for delivery and additional subjects they wish to provide" (NCC 1989).* However, the feasibility of such a breadth of activity for all pupils due to pupil and teacher workload was recognised by Davis et al (1992) and addressed in the latest NC requirements (1995).

Progression from the primary phase to secondary phase was to offer more continuity for pupils in terms of style, structure and content of education. It was also considered that the movement of pupils from one school to another would be much smoother.
The compulsory years at school were divided into four groupings known as 'key stages'. These were:

Key stage 1 - from age five to seven;
Key stage 2 - from age seven to eleven;
Key stage 3 - from age eleven to fourteen;
Key stage 4 - from age fourteen to sixteen.

The original NC was designed to consist of ten subjects that all pupils must study at school: English, Mathematics, Science, Technology, History, Geography, Music, Art, Physical Education, and a modern language from the ages of eleven to sixteen. For each subject there were to be objectives or goals outlining what children should know and be able to do at each stage of their schooling. These objectives were called 'Attainment Targets' (AT's). For each subject there were also descriptors and programmes of study detailing what children should be taught in order to help them achieve the attainment targets. The National Curriculum specified that at the ages of seven, eleven, fourteen and sixteen pupils were to be assessed on a ten point scale, this assessment of pupils lead to much national debate.

As explained earlier, compared with other subject areas in the school curriculum, design and technology is relatively young in terms of its historical base. The subject which began life as Handicraft has, over the years, developed and evolved into NC Design and Technology as it is today. It is at present defined as *"... providing opportunities for pupils to develop their capability, through combining their designing and making skills with knowledge and understanding in order to create high-quality products" (DATA, 1995).*

Since the Second World War the importance to the nation of developing the design and technology curriculum has been recognised by teachers, educationalists, industrialists and the government. The interested parties have come from diverse backgrounds. They have had strong beliefs and the power to influence policy makers in a variety of ways. The path has often been tortuous, and remains so (Refer to the section on the developing Design and Technology philosophy).

Such national initiatives as TVEI, GCSE, local financial management and the introduction of the National Curriculum have all influenced, and in the majority of cases, continue to influence the shape of education in our schools today. This is particularly so in the curriculum area of design and technology.

Project Work

Project work is used as a common means of delivering the school curriculum. It is child centred and problem centred rather than content-orientated (The American Centre for Vocational Education (ACVE, 1977). In America in 1900, Kilpatrick, an early exponent of the use of project work, wrote of his unease regarding the education of young people. He believed it was not sufficiently concerned with process or pupils (Tenenbaum, 1951). Concern regarding a 'traditional approach to education' has lead to many developments in the use of the project method within different age phases and subject areas in the school curriculum (Belham, 1966; Ferguson, 1967; Schools Council, 1975; Design Council, 1980; Hargreaves, 1984; Down, 1986; Interim report,1988).

The motivational advantage which underpins the use of project work has been recognised by many educationalists (Wray, 1988; Down, 1986; Stables, 1993). Wray suggested that *"Children's thirst for information is the key to the success of project work."* He went on to indicate that this type of child centred work built upon pupils interests, encouraged good behaviour and that it therefore allowed pupils to learn more easily (Wray, 1988).

Successful project work has been shown to have the potential to develop for learners essential communication skills, curiosity, independence and co-operation between pupil and teacher and pupil and peers (ACVE, 1977, Denton 1992).

Project work has been approached using sequential, concurrent and integrated strategies. Although fairly common, the sequential approach has been shown to be the least acceptable method, in that there has been a tendency for skills that have been learnt to be forgotten before they are required (ACVE, 1977). Preece (1993) also reported dissatisfaction by the general learner when required to practise skills that were unrelated to the task in hand. The sequential approach has also highlighted the fact that many pupils have difficulty in transferring skills from one context to another (AVCE, 1977; APU, 1991; McCormick et al, 1993).

The concurrent approach has been a popular method with teachers in a number of curriculum areas. It has allowed teachers to support the project work and, at the same time, teach skills systematically, in a structured way. AVCE (1977) suggested that this method demanded a good deal of forethought and planning by the teacher. They indicated that pupils with different abilities to learn new skills needed more individual work and less class teaching.

The integrated method, a pupil centred approach in which the need to learn new skills were identified by the pupil, has had its supporters but also its opponents. Many teachers have understood the sound educational reasons for adopting this method but have found the integrated, ambiguous nature of this approach very difficult to cope with (NCC 1992).

A major concern with the integrated approach has been that certain important skills or areas of knowledge have in the past been missed or insufficiently dealt with by individual pupils (AVCE, 1977). However, the DES (1989) believed that the NC, with its planned progression should assist teachers to plan their project work in a manner that would overcome this problem.

For teachers, a lack of feeling in control (Down 1986), a lack of material resources (NCC 1992), a lack of technical expertise to support the variety of work (Down 1986), and the time management of project work (APU 1991) have all been identified as aspects of project work that have caused problems. These difficulties have been particularly apparent when an integrated approach has been used (Down 1986).

Teacher Assessed Coursework

Teacher assessed coursework in the context of this research refers to coursework assignments which have been carried out by pupils during Years 10 and 11 as part of examination courses for the purpose of providing marks or grades towards a GCSE in Technology.

Educational philosophy suggests that the assessment process used to judge pupils work should not determine what is taught or learned. The assessment should be an integral part of the education process, and should provide both a feedback and a feed forward role, neither should it be a bolt-on addition (The Task Group on Assessment and Testing (TGAT),1987). In terms of examination courses, these sound educational aims can become lost in the need for pupils and teachers to achieve good end results (Torrence 1986). The result of any assessment of coursework, test, or end of course examination can serve a number of different purposes, be it formative or summative. Teachers believe that they would be failing in their duty if they do not discuss and make candidates familiar with the marking criteria at the commencement of an examination project (Schools council 1986; University of Oxford Delegacy of Local examinations, 1993). Therefore, even though it is not necessarily educational good practice, when work is for examinations there is a tendency for assessment criteria to dictate what is taught and learnt. Although Mockford & Denton (1996) in their research into student learning in Higher Education suggested that opportunities for creative thinking were reduced or lost if the primary focus of learning was targeted towards assessment (Mockford & Denton, 1996). Whilst from the student's perspective Entwistle & Ramsden (1983), also researching into learning strategies in Higher Education suggested that there was a conflict between results and learning. They explained that students tended to use strategies that would obtain them good grades at the expense of understanding the material they were expected to learn.

With regard to assessment certain skills are more suited to being tested in certain ways. Therefore, careful consideration needs to be given to the assessment process used to judge pupils' learning (SEC 1987).

Coursework is the most suitable means of assessing the following skills: experimental skills; fieldwork skills; communication skills; research skills; interactive skills; co-operative skills; motor skills ; speed of thinking skills; awareness of safety skills; explorative skills; skills that involve reflection and contemplation; skills of adaption and improvisation and the ability to put into practice simple theoretical models (SEC 1987).

At examination level it is only in recent years that coursework has become an important method of assessment. The new GCSE examinations established the use of teacher assessed coursework in all syllabuses. This was not an entirely new innovation since it had been suggested in the Beloe Report in 1960. The report advocated that there was a place for teacher assessment within the examination system and that such assessment would increase the examinations validity. Some practical subjects such as woodwork and metalwork had included coursework and teacher assessment in CSE, GCE and 16+ examinations, but it was the National Criteria for GCSE that incorporated this thinking into its statutory requirements. It stated that at least twenty percent of a candidates' marks were to come from coursework, either in the form of project work or by continuous assessment of pupils regular classroom activities (DES 1985).

For some areas of the curriculum the introduction of a coursework element into the examination was a new venture. For others the implementation of the minimum requirement would have resulted in a cut in the amount of coursework to be examined. As an example, examination boards (NEAB,SEAG, MEG) had for a number of years provided examinations in such subjects as Design, English, Mathematics and Humanities that were assessed by one hundred percent coursework.

As teachers recognised the benefits of coursework for both teaching and learning, the popularity of coursework biased examinations grew (Scott, 1990). The effect of the increase in coursework and the demise of the end of course examination in many areas of the school curriculum brought about a vigorous debate on the merits and demerits of coursework and teacher assessment. The rigour of such methods of assessment were strongly questioned by some teachers and educationalists (Down, 1986; Patten, 1992). Maintaining a position firmly in both camps, the most recent update of the GCSE criteria has stipulated that the weightings allocated to coursework should be no less than forty percent, but no more than sixty percent (SEAC 1992).

In the sphere of public examinations fairness, validity, reliability, flexibility and standardisation are all important issues (TGAT 1987).

Well designed coursework programmes have allowed a fairer assessment of pupils (Macintosh, 1987). In certain subjects although not all, coursework regulations have permitted the 'best' performance of the pupil to be recorded. This has given pupils the maximum opportunity to obtain a high mark.

An emphasis placed upon coursework has widened the scope of the examination and as a consequence increase its validity (Torrance, 1986). Coursework has provided a larger sample of work which has given teachers the opportunity to assess pupils capabilities at more frequent intervals. Increased reliability of the examination has been achieved by the assessment of the same examination objectives through both coursework and end of course examination (DES, 1985; Torrance, 1986). However, it must be pointed out that variations in conditions under which coursework assessment has taken place has lead to instances of assessment unreliability (Nuttall and Goldstein, 1984).

Coursework has allowed a greater degree of flexibility for both teachers and pupils. Internally assessed components have been shown to assess objectives that were not easily assessed externally. Teachers have been able to assess objectives differently from in the written examinations, and have assessed objectives for which there has only been ephemeral evidence. Flexibility has caused standardisation problems (TGAT, 1987). Moderation procedures have been set up in an attempt to achieve the necessary standardisation between teachers and between schools. Opponents of teacher assessed coursework would have us believe that internally assessed examination components are unlikely to meet the requirement of national comparability (Scott, 1990).

Not all pupils enjoy coursework, but the majority do (Schools Council 1986; APU, 1991). There has been a tendency for those who enjoy coursework to achieve higher grades than if they had tackled end of course examinations (SEC, 1987). The use of coursework assessment has, to some extent, guarded against false negative or false positive errors which have occurred during end of course examinations (Wood and Power, 1987). False negative errors occur when pupils, due to anxiety, examination nerves or for other valid reasons do not perform to their expected level of capability. False positive errors occur when pupils obtain unexpectedly high marks in a particular task and exceed their expected capability level.

Some very recent research has suggested that there is a gender difference between the results obtained by girls in comparison to those achieved by boys. This has been found to be the case across the majority of subjects although the literature also reported that this trend did not continue at A level where boys have been found to out perform girls (TES, 1996). The suggestion was made that the cause for these gender differences in performance was a combination of the type of assessment utilised in the two different examinations systems and the differing approaches adopted by boys and girls to their school work and examinations.

The majority of writers have suggested that teacher assessed coursework has the potential to increase motivation in all pupils (Down, 1986; Stables 1993). However, Kingdon and Stobart (1988) highlighted the fact that the demands of coursework could cause pupils with minor absences or apathy to fall sufficiently behind in their work so as to make dropping out seem the obvious strategy.

With regard to the less able, it has been suggested that coping with the flexibility of coursework has caused difficulties (Schools Council 1986). At the same time supporters of the motivational influence of coursework upon less able pupils believe that with close specification of target objectives and short term goals, projects may lead to increased effort (Scott, 1990).

Several other points regarding teacher assessed coursework have given rise to concern; coursework has, depending upon the pupil, increased or decreased pupil stress (North, 1987; SEC, 1987); coursework loading upon individual pupils can put an unnecessary burden on conscientious students (Kingdon and Stobart, 1988); and excessive use of coursework has been portrayed as the reason for the significant increase in the drop out rate of pupils entered for examinations (Professional Association of Teachers,1988; Kingdon and Stobart,1988).

Instances of parental assistance, 'unfair' resourcing (Kingdon and Stobart, 1988) and teacher bias (Massey and Newbould,1986) have all caused teacher assessment to be termed unreliable, as it has advantaged certain pupils. Murphy (1987) also suggested that accountability in schools had put additional pressures upon teachers causing them to grade pupils coursework more highly than the pupils deserved.

The thinking behind teacher assessed coursework, with a move away from end of course examinations, was that it would be fairer to the pupil. It would benefit those who did not perform well in examinations. Stimulating a sense of discovery and helping pupils make connections with other areas of study and life outside school (SEC, 1987). The notion was that it would be more rewarding for both teacher and pupil than examinations had ever been. This has on the whole been the case, but the shift has been significant and has raised a number of issues which still need to be resolved (Rafferty, 1993).

Problem Solving Approaches in Education

Problem solving processes have long been seen as important teaching and learning strategies across the majority of curriculum areas within education. Activities incorporating problem solving have been known to stimulate and develop skills of thinking and reasoning (Fisher, 1990). The evidence suggested that they utilised and made relevant the pupil's knowledge of facts and relationships. Achieving worthwhile results have been shown to develop a pupil's confidence and capability. Whilst research suggested that such activities also provided opportunities for pupils to share ideas and learn to work effectively with others.

Problem solving has been explained as applied thinking. It has been contrasted with two other kinds of thinking, creative (divergent) thinking and critical (analytical) thinking. These three kinds of thinking have been shown to be closely inter-related. *"Creative and critical thinking are essentially forms of investigative thinking, which may entail forms of enquiry for their own sake or be applied for a purpose in problem solving" (Fisher, 1990).*

In his book 'Teaching Children to think', Fisher (1990) explained that there were three sets of interacting factors involved in problem solving; a pupil's attitude, cognitive ability and experience. He also suggested that in order to make the best use of problem solving activities pupil's needed security in the form of structure, order and support and that these, he believed, were closely related to a teacher's own attitude.

Traditional approaches to education were seen in America in the early part of this century as not having sufficient regard for process or pupils. This concern lead to the development of child centred, problem centred education. For the same reasons this approach to education was adopted by many forward thinking educationalists in this country where the terms project work, coursework, problem solving and topic work, have all been used by different educationalists in a variety of educational context to describe work which would fall into this category.

The researcher believes that project work has the potential to develop within the pupil independence, co-operation, and curiosity. Written, drawn and verbal skills can be taught within a suitable context which is recognised as a more meaningful route to skill acquisition. Even more importantly there is a motivational advantage when work can be built around pupils interests.

Course work assessment has many advantages for the pupil. It has widened the scope of what can effectively be assessed; it is more flexible.Therefore, it is fairer for the individual candidate as a means of examination.

A popular expectation is that pupils enjoy designing and making things that are worth while. They particularly enjoy making products that work, that they can be proud of and which they can take home. Pupils become very involved in their project work and produce more than is expected of them. There is a tendency for conscientious pupils to overload themselves, causing pupils stress and putting strain upon their other subjects. In the past, when design and technology was one of the few subject areas to use project work as part of their courses, pupils enjoyed the different approach and any overloading did not appear such a problem. Now that almost every area of the curriculum is setting projects, the cry, 'not another project!' can be heard time and again. Time management has become a crucial skill for all GCSE pupils if examination success is to be achieved.

The new GCSE examinations established the use of teacher assessment of coursework in all subject areas of the curriculum. Course work is tackled in a variety of ways, but for examination purposes, long term pieces of coursework are the main vehicle for assessment.

Teachers therefore need to be more aware of the work load on their pupils across the complete portfolio of subjects that they are studying. Many teachers, understandably, find it hard to advise pupils not to do any more to a project; the pupil is obviously enjoying doing the work and is achieving good results which will reflect in the pupils examination outcome and in the accountability of the curriculum area in the school. In fact it is quite difficult to persuade well motivated pupils that enough is enough.

Concerns have been voiced amongst teachers regarding a lack of progression, and the potential for pupils involved in project work to miss learning essential skills. By planning progression within the National Curriculum structure and by the careful targeting of projects to cover required skills and knowledge, teachers should be able to address these perceived problems.

For certain teachers, a lack of feeling in control, a lack of material resources, an inability to cope with the time management of projects, and a lack of technical expertise to support the variety of work are seen as valid reasons for avoiding project work.

Many teachers do not show an understanding of the need for a carefully designed framework to support successful project work. Too often, pupils are given complete freedom to choose their projects and are then left to fend for themselves with only the prescribed assessment criteria to act as hoops to jump through. In many instances this leads to unsatisfactory results and dissatisfied pupils, staff and parents who receive the end product.

In design and technology, project work is not a new method of delivering the curriculum. This curriculum area has developed an understanding of the use of project work and its assessment since the mid 1960's when designing and making were first brought together as a single activity. In the early days assessment was very subjective, and unreliable. As a founder member of the Craft and Design Project in Leicester University, the author of this thesis spent a year researching, with Professor Eggleston, the need for the objective assessment of design work. It had been hoped, by the team, that they would be able to say that the subjective methods that they used were sound. These methods seemed to have worked satisfactorily for them, a small band of like-minded design teachers. They disliked the constraints that an objective system would impose upon them. They believed that it was foreign to their way of working. The conclusion they reached however, after much discussion, research and trialling of materials, was that there was a need for an objective marking system. They established that accurate marking could be achieved subjectively only so long as all teachers involved had the same understanding of designing. They came to the conclusion that one could never hope to achieve that level of compatibility given the varied background of teachers involved in delivering the new design courses.

The researcher continues to believe that the lack of a common understanding regarding the theoretical underpining of the activity of designing, is a thread which links many of the problems which still beset this area of the curriculum. This theory will be dealt with in more depth in the later section describing approaches to designing.

As the use of coursework to examine pupils' capability has become more popular across the curriculum, the national debate regarding its merits and demerits has become fervent. What one educationalist sees as a benefit, for instance, its flexibility, has been seen by its opponents as a reason to attack its national comparability. After much debate, amendments have been made to the National Criteria for all subjects. A limit of fifty percent coursework assessment has been imposed. For some subjects this is a marked increase. For other syllabuses it has meant a fifty percent decrease.

The use of project work as a means of delivering and assessing the activity of designing and making is a pivotal feature of the research. It is therefore revisited in more detail in the later section of this literature review 'Approaches to the Activity'.

Motivation in the Context of this Research

The concept of motivation is a key aspect of this research project. Weiner (1992) in 'Human Motivation : Metaphors, Theories and Research' suggested that both ability and effort were needed to attain success in a difficult task and that if success was anticipated then actual success had a tendency to follow.

Most motivational psychologists have accepted the belief that behaviour is controlled by the pleasure-pain principle in which people maximise the pleasure linked to success and minimize the pain generated by failure (Weiner, 1992).

Attitudes have an important bearing upon motivation. Weiner described the concept of *"ego enhancing"* and *"ego-defensive"* attitudes. Ego-enhancing, he explained, related to individuals who took credit for success rather than ascribed success externally. An ego-defensive attitude could be ascribed to people who apportioned the blame externally rather than on themselves.

In achievement-related contexts Weiner suggested that people attributed their wins to skill and effort, their losses to bad luck. He gave as an example the school environment where teachers ascribed improved performance of pupils to good teaching and poor performance to pupils' low ability and/or effort.

Causal Attribution

Weiner (1992) proposed the theory that attributions were conscious devices that were used by individuals to appear favourably in the eyes of others. He suggested that given a task, if the majority succeeded or the majority failed then the outcome would be attributed to the difficulty or simplicity of the task itself. If, on the other hand one person succeeded when others failed, or failed when others succeeded, then the outcome would be attributed to the person.

Weiner explained that in 'achievement domains' such as the school context, there were fairly well agreed-upon sets of causes of success and failure: ability, immediate and long term effort, task characteristics, intrinsic motivation, teacher competence, mood and luck. He stressed, however, that many other factors could influence these causes.

Causal Structure

Weiner (1992) expanded upon Rotter's work (1966) in which he put forward the theory that causes were on an a internal-external continuum that he referred to as a dimension of locus. Weiner suggested that the result of an action was felt to depend upon two sets of conditions, namely factors within the person (e.g. ability, effort, strength) and factors within the environment (e.g. ease of task, good teacher).

Rotter and Weiner agreed that a second dimension of causality was required, that of stability (see Figure 1.2). He explained that internal causes of behaviour could fluctuate whilst others remained relatively constant. Ability or aptitude were perceived as invariable, whereas causal factors such as effort and mood were perceived as more variable.

	INTENTIONAL		UNINTENTIONAL	
	Stable	**Unstable**	**Stable**	**Unstable**
Internal	stable effort of self	unstable effort of self	ability of self	fatigue, mood, & fluctuations in skill of self
External	stable effort of others	unstable effort of others	ability of others, task difficulty	fatigue, mood, & fluctuations in skill of others, luck

Figure 1.2 Illustrates the three dimensional taxonomy of perceived causes of success and failure (from Weiner, 1974, p.6 & Rosenbaum, 1972, p. 21).

Weiner (1992) established that a new third dimension of causality was also necessary (see Figure 1.3). He called this controllability. He defined external causes as being uncontrollable, but pointed out that not all uncontrollable causes were external. As an example he referred to aptitude as an internal cause that was uncontrollable, whilst laziness was an internal cause that was controllable. He went on to indicate that one could fail because of internal causes such as low aptitude or lack of effort, or because of external causes such as a biased teacher or friends who failed to help.

	Stable	**Unstable**
Uncontrollable	Aptitude	Fatigue
Controllable	Long term effort Laziness Industriousness	Temporary exertion

Figure 1.3 Illustrates the internal causes of success and failure classified according to stability and controllability (from Weiner, 1992, p. 251 & 1986, p. 49.)

Attributions of Academic Success and Failure

Dweck and Leggett (1988) investigated how pupils acquired beliefs and attitudes related to their own work and talent. Their research demonstrated that pupils showed either *"helpless"* or *"mastery"* patterns of behaviour when confronted with difficulties in learning. They suggested that pupils who avoided challenge and showed an inability to face obstacles were initially equal in ability to those who sought challenge and showed persistence. Dweck and Leggett suggested that the style of helpless or mastery behaviour was not related to intelligence. They believed that it was not only those with weak skills or histories of failure who avoided difficult tasks or were unsuccessful in what they tackled. They explained that some of the brightest, most skilled individuals exhibited the helpless pattern.

They expanded on the theory that helpless pupils avoided challenge and gave up easily, whereas mastery-orientated pupils persisted in the face of obstacles and sought new, challenging experiences. Helpless pupils reported negative feelings regarding themselves when they met obstacles whereas mastery pupils had positive views of their competence, even when confronted by obstacles. This, they suggested, made them task-orientated and resilient in the face of difficulties because they were confident and positive.

Dweck and Leggett expanded upon their belief that helplessness was further related to differences in pupil's goals. Helpless pupils pursued goals of obtaining rewards from adults, whereas mastery-orientated pupils pursued goals of learning and discovery on their own. Mastery-orientated pupils would rather learn something new than perform an old skill well. Because they were orientated towards learning and skill acquisition, mastery pupils did not feel failures when things went wrong and were happy to concentrate on the task in hand. Helpless pupils, by way of contrast, attributed their failure to their own inadequacies and instead of concentrating their resources on achieving success they would attempt to bolster their image in irrelevant ways. Helpless pupil's failure produced externalised negative moods. Mastery pupils were less concerned about adult approval and so feared failure less. Helpless pupils avoided effort because they believed extra effort would get them nowhere, they saw success and failure as inherent in themselves and viewed challenging problems as a threat to their self-esteem.

Elliot and Dweck (1988) suggested that in challenging achievement situations, helpless pupils pursued the *"performance goal"* of proving their ability, whereas mastery-orientated pupils pursued the *"learning goal"* of improving their ability (see Figure 1.4). Individuals who adopted different goals were seen to approach a situation with different concerns, asking different questions, and seeking different information.

Elliot and Dweck went on to indicate that when children were orientated towards skill acquisition, their assessment of their present position was largely irrelevant. They all tended to show a masterly-orientated pattern. When the pupils were orientated towards evaluative tasks the achievement pattern they adopted was dependent on their perceived ability. Pupils who believed in their ability selected challenging performance tasks that allowed them to obtain judgments of competence, whereas children who did not believe in their own capabilities selected easier tasks that allowed them to avoid judgements of incompetence.

	HELPLESS ORIENTATIONS maladaptive		MASTERY ORIENTATIONS more adaptive
	IMPLICIT BELIEFS REGARDING ABILITY		
	wish to gain favourable judgement regarding competancy		concerned with increasing their competancy
	PERFORMANCE GOAL ORIENTATED		LEARNING GOAL ORIENTATED
Intellectual beliefs	those who avoid challenge	those who seek challenge	seek challenge
Entity theory - Intelligence is fixed	50 %	31.8%	18.2%
Incremental theory - Intelligence is controllable malleable, and increasable	9.8%	29.3%	60.9%

Figure 1.4 Illustrates patterns of cognition, affect and behaviour classified by intellectual beliefs

Results from research completed by Leggett and Dweck (1988) indicated that those with performance goals used effort as an index of high or low ability. They viewed effort and ability as inversely related. High effort that resulted in success or failure implied low ability, and low effort that resulted in success implied high ability. In contrast, those with learning goals were more likely to view effort as a means of activating their ability for mastery. In this instance effort and ability were seen as positively related and a source of pride.

"... performance goals created a context in which outcomes (such as failures) and input (such as high effort) are interpreted in terms of their implications for ability and its adequacy. In contrast, learning goals create a context in which the same outcomes and input provide information about the effectiveness of one's learning and mastery strategies" (Leggett and Dweck, 1986).

In two studies Dienar and Dweck (1978, 1980) suggested that the emotions of anxiety, depression, boredom or defiance were apparent among helpless subjects as failures accumulated. For a learning goal subject the occurrence of failure simply signalled that the task would require more effort and cause the pupil to be determined to succeed.

Bandura and Dweck (1985) reported that pupils with learning goals would feel bored or disappointed with a low-effort success, whilst pupils with performance goals felt proud or relieved about a low-effort success.

"... events that produce negative or depressed affect within one goal may produce positive affect and heightened engagement within the other" (Dweck and Leggett, 1988).

Dweck and Leggett (1988) suggested that within a performance goal a suitable task was one that *"maximized positive judgements and pride in ability, while minimizing negative* *judgements, anxiety and shame."* Performance-orientated pupils with low confidence in their abilities experienced dislike of the task, high anxiety, expected negative judgements and loss of esteem. They would tend to seek easy tasks that would avoid negative feelings and outcomes. Performance-orientated pupils with high confidence would also avoid challenges because of the possibility of failure. They suggested that these pupils would sacrifice learning opportunities to avoid risk of mistakes and difficulties.

Dweck and Leggett indicated that the ideal task for learning goal pupils would be one that maximized the growth of ability and the pride and pleasure of mastery.

Bandura and Dweck (1985) provided evidence that suggested that learning-orientated pupils with low confidence were the most likely of any group to seek a challenging learning opportunity. These pupils would not withdraw from a task that proved to be unexpectedly difficult, but they would withdraw from a task that became useless or boring even if it promised favourable ability judgements.

Dweck and Leggett referred to *"implicit theories of intelligence"* . They suggested that there were pupils who viewed intelligence as fixed and there were those who viewed it as incremental. Incremental intelligence, they explained, was *"a malleable, increasable, controllable quality"* and that this form of intelligence was normally found in pupils who pursued learning goals. Fixed intelligence was normally associated with pupils who pursued performance goals in a fixed world where intelligence stayed static, despite effort.

The Role of the Teacher

Fisher (1990) when referring to the part teachers play in pupil motivation suggested that pupil motivation could be achieved in three ways: the pupil's natural interest (intrinsic satisfaction); the teacher's motivation (extrinsic rewards); success in the task (combining satisfaction and reward). He also gave support to Amabile's (1983) belief that intrinsic motivation was more easily undermined than created.

The importance of teacher expectations, have been confirmed by extensive research (Brophy & Good, 1974; Purkey, 1978; Fisher, 1990) as a strong influence upon pupil motivation. Building pupil self esteem; communicating with each pupil individually; listening with care; being genuine; being positive; being clear; and being a learner were all suggested by Fisher(1990) as motivational factors for pupils that could be affected by teachers.

Gender and Helplessness

An area of research which has generated much interest has been identified by the label of *"learned helplessness" (Seligman, 1975).* This topic of study brought together both the notion of perceived responsibility (locus of control) and causal stability (Weiner, 1992).

The theory suggested that *"an objective non-contingency between responding and outcome produced an expectation that outcomes were uncontrollable, which was sufficient to generate, cognative, emotional, and motivational consequences, or a syndrome resembling depression" (Weiner, 1992).*

Licht and Dweck (1983) revealed that girls acquire helpless orientation during their schooling. Boys, they suggested, were more likely to attribute failure to the tasks set, to poor effort or on adults 'picking on them', whilst girls attribute their failure to their own low ability.

Licht and Dweck(1983) suggested that when challenged regarding their work boys tended to choose a difficult task to attempt next. Girls when challenged chose easy tasks because they became depressed rather than frustrated with their own performance. Girls consistently underestimated their own ability (Sylva, 1992). These gender issues and others pertinent to motivation in relation to this research project have been summarised in Figure 1.5.

Girls	Boys
* acquire helpless orientation during schooling	
* attribute failure to low ability	* attribute failure to low effort or teacher picking on them
* underestimate their ability	
* choose easy tasks as become depressed rather than frustrated about their performance	* when challenged by adult evaluator counter by choosing difficult task to perform next
* feedback girls receive irrelevant characteristics of their work	* feedback in the form of performance evaluation

Figure 1.5 Illustrates motivational attributions classified by gender

In dealing with the concept of motivation in relation to this research project it has been particularly interesting to read the work of Weiner, Dweck and Sylva. The pupils whom the researcher has taught and those subjects studied in the field programme demonstrated these motivational characteristics.

Weiner (1992), and Roberts' (1992) suggestion that motivation was not a pre-requisite for achieving success in a learning situation can be supported from observational evidence gained through professional experience. It has also been made clear that demotivation can cause the most capable of pupils to fail and that one must not assume that if achievement is enhanced that motivation would also be enhanced for all pupils (Nicholls, 1989).

We all enjoy succeeding. Human behaviour is controlled by the pleasure/ pain principle where people seek to maximise the pleasure linked to success and minimise the pain generated by failure. Attitudes towards success and failure have an important bearing on motivation and therefore on this research project. This body of knowledge must be borne in mind when completing the next stages of this research project.

During professional contact with schools over a ten year period the researcher observed the lack of motivation in a growing number of pupils. Research has shown that teachers see motivation as their single biggest problem (Biggs & Moore, 1993). This was particularly evident at a time in the pupil's school career when they had chosen to study design and technology at GCSE level. It was therefore with great interest that the literature search identified the work of Weiner, Dweck and Sylva, all of which had a significant bearing on the thesis.

The researcher had noted from her teaching experiences that both intelligent and less able pupils could become de-motivated. Although it was well understand that motivation was not a pre-requisite for achieving success, success was seen to bring about motivation, which could then lead to more success.

The researcher's observation of pupils suggested that attitudes were caused by both internal and external dimensions. This was supported by Weiner, who explained that internal causes could either fluctuate, for example in the case of effort, or, as in the case of aptitude, be stable. In a similar manner these internal causes could either be controlled by the person, or be uncontrollable.

In an achievement context, such as in school, pupils show either helpless or mastery patterns of behaviour when confronted by difficult tasks (see Figure 1.6). These patterns of behaviour are not necessarily related to levels of intelligence. Helplessness it has been suggested can be learnt by pupils during their education. Learned Helplessness (Seligman, 1975) does not only effect the less intelligent, but there is a greater tendency for girls to acquire helpless orientation when they are faced with the possibilities of failure. Boys tend to attribute their failure to external causes.

The effect of attitude on motivation is significant. To identify which attitude has caused demotivation and then determine whether it is internal or external, stable or fluctuating and whether it can be controlled or is uncontrollable will be a difficult task. The complex relationship between all these and external forces such as culture, context, parental and teacher expectations all have a powerful bearing upon the situation.

'Helpless' Orientation	'Mastery' Orientation
* focus on their ability & its adequacy (or inadequacy)	* focus on mastery through strategy and effort
	* pursue learning goals
* pursue performance goals	* persist in face of obstacles
* avoid challenge	* seek new challenges
* give up easily	* confident/positive views of their competence even when confronted with obstacles
* neg. feelings & views of themselves when confronting obstacles- threat to their self esteem	* task-oriented & resilient
	* pursue goals of learning & discovery on their own
* pursue goals to get rewards from adults	* rather learn something new than perform an old skill well
* erratic in strategy when difficulties appear	
* engage in self-recrimination	* do not feel failures when things go wrong
* failure brings on neg. moods	* care less for adult approval so fear failure less
* avoid effort because think it will get them nowhere	* view intelligence as incremental
* see success/failure as inherent in themselves	
* view intelligence as fixed	
* express pronounced negative affect	
* aversion to task	
* boredom with problems	
* anxiety over performance	
* 2/3rds engage in task-irrelevant verbalizations (bolstering image)	
* attempt to alter rules of task	
* speak of talents in other areas	
* boast of unusual wealth & possessions	
* 60% lapse into ineffective strategies - with characteristics of pre-schoolers.	

Figure 1.6 Illustrates motivational attributes classified by helpless/mastery orientation

Creativity in the Context of this Research

In recent years the critically important yet elusive topic of creativity has earned the serious attention of a great many psychologists, educators, and individuals in business and industry. For centuries it was believed that only exceedingly rare people were genuinely creative. Creativity was ascribed to divine origin (Plato circa 300 BC; Guilford, 1964; McAlpine, 1988; Ochse, 1990). Creators have, throughout history, tended to perpetuate that image as they have enjoyed the mystical view of creative inspiration which surrounded them. In early studies of the gifted creativity did not feature, as intelligence tended to be narrowly defined and measured in most cases by the Stanford Binet I.Q. test as its sole criterion. However, creativity is now firmly established as one of the significant categories associated with giftedness and talent, an association which is particularly pertinent to this research study.

Although psychological definitions of creativity have varied (Torrence, 1988; Walberg, 1988; Sternberg, 1988; Ochse, 1990), there has, on the whole, been common agreement on what creativity involves; *"bringing something into being that is original (new, unusual, novel, unexpected) and also valuable (useful, good, adaptive, appropriate)" (Ochse, 1990).*

Ochse (1990) suggested that the 'something' could, in psychological literature be anything from *" a toddler's finger painting to Einstein's theory of relativity"*. 'Original' could refer to *"something that is merely new to the person concerned ...but it may also refer to* *something which is new to the world"* whilst 'Valuable' could be *"... answers that gain high marks on creativity tests or an invention that changes the quality of human life"*.

The types of people and behaviours commonly described as creative have tended to be classified into two categories. Those seen as personally creative and those seen as culturally creative. The first category, those who displayed personal creativity have been further divided into: those thought of as creative because they performed well in creative tests; and those designated as creative because of their life style. The later being considered original, because they did not copy the behaviour of others and valuable because they were adaptive and responded spontaneously to the various demands of daily life. The second category, those who were classified as cultural creativity, were seen to achieve major new discoveries or inventions which produced something of lasting value for mankind (Gowan et al,1981; McAlpine, 1988; Ochse, 1990).

Creativity has been considered by many to be a resolution of conflict. Wallace (1986) reminded us that Jung saw creativity as *"the balance between conscious and the subconscious, the rational and the irrational, extroversion and introversion, divergent and convergent"*. Whilst others, McAlpine (1988) Parke (1985); Gowan et al (1981) have suggested that it was both a resolution of conflict and a fusion of thinking, feeling, sensing and intuition.

A number of investigators have defined the multifaceted phenomena of creativity by contrasting it with conformity. Torrence (1988), supported Starkweather's belief that a creative person was neither conforming nor non-conforming, but was free to conform or not, depending on what they perceived was true, pleasing, good or beautiful.

As evidenced by various researchers of creativity, creative thinking has been categorised as a sub-set of thinking as a whole. Much has been written to suggest that thinking cannot be divorced from knowledge (Langley & Jones, 1988; McAlpine, 1988; Ochse, 1990). To be of value creative thinking must integrate the fundamental aspects associated with thinking: recalling and imaging; classifying and generalising; comparing and evaluating; analysing and synthesizing; deducing and inferring (Kamii, 1980).

Originality and intuition have been shown to have a great deal to do with creative thinking. Torrence and Rockenstein (in McAlpine, 1988) suggested that to encourage originality one needed to: give adequate time for the production of alternatives; provide opportunities to play with ambiguities and uncertainties; increase the difficulty of problems; and make original thinking legitimate and offer rewards for it. Whilst de Bono (1980) suggested that to improve any of the thinking skills required practice using the right tools in the right environment.

Walberg (1988) referred to the natural continuity and linkage between talent, creativity and expertise. He believed that creativity depended upon talent - inherent or acquired. He suggested that creative talent was *"a rich and complex association of cognitive elements perhaps involving effective and psychomotor connections"*. He referred to achievement as the acquisition of elements from the environment and their recall to conscious memory. He explained that creativity (including problem finding and solving) was the trial-and-error search for novel and useful solutions by combinations of stored and externally found elements. He suggested that practice could develop talent, and that persistence could overcome initial deficits, handicaps and inabilities.

As Gowan et al (1981) stated learning was seen by many researchers as a necessity to the development of creativity. This he believed should not be taken to mean *"learning to be creative"*, or *"learning to think creatively"*. He explained that it referred to acquiring knowledge and skill within the area of the creator's speciality. Skill and creativity should not be seen as synonymous. Skill though not sufficient in itself to provide creativity, has been shown to be an important vehicle for its development. Kamii (1980) and Ochse (1990) proposed that productive creativity could not be divorced from skill. Torrence (1964) suggested that it was essential. He also stated that creative children suffered when the acquisition of knowledge and skills were confused with conformity for conformity's sake.

The various approaches that have been adopted when creativity has been researched have not just been different ways of looking at creativity, they have been based on different conceptualization's of the term creativity. Whilst not all have agreed upon what has been meant by creativity, in most cases one of the aims of each of the studies carried out, has been to develop methods of enhancing it. Ochse (1990) suggested that many creativity training programmes had several sub-goals. They aimed to develop a healthy creative personality; increase the tendency to engage in creative thinking; improve the ability to solve problems; encourage the imagination to run free; set out to make creative classroom activities intrinsically satisfying. However, what was interesting to note on analysis of various programmes was that they did not set out to enhance skills, knowledge or the ability to solve problems in any one particular area. Ochse (1990) suggested that this was because it was assumed by many researchers that problem-solving skills could be transferred from one domain to another. Although there has been those who would support this theory there have also been researchers who have been highly sceptical of the transference of improved performance in tests into real life situations (Treffinger,1986; McAlpine, 1988; Ochse, 1990).

An alternative interpretation of creativity has been in terms of problem solving capability. Early followers of this 'intellectual approach' formulated their thoughts by using information gained from eminent creators who had examined and analysed their own thinking. The various stages of the creative process were identified from analysis of the problem solving methods used by these exceptional people.

Various dimensions have been referred to by a number of writers on the subject of creativity. McAlpine (1988) referred to originality as one of the significant dimensions and fluency as perhaps the most significant of the divergent thinking cluster. Torrence and Rockenstein (1986) indicated that whilst high scores on fluency did not guarantee flexibility and originality, research indicated a positive correlation between them. Similarly Nickerson et al (1986) saw fluency as an 'enabling' ability for creative thinking, not a guaranteeing one. Taylor (1984) on the other hand stressed the importance not only of fluency of ideas but also the quality of those ideas. Flexibility of thinking, McAlpine (1988) suggested, represented the degree to which ideas could change direction as they developed. Shouksmith (1970) claimed that creative thinking required flexibility in switching from one cognitive style to another during problem solving. Whilst McAlpine (1988) also referred to the ability to re-classify and restructure as being important abilities associated with creative thinking. He also explained that levels of ability appeared to be related to an *"exploratory drive to curiosity and a playful attitude to knowledge"*.

Other researchers concerned with the intellectual approach to creativity interpreted creative problem solving in terms of specific mental processes rather than intellectual factors. They particularly focussed on the process of association (e.g. Thorndike 1924). This approach was called synectics which McAlpine (1988) explained employed analogy and metaphor and encouraged the problem solver to make the *"strange familiar and the familiar strange through a conscious effort to look at the world in a new light"*.

Over the ages philosophers have identified that learning and thinking involved forming new associations between items of existing knowledge. Twentieth century psychologists have described creative thinking as a matter of forming remote associations between concepts that have until that point in time not been connected (Ochse 1990). McAlpine (1988) suggested that the ability to break the norm and produce something novel was central to creative thinking.

In educational terms although there is a common belief in the need to develop creativity in all pupils there are those who believe that to advocate the promotion of creativity by producing people who possess the capacity to create but who never actually create anything of cultural value is not a sufficiently adequate educational goal (Winchester, 1985; Bailin 1985; and Ochse 1990).

Gifted children have been shown to need an extensive support system, including devoted parents and committed teachers in order to master the skills required for creativity to blossom. The importance of this fact has been well documented by such writers as Bloom & Sosniak, (1981) Csikszentmihalyi, (1988) and Ochse (1990). Research has also shown that a disproportionate number of creative achievers have been first-born children and/or were in a favourable position to receive special attention from an early age. One can also read much to support the theory that potential creators from such home backgrounds have had a strong personal commitment to succeed. It was also evident that despite family tensions, creators have generally been well supported by their families in their attempt to achieve their goals.
"... childhood homes ... were typically rich in opportunity and encouragement to achieve intellectually, but poor in emotional comforts" (Ochse 1990).

Education and Creativity

"Current learning and behaviour are strongly determined by the past; a good start enhances later opportunities and environments ... early advantages confer future advantages" (Walberg, 1988).

On the one hand historical studies have revealed that attendance at some form of academic institution was not essential for the young would-be creator, for although a few have excelled at school not all have been good pupils or academically successful. Einstein went so far as to condemn educational methods with the words *"It is, in fact, nothing short of a miracle that the modern methods of instruction have not yet entirely strangled the holy curiosity of inquiry; for this delicate little plant, aside from stimulation, stands mostly in need of freedom; without this it goes to wreck and ruin without fail" (Simonton, 1988).*

On the other hand as Einstein also hinted the importance of stimulation must not be overlooked. Early encouragement, specific goals, clear attainments, continuous effort and appropriately set high standards have always been seen, by the majority of researchers of creativity, to be aspects necessary to promote creativity and that these can be pursued to advantage in a supportive school environment.

From the research carried out it has been made evident that creators have engaged in a considerable amount of self-instruction rather than relying solely upon a normal school curriculum. Most young creators have shown that they inherently understood what they needed to do, and had developed the necessary skills and knowledge base using whatever means seemed to them most appropriate.

At a school level creators have appreciated teachers who have: continued the positive attitudes towards work which were initially established at an early age in their homes; allowed them to follow their particular interests; fed them with rich experiences (Marjoram, 1982; McAlpine, 1988); let them work on their own; encouraged risk taking in search of creativity (Torrence, 1981); provided them with a responsive environment rather than just a stimulating one; provided good examples to emulate (Zuckerman 1977), and encouraged them to pursue careers which would make best use of their interests and abilities (Ochse, 1990).

In order to encourage creativity Torrence (1981) suggested that it was important for teachers to build a responsive environment in which there was an atmosphere of receptive listening. Also one in which: over-teaching and over-guidance were avoided, disparaging or destructive criticism was not used, in-depth study was provided, pupils sensory awareness was addressed and the zest for learning and thinking were kept alive. Interestingly Torrence (1981) claimed that teacher creativity was not a significant factor in influencing pupil creativity. The researcher would however, suggest that teacher enthusiasm was a key factor in encouraging the road to creativity.

Torrence (1981) explained that in schools creative pupils were seen as different and that that was one of the fundamental reasons why they ended up being ridiculed. He pointed out that parents even though proud of their creative children did not wish them to be seen as different. Even teachers, he suggested, strove to make their pupils conform to behavioural norms and become socially adjusted and thereby be accepted, particularly by their peers.

The drop in creative ability noted in children between the ages of five and thirteen has been well documented by Torrence (1962) and others, although reasons given have usually been associated purely with developmental phenomena. More recently Gowan (1981) put forward the theory that the drop in creativity was due also to *"the extinction of right hemisphere imagery"*. He suggested this was caused by the over-teaching of left hemisphere functions such as reading, writing and arithmetic, at the same time as a lack of stimulus of right hemisphere functions. Torrence in 1962 had indicated that pupils needlessly abandoned creativity at about ten years old and that many of them did not revisit that aspect of their education during the rest of their schooling. Gowan in 1981 was more specific when he indicated that the drop in creative activity usually coincided with option choices when pupils chose to move away from such subjects as music and art. Torrence (1964) in his research indicated that many school drop outs, delinquency and mental illness he had uncovered, had abandoned creativity, although he suggested that much more research was needed to support his hypothesis.

Torrence's (1964) firm belief that teaching could make a difference to a pupil's creativity led him to suggest that correct methods, materials, attitudes and relationships with pupils, could all contribute to a pupil's creative development. He also proposed that destructive behaviour could be transformed into positive creative energy and generally constructive behaviour as a consequence of teaching creativity satisfactorily.

Gowan (1981), referred to over-achieving and under-achieving in school and suggested that some of the so-called over-achievers in schools may belong to the creative category, whilst some highly creative youngsters may well be amongst the under-achievers. He suggested that the later could be caused by a lack of recognition of creativity and encouragement at the right time.

Personality Characteristics and Creativity

It has for some time been recognised that creative achievement is closely related to certain personality characteristics (Cox, 1926; MacKinnon, 1978; Gowan et al, 1981; Hennessey & Amabile, 1988; Taylor, 1988; Ochse, 1990). Despite the fact that researchers have come from diverse camps the findings have been fairly consistent in suggesting that the traits in question may have some bearing on creativity in the abstract regardless of the field. Research established that one cannot predict creativity on the basis of a persons' characteristics nor can one engender creativity by trying to instil traits in uncreative subjects (Guilford, 1981; Ochse, 1990). One also needs to be aware that an appreciation of these characteristics does not necessarily help in understanding the nature of the creative process itself, (Gowan et al, 1981) only in its promotion.

Not being satisfied with things the way they are is a matter of evaluation. Creators have been shown to use evaluation as a method of making progress with their ideas. Guilford (1981) and Sternberg (1988) suggested that non-creative people were often willing to settle for tolerably successful solutions to problems whilst creators were willing to persevere in an attempt to achieve a superior outcome.

McAlpine (1988) suggested that there was a cluster of personality traits that characterised creative thinkers. These traits related to valuing complexity (Gowan et al, 1981), showing a tolerance for conceptual ambiguity (Sternberg, 1988; Perkins, 1988) and deferring judgement. Simonton (1988) suggested that especially important was an individual's cognitive and motivational capacity to generate *"a cornucopia of ideas"* in their own domain of interest. Nickerson et al (1985) highlighted other characteristics and suggested that creators encountered complexity and uncertainty with equanimity and enjoyed resolving them. Sternberg (1988) and Simonton (1988) identified creators as risk-takers which McAlpine (1988) suggested was related to their wide knowledge base, sense of confidence and lack of fear of making mistakes. Torrence (1964) and Gowan et al (1981) suggested that creative thinkers had a strong sense of humour. Simonton (1988) believed that the distinguishing characteristic of the genius was immense productivity. Whilst Lawson (1990) described the creative as temperamental, sometimes arrogant, frequently rather precious, often originally dressed and highly individual. Guilford (1981) explained that they were impulsive, cheerful and relaxed. He also suggested that they were self assured and self confident. Sometimes this could lead to conceit, which Guilford suggested might indicate an underlying hypersensitivity to criticism. Creative thinkers have often been described as independent thinkers (Simonton, 1988) which Torrence suggested included working to an independent set of values. Ochse (1990) believed that creative achievers were not only conscientious but were also ambitious with high levels of aspiration. He explained that they were constructively critical and tended to be less satisfied with their own output than others. Taylor (1988) referring specifically to creative scientists reported that they enjoyed becoming immersed in problems. Whilst Sternberg (1988) spoke of creative people as thriving on encountering obstacles.

Many writers refer to the need for the creative to possess sensitivity and an independence of thinking and judgement. Torrence (1981) indicated that sensitivity or openness was a feminine virtue while independence was a masculine value. This lead him to propose that it was only people with divergent personalities who could maintain both sensitivity and the independence of mind necessary for high level creative thinking.

Perkins (1988) maintained that the creative needed *"curiosity"* about boundaries, *"restlessness"* concerning their limits and *"toughness"* in tolerating the ambiguity that he suggested inevitably appeared when boundaries were being challenged. Perkins believed that in that aspect more than anywhere else psychological traits emerged that differentiated the more creative from the less creative individuals within a field.

On the whole researchers have found that creative subjects have possessed above average intelligence (as measured by tests). However, it was also interesting to note that above a certain level, intelligence has been found not to be related to creativity (Cox 1926; Guilford, 1981; MacKinnon, 1978; McAlpine, 1988; Torrence, 1981). Ochse (1990) suggested that intelligence was necessary but not sufficient to produce creative achievement. Cox (1926), Simonton (1984) and Ochse (1990) have all pointed out that many different factors could decide whether or not a person's intelligence was used to produce highly creative outcomes.

A significant link has been established between creativity, intelligence and wisdom with Sternberg (1988), Ochse (1990) and others believing that creativity was closer to intelligence than to wisdom. There has been a tendency in the past for people to believe that geniuses were intellectually brilliant in most respects but research has indicated that that has not always been the case. Creators may be outstanding in certain areas but as Ochse (1990) put it they have been shown to be *"rather unwise, inept, or even rather stupid in others"*. The direction as well as the level of a creator's intellectual ability has been shown to be important for creativity to occur in different fields (Sternberg, 1988; Ochse, 1990). Highly creative individuals have been found to possess many qualities in common, they have also been shown to have marked differences between them (Guilford, 1962).

There has been ample evidence to support the belief that creative people are self-confident regarding their work whilst at the same time being concerned about their poor social image. The inability of others to recognise immediately the value of their endeavours has been a continual and powerful source of frustration to creators although their faith in themselves has helped them to overcome this frustration (Ochse, 1990). It has been suggested, by Ochse (1990) that the self confidence shown by creators was a determinate or catalyst rather than an outcome of creative achievement.

Creators have been shown to be independent in a number of ways. Emotionally, intellectually and, as Ochse (1990) suggested, independent in the sense of being *"non-conforming, unconventional and radical"*. He believed that this independence was either an innate quality or a reaction to something other than parental encouragement.

Torrence (1988) stated that although the elements of a creative solution could be taught, the creativity itself must be self-discovered and self-disciplined.

Studies regarding adult creators have indicated that whilst being very independent the creative have a tendency to be reserved, withdrawn and introverted (Barron, 1968; MacKinnon, 1978). This has often displayed itself in a creator's preference for solitary rather than group activities. However Amabile (1983) and McAlpine (1988) suggested that the situation was not as simple as always wishing to be absorbed in solitary intellectual activity. They noted that at times creators chose to work on their own, particularly at the early incubation and illuminating stages of the process, whilst at other times, for example at the evaluation stage, they appreciated group activities for learning and cognitive feedback.

Other research has shown them to be dominant, self sufficient, autonomous, display initiative (Barron, 1968; MacKinnon, 1978) and reject external regulations (Ochse, 1990). On the other hand there has been much evidence to support the belief that creator's have been genuinely interested in the work of others and like the majority of people they have a need to be recognised.

Motivational Traits

Modern psychologists have isolated intellect, emotion and motivation as major determinants of creativity. They have stressed that these human qualities are interdependent and that to restrict any one function could reduce creativity (Callaway, 1969; Clark, 1979; McAlpine, 1988; Walberg, 1988; Ochse, 1990).

"socially useful creativity demands the synergistic cooperation of the entire personality, including all physical mechanisms and modes of thought. Affective and conative dimensions are as essential as the cognitive ones" (Callaway, 1969). On the other hand the importance of motivation as 'the' major determinant has been well documented. *"... the most salient and most consistent characteristic of creative achievers is persistent enthusiastic devotion to work" (Ochse, 1990).*

The motivation to create has been shown to be brought about by a satisfaction in mastering the environment and has been highlighted as above average needs related to such aspects as curiosity, inquiry, exploration, novelty, complexity and order (MacKinnon, 1978; Ochse, 1990).

Csikszentmihalyi (1988) believed that creativity involved the interplay between motivation and effective as well as cognitive variables although he agreed that a great number of variables could affect how creative individuals became. Perkins (1988) maintained that to be truly creative within a discipline, motivation seemed to be of greater importance than strategies of creativity (which he called *"patterns of deployment"*) although he saw strategies of creativity as of more significance than raw ability. However as he pointed out a lack of basic skills prevented the majority of people from becoming creative.

Numerous researchers have referred to creators as being inherently energetic, persevering, dedicated, productive and thorough. Walberg (1988) suggested that creativity involved rare rather than unique accomplishments, that were attainable by nearly anyone with sufficient instruction and perseverance. Ochse (1990) pointed out that in the relevant research studies not only each sample, but every individual within the samples had been characterised by a persistent dedication to work. He went on to suggest that the intense effort expended by creative achievers was not merely undirected hyper-activity, but was targeted at achieving excellence.

Although motivation has been recognised as the creator's most salient characteristic, (Gowan et al, 1981; Ochse, 1990), relatively little attention has been given to investigating its origin and nature. Ochse (1990) suggested that it was unfortunate that empirical research had offered a blinkered view of the determinates of creativity. He maintained that that was for one of two reasons. Firstly because of the current tendency to view creativity as a matter of spontaneous un-stereotyped reaction to the demands of daily life, or secondly because of a tendency to conduct investigations relating to creativity in laboratories or classrooms where observations of the effects of situational variables on unexceptional subjects performing trivial tasks have been observed. Ochse suggested that the 99 per cent perspiration referred to by Edison did not have its counterpart in such structured situations. He proposed that high level productive creation was more a way of life for creators.

Much research has lead to the suggestion that creativity is promoted more by intrinsic than extrinsic rewards (Rogers, 1959; Taylor, 1960; Wallace, 1985; Hennessey & Amabile, 1988; Sternberg, 1988; Simonton, 1988). External rewards or expectation of external rewards have in fact been shown to dampen creativity (Gowan et al, 1981; Hennessey & Amabile, 1988). A lack of choice has also been established as an extrinsic constraint which has had a negative impact on creativity (Hennessey & Amabile, 1988). Amabile (1985) explained that the expectation of extrinsic rewards competed with intrinsic motivation. She suggested that in a classroom situation pupils were more likely to be creative when there was no expectation of a reward. She went on to explain that those subjects who expected extrinsic rewards tried to gain them with as little effort as possible and that even thinking about extrinsic reasons for being creative lowered levels of creativity.

As has earlier been mentioned certain researchers of creativity have been opposed to 'goal directed' creativity. Ochse (1990) who was supportive of goal-directed creativity believed that as long as the goals were related directly to the task in hand than there was a sense of subjective freedom rather than the expected imposed obligation. He referred to the need for there to be a balance between capability and opportunity. He explained that, when capability exceeded opportunity, boredom resulted and when opportunity or goals exceeded capability, anxiety resulted.

Ochse (1990) suggested that it was a creator's competence that was likely to enhance their intrinsic satisfaction and reinforce their motive to master. He further explained that a well-founded sense of competence was likely to be one of the major factors that lead children to become engaged in relatively complex tasks where they could set themselves increasingly higher goals. This was also supported by Bloom and Sosniak (1981) who suggested that forcing children to devote time and attention to tasks in which they had little talent or ability could be de-motivating and have a negative effect on talent development.

Another point of interest regarding motivation and productive creativity pertinent to this particular research project is the theory that exploring objects or facts from a variety of points of view is motivationally more satisfying than repeatedly focussing on the same aspect (Harlow, 1953; and Woodworth, 1958 in Ochse, 1990). This supports the researcher's own professional experience with pupils who become easily bored by repeating the same 'design process' time and again.

Walberg (1988) who believed that although characteristics of perseverance and intellect were necessary for the production of creative endeavours, they were insufficient in themselves. He believed that problem finding, aesthetic ability and originality more than *"mere craftsmanship and the mastery of basics"* were the key to success.

Ochse (1990) suggested that something more than intrinsic satisfaction and fame was needed to explain the *"powerful, unrelenting, un-directional impetus so clearly seen in the lifestyles of creative achievers"*. His theory was that creators felt threatened. Threat, or stress he believed played an important role in the development of the motivational habits of creative people. Threat, he suggested could raise the levels of the hormone which he explained was associated with 'learned helplessness' In the context of this research project the importance of 'learned helplessness' has already been discussed in the section on motivation. It is therefore interesting to add Ochse's (1990) thoughts to the equation, for he believed that it was out of the perceived threat of failure that determination and therefore the motivation to succeed came.

The suggestion that genius is associated with madness has its followers. Although there is also a school of thought who believes that creativity and pathology are negatively related, and another who denies that there is any relationship between them at all (Ochse, 1990). Recent research findings have pointed to the fact that the incidence of psychopathology has been found to be higher amongst creative achievers than in the general population. Ochse (1990) suggested that creators fluctuated easily between cheerfulness and depression, becoming angry at the slightest provocation. Creative children have been said to be rebellious with Guilford suggesting that this was likely to be due to frustration because their creativity was not recognised. Cox (1926) mentioned in her study that depression and anger were characteristics portrayed by youths who were found to be creative.

Despite emotional instability creators have been shown to have a high degree of self-control and be remarkably adjusted in the sense of being effective and happy in their work (Ochse, 1990). Gowan et al (1981) explained that creators had the ability to handle anxiety without losing creative impetus, he suggested that this was because they possessed much *"free energy"* which came from within themselves.

Research has highlighted the fact that creative people have been shown to have a high degree of sensitivity to problems (Guilford, 1981; Walberg, 1988; McAlpine, 1988). The importance of 'problem finding' as an approach to creative tasks has been well documented in several longitudinal studies (Csikszentmihalyi, 1988). Guilford (1981) referred to creators strong evaluative capabilities as performing the function of getting creative thinking started. McAlpine (1988) stated that the problem-finding characteristic as opposed to the problem solving trait appeared to be related to *"epistemic curiosity"*, and to a creators questioning approach to knowledge.

As already mentioned earlier creative children develop the habit of working alone (Torrence, 1981; Ochse, 1990). Great creators have written frequently of their need to be alone, they have suggested that their best thinking has been done in solitude. It has been suggested, by creators themselves, that interruption was one of the major enemies of creative thinking (Ochse, 1990). This belief is totally opposed to the modern school of thought which has been trying to encourage creativity through group interaction (see section of literature review on group work). Much evidence has been collected which supports the use of group work to promote and develop creativity. The synergetic power of group work has been referred to by those following a problem-solving approach. They have highlighted the use of brainstorming techniques, attributed initially to Osborne, as proof of the creative effectiveness of people working together rather than in isolation. It has been said that a team of people can more effectively develop good, new, exciting products by building upon one another's ideas. Recently, Lawson (1990) wrote that productive creativity could not be practised in a social vacuum. He suggested that the social context influenced not just the outcome but the way people thought about creating. He went on to suggest that it was the very existence of the other 'player' that made creating so challenging. Whereas, Schlesinger (1960, in Ochse 1990) on the other hand, a supporter of the need for solitude was sceptical of the benefits of group interaction. He suggested that group tactics were *"essentially means by which individuals hedge their bets and distribute their responsibilities resulting in dilution of insight and the triumph of mishmash"*.

Women as Creators

Historically there have been very few women creators at least at a public level. Torrence and Ochse suggested that it has been the difference in the roles which the sexes have played in our society that has lead to the lack of women creators (Torrence, 1981; Ochse, 1990).

A study of the few women who have been exceptionally creative has shown that the pattern of influences that acted upon their development was similar to that of male creators (Ochse, 1990). The research has indicated that they have usually come from professional homes and have had a strong respect for cultural values. It has also been noted that they have usually suffered some form of insecurity when young and have tended to be intellectually stimulated, particularly, by their fathers who were seen not to be affectionate towards them. Women creators have tended to be introverted, aloof, self-sufficient and as with their male counterparts have favoured working alone.

Traditionally society has persuaded woman to gauge their worth in terms of their ability to please others (Ochse, 1990). In the past young girls have generally been afforded less intellectual stimulus, less education, less encouragement and fewer rewards for indulging in intellectual pursuits. Institutional structures have denied females access to cultural materials and their intellectual interests have been regarded as hobbies rather than essential aspects of their lives.

It is recognised that when creators produce their finest work is dependent upon the subject, for instance in Science and Maths it tends to be in the twenties, whilst in history, it is in the eighties, although one must acknowledge the fact that within subjects there is a lot of variation (witness Darwin). However, whilst bearing this in mind, it has been suggested that another important determinant with regard to female creators has been that at a time when most creators are producing their finest work, a large proportion of woman are pre-occupied with bearing and bringing up children. Even those who have others to care for their children have been shown to find it difficult to achieve the intense uninterrupted solitude identified as being important to productive creativity. Ochse (1990) pointed out that the formation of an identity in adolescence depended upon different factors in males and females. Females, he explained, were on the whole, more interested in personal relationships and displayed a greater need to be with people. This quite often lead to the solitude needed for creativity being seen by females as a state of loneliness. The researcher must admit to being supportive of Ochse (1990) when he suggests that the lack of 'un-interrupted solitude' could be perceived to be partially their own fault.

Thinking Styles and Creativity

Before considering some of the thinking processes associated with creativity in any depth it is important to examine some of the myths surrounding it. One suggestion has been that analytical thinking has nothing to do with creative thinking (McAlpine,1988). However considerable support can be found for the view which states that it is impossible to pursue productive creative thinking without employing analytical and critical thinking (Rawlinson,1981; Khatana, 1981; Nickerson et al 1986; Ochse, 1990). *"... critical thought can be uncreative, but creative thought cannot be uncritical" (Nickerson et al , 1986).*

McAlpine (1988) also highlighted what he believed to be another misconception, the suggestion that all that was needed to encourage creativity was to supply the learner with a warm supportive learning environment. This he explained, denied the critical importance of cognitive challenge. *"it behoves us to remember that it is the grit in the oyster that makes the pearl" (McAlpine, 1988).*

The differing thinking styles of creators have been diagnosed by many researchers. Several, including Ryle (1949, in Lawson, 1990) suggested that thinking embraced many different kinds of activity which had little in common. MacKinnon's research (1978) into the work styles of inventors revealed that research scientists tended to be cautious and gave relatively few wrong answers whilst independent inventors did not hesitate to take chances. The research carried out by Gough and Woodworth (1960) suggested that inventive people were happy to involve themselves directly with the practical aspects of a problem, took chances and found ways of using the insight they had gained through practical experience rather than concerning themselves too much with *"methodological niceties"*.

Freedom of expression has usually been associated with creativity, however an examination of the lives of great creators reveals that the basic rules and techniques of a discipline are a necessary basis from which productive creativity leaps are made.

"... there is very little indication in the facts relating to the lives of creators that significant ideas emerge from untutored minds. ... Culturally valuable creative ideas are, indeed, more likely to emerge from sophisticated scepticism" (Ochse, 1990). Khatena (1982, 1984) emphasised the necessity to accommodate disorder and difference in the search for order and structure in knowledge. Whilst Stanish (1986) insisted that randomness in the early stages of creative thinking was of significant importance and warned against *"speeding up the structuring of knowledge for pupils"*. He suggested that premature structuring to a single correct answer or the answer that the teacher wanted was a deterrent to creativity.

As far as the creative child is concerned independent learning is one of the most favoured and effective methods of developing new ideas. However independent learning is not the way forward for all children. Many who are given freedom are not able to cope with it. Ochse (1990) suggested that the ability to cope depended greatly on an individuals needs, values and competence which he believed had been to a great extent influenced by early experiences in the home.

Promoting Creativity

A large number of studies have indicated that creative thinking can be increased through certain types and styles of direct instruction (Torrence, 1972; McAlpine, 1988; Ochse, 1990). Csikszentmihalyi (1988) suggested that in creative children the difference in the effectiveness of teaching methods was caused by a creator's sensitivity to certain ranges of stimulation and the development of different information-processing strategies from 'normal' children.

Ochse (1990) suggested that if one wished to promote culturally valued creativity then one needed to use socially acceptable methods, which he listed as *"domain-relevant modelling, pace setting, standard setting, tuition, and also constructive feedback as to where children are not meeting required standards"*. He explained that creativity could be facilitated in creative achievers by first giving children the basic knowledge and discipline needed, and then providing them with the freedom to work independently. He suggested that creative achievers needed to be able to call upon expert advice, feedback and resources, the quality of which he felt was highly significant. *"The development of transcendent creativity is not obstructed by discipline, or even drilling: it is impeded by confinement to a narrow perspective - to a limited range of information and poor standards. ... Great minds are indeed disciplined - but they are not confined" (Ochse, 1990).*

Perkins (1988) maintained that in creative training, creativity tended to be treated as a matter of technique rather than as a matter of attitude. He explained that in his view, it was both, and that efforts to foster creativity needed to pay at least as much attention to building creative attitudes as imparting technical resources.

In a discussion regarding the development of creativity, Guilford (1981), suggested that the development of cognitive and memory abilities were most important. Cognitive abilities he explained had to do with discovery, recognition or comprehension of information in various forms whilst memory abilities had to do with the storage or retention of information.

He went on to report that recently in schools, there has been a move away from encouraging memory ability. He believed that some teachers rightfully emphasised the importance of thinking but seemed wrongly to believe that good thinking and good memory were incompatible qualities.

There have been many models developed by researchers in an attempt to promote creativity. McAlpine (1988) named the most common method used as the Creative Problem Solving model (CPS) developed by Parnes in 1981. Users of the model claim that the CPS encourages individuals to: break away from habit-bound thinking; increase ideational fluency, flexibility and originality; see new relationships; defer judgement; define problems in different ways; employ critical, evaluative and research skills; develop interpersonal and social skills. McAlpine (1988) described CPS as a systematic approach which involved six steps, one of which employed Osborn's brainstorming technique. He identified the six stages as: objective-finding; fact-finding; problem-finding; idea-finding; solution-finding; acceptance-finding. Concern regarding the simplistic linear nature of the CPS model can be found in the work of McAlpine (1988) *"do creative thinkers really work as systematically as this?"* and in numerous recent research studies (e.g. APU, HMI) referred to in an earlier section of this study.

Other methods used to promote creativity have been: synectics which employs three metaphorical mechanisms (personal, direct and symbolic analogy) in a group brainstorming situation; attribute listing that involved modifying important attributes of a problem by transferring attributes from a given situation to a new one; William's model that integrated four cognitive and four affective dimensions; the Sociodrama model that stressed feelings and interpersonal relations in resolving social problems in a freewheeling drama context; and several other approaches which have been based upon Guilford's Structure of Intellect Model have also been developed. They have mainly emphasised cognitive strategies involving systematic training in sensing problems; re-defining problems; developing fluency, flexibility and originality of thinking (McAlpine, 1988; Meeker, 1981).

The Development of Creative Talent

Evidence from the research has indicated that many creative achievers have disliked school, although it is clear that they have generally enjoyed learning. As children creators have been shown to gain a great deal of satisfaction from self-directed intellectual activity that has then gone on to contribute significantly to their performance in adult life (Taylor et al,1985 in Ochse,1990).

Ochse (1990) pointed out that the benefits of independent intellectual activity were not necessarily reflected in a pupil's academic achievement. He maintained that this was sometimes because the subject of the child's interest did not form part of the school curriculum. Whilst at other times he suggested that the subject was included but the content of the lessons was structured so tightly to syllabus requirements that it prevented the creative child from having the freedom to go off at a tangent in order to visit avenues down which their specific interests lay.

Ochse (1990) proposed that bright, inquisitive children who worked independently were not only likely to encounter a wider variety of knowledge than their peers, but of even greater importance to their development was the fact that they would encounter the same knowledge in a wider variety of contexts. Much historical evidence has indicated that creative pupils tend to explore more advanced material than their peers.

As the creative process is usually regarded as a new combination of existing knowledge, one can conclude that children who have acquired a wide range of knowledge and skill upon which a new combination could be drawn, have a greater chance of being creative. However this is not always the case, from historical studies it is evident that gifted children do not necessarily become creators. Even for those with creative tendencies something extra has been shown to be needed in order to translate talents into the power to create. This something has already been identified, earlier in this section, as the ability and motivation to work extremely hard (Ochse, 1990).

Approaches, Strategies and Styles of Learning

The approaches to learning that pupils and others adopt have been well researched (e.g. Craik & Lockhart, 1972; Marton & Saljo, 1976a, 1976b; Entwistle & Ramsden, 1983; Thomas & Bain, 1984; Riding, & Cheema, 1991; Biggs & Moore, 1993; Morris & Summers, 1995) Approaches, in the context of this research project, have been identified as the consistent way of going about a specific task or learning in general (Biggs & Moore, 1993). They link motive and strategy, with perceived task demands and desired type of learning outcome (Atkinson & Feather, 1966; Entwistle & Wilson, 1977). Riding & Cheema (1993) supported the notion that an approach to learning reflected the interaction between a pupil's current motivation and the teaching context but they also added that it was modifiable. Entwistle & Ramsden (1983), from their findings concerning student learning in Higher Education, indicated that there was a distinct relationship between a student's personality type and their approach to study. Whilst Brophy (1986) writing about learning strategies in schools, suggested that the main aim of many pupils when presented with a task was to get it out of the way, rather than be interested in understanding what they had learnt from carrying out the task.

Research has identified and categorised learning approaches into three main types. Most writers have referred to these as: surface; deep;and achieving, with deep-achieving and surface-achieving as possible combinations within the latter category (Entwistle &

Ramsden, 1983; Biggs & Moore, 1993). Entwistle & Ramsden (1983) have also named these categories: reproducing orientation; meaning orientation and organised study methods.

The motive for using a surface approach to learning has been described by Biggs & Moore (1993) as extrinsic. This category of learners has been shown to carry out a task because of either positively or negatively reinforced consequences (Entwistle & Ramsden, 1983). Biggs & Moore (1993) suggested that it was a low-level strategy akin to *"corner cutting"*. They, supported by others (e.g. Brophy, 1986; Entwistle & Ramsden, 1983), explained that it allowed learner's to *" get off the hook"* and rarely led to a real understanding of the problem being tackled. The surface approach has generally been associated with negative factors such as: poor performance; ill-structured learning; drop-out; poor academic self-concept; syllabus boundness and fear of failure (Entwistle & Ramsden,1983). A tired, impersonal reaction to an uninspired work demand was the way in which Biggs & Moore (1993) described it.

At the other extreme the deep approach has been shown to be based on intrinsic motivation (Entwistle & Ramsden, 1983; Biggs & Moore, 1993), or more particularly, as Hidi (1990) and Schiefele (1991) explained, on a pupil's interest in the task. It has been described as a combination of the wish to complete a task with the active search for meaning (Entwistle & Ramsden, 1983). Biggs & Moore (1993) referred to it as *"... an energetic involvement to maximise meaning"*. They also suggested that in a deep approach the pupil would: possess a great deal of relevant content knowledge; operate at a high, or abstract level of conceptualisation; reflect metacognitively on what was to be done, use optimal strategies for handling the task; enjoy the process; and be prepared to invest time and effort. Entwistle & Ramsden,1983 supported this theory although they pointed out that it would only be the case when the focus was: on a personally valued subject; involved in qualitatively rich learning; and when the pupil had good academic self-concept (also Biggs & Moore, 1993).

The achievement approach was likened to the surface approach, by Biggs & Moore (1993), in that it too was focused on the product. However, in this instance, the focus, they suggested was an *"ego trip"* that came from obtaining high marks and winning prizes. They suggested that for pupils the achieving approach was a calculated attempt to maximise marks cost effectively. They also implied that like the deep approach, the achieving approach could be academically positive. Although, in this instance they believed the motive was externally driven by the pupil's need to excel. Entwistle & Ramsden (1983) also suggested that the achieving approach could have a high negative loading on disillusioned attitudes.

Whilst deep and surface approaches were seen to be mutually exclusive at any given time, an achieving approach was seen to be linked to either (Biggs & Moore, 1993). Researched literature suggested that surface-achieving was the approach adopted by pupils who wished to obtain high marks and thought that the way to achieve this was to do so by surface techniques. Whilst deep-achieving, a planned and cost-effective search for meaning, was a characteristic of many of the more able pupils. Biggs & Moore (1993) also supported the belief held by others (e.g. Entwistle & Ramsden, 1983) that good pupils typically used elements of both deep and achieving approaches as they worked on their tasks.

Also of interest to this research into pupil motivation in design and technology, was Biggs & Moore's (1993) belief that although people tended to have stable predilections or inclinations regarding an approach once they had become involved in a task, what each approach actually involved, performance-wise, was dependent upon the task itself.

Entwistle & Ramsden (1983) in their research into student approaches linked to degree outcome, identified five distinct categories of student attitude towards studying. Their findings suggested that students who were *"disorganised and dilatory"*, or were *"cynical and disenchanted"* achieved poor degree results. Students who were *"syllabus free"*, or were *"fearful of failing"* achieved above average degree results. Whilst students who were *"competitive and efficient"* achieved very good degree results. The detailed characteristics of students belonging to each of these categories showed a distinct similarity to categories of GCSE pupils that the researcher had observed in her professional capacity within the classroom.

Writers have nominated several features as contributing to deep and achieving approaches to learning. These include: a well structured knowledge base; interaction with others; learner activity (Biggs & Moore, 1993) and a positive motivational environment (Entwistle & Ramsden, 1983).

Biggs & Moore (1993) suggested that an enabling feature of an environment was that it was well ordered, well planned and resourced, with the directions for action clearly established. They also believed that the more a task-orientated activity required of the learner the better the learning would be.

As far as the pupil was concerned it was seen as important that the task was valued and that the pupil had a good chance of succeeding whilst carrying it out. One word of warning given by Fisher (1990) in his book 'Teaching Children to Think' was that although one would expect that enhanced learning and enhanced teaching would come hand in hand he believed that this was not always the case.

Riding & Cheema (1991) supported by Biggs & Moore (1993) identified a distinction between learning approaches or strategies and learning or cognitive styles. On the one hand they explained that approaches or strategies were concerned with motivation. They were the methods people used in order to cope with situations or tasks. These they suggested could vary from time to time as they were learnt or developed. Whilst on the other hand learning or cognitive style they believed was a fairly fixed characteristic of an individual that was purely cognitive.

The terms learning style and cognitive style have been widely used by educational theorists for the past sixty years, although what has been meant by the terms has varied from writer to writer (Curry, 1983; Riding & Cheema, 1991). Curry (1983) claimed that this plethora of meanings had lead to confusion. She believed that the chief difficulties were *"... the bewildering confusion of definitions ... and the concomitant wide variation in scale or scope of behaviour claimed to be predicted by learning style models"*. Various writers have suggested that the two terms meant the same thing and were therefore interchangeable (e.g. Entwistle 1981) whilst others considered the two to be different and defined them as separate concepts (e.g. Das, 1988).

Riding & Cheema (1991), building upon the work of others (e.g. Allport; 1937; Lewis, 1976; Kolb, 1976; Kogan, 1980; Entwistle, 1981; Curry; 1983;) indicated that learning style was like cognitive style in that it was a permanent personality characteristic or trait that could be displayed over a range of tasks and situations. Whilst Biggs & Moore (1993) used the same meaning to describe cognitive style without making any reference to learning style. They explained cognitive style as a qualitatively distinct and consistent way of encoding, storing and performing and one that was mainly independent of intelligence. They suggested that its origin lay in an individual's *"... psychodynamic history rather than in academic contexts."*

Harre & Lamb (1986) defined cognitive style as an individual's characteristic and consistent manner of processing and organising what he sees and thinks about. Borg & Riding (1993) suggested that it was an automatic, habitual way of judging the quality of information or situations. They believed that it affected an individual's ideas and attitudes, and the manner in which the person thought and made decisions. Borg and Riding (1993) also went on to support Hockey (1990) who had suggested that cognitive style was different to cognitive ability in that 'ability' could be inferred from performance on cognitive tests whilst 'style' could be inferred from the manner in which a test was completed.

Curry (1983) referring to measures of cognitive/learning style suggested three main types that she likened to the layers of an onion. She suggested that by organising learning style measures in that way learning behaviour would be "... *fundamentally controlled by the central personality dimension, translated through middle strata information processing dimensions and, given a final twist by the interaction with environmental factors encountered in the other strata.*"

Riding and Cheema (1991) suggested that the main difference between cognitive and learning style was in the number of style elements that needed to be considered. They explained that whilst cognitive style was a bipolar dimension, learning style entailed many elements that were usually not 'either-or' extremes.

Over the years cognitive/learning style has been viewed in three main ways (Riding and Cheema, 1991), as a structure (content), as a process or as both. Riding & Cheema (1991) explained their understanding of the three differing views by suggesting that if cognitive style was viewed as a structure, then the focus was on stability over time. In this form once the style had been identified the teaching material could be adapted or matched to the individual's cognitive style. They indicated that the second view of cognitive style as a process focussed on how style changed, and the ways in which teachers might foster that change. In this context style was seen as dynamic, not "*...frozen forever*". Finally for those who viewed cognitive style as both process and structure it was seen as relatively stable and yet at the same time always in a state of flux. They believed that this allowed it to be continually modified as new events influenced it directly or indirectly (Riding & Cheema, 1991).

Messick had in 1984 identified nineteen cognitive styles, whilst Riding and Cheema (1991) in their search of the relevant literature had found over thirty labels referred to as cognitive or learning style. Their analysis of this long list suggested that they could be grouped into two principal cognitive styles and a number of learning strategies. These two categories Riding and Cheema (1991) referred to as a Wholist-Analytic Cognitive Style Family, and a Verbalizer- Imager Cognitive Style Family. Wholist-Analytic meaning that an individual tended to process information in wholes or in parts and the verbal-imagery style where an individual was inclined to represent information during thinking verbally or in images. They believed that these two styles were orthogonal to one another, such that an individual's position on one dimension did not affect their position on the other.

The perception and evaluation of information, be it in wholes or in parts, in images or in words, were seen by the researcher to form an integral and important part of designing. The findings of Riding & Cheema (1991) and the development of Riding's computer presented Cognitive Style Analysis Test (1991), that would determine a person's predominant cognitive style, were therefore seen as most important to this research project.

Another factor which also made the study of cognitive style of interest to the researcher was its possible effect upon stereotypical images of children. In a curriculum area in which the gender inbalance has for some time been considered an area of concern (see section on equal opportunities in Design and Technology) it was with interest that the researcher read that cognitive styles may predispose an individual to respond to a stereotype in a particular way (Newton & Newton, 1992). Newton and Newton (1992) suggested that faced with a sympathetic stereotype, those with styles reasonably in accord with the needs of the activity may be attracted and that faced with an unsympathetic stereotype, those with a mental make-up which equipped them to go against the norm may also tend to be attracted. They went on to suggest that: *"On this basis the thinking styles of women scientists may not be quite like their predominantly male colleagues (Head, 1987). Nor may they be good role models for those of different thinking styles."*

Teaching Styles and Strategies

The most effective method of teaching depends on the goal, the pupil, the content and the teacher (McKeachie, Pintrich, Lin & Smith, 1986). Biggs & Moore (1993) suggested that it was the pupil and the teacher acting together with the pupil's learning process central to the issue that made the difference to the outcome of learning. Entwistle & Ramsden (1983) suggested that in the real world improvements in teaching and learning were two sides of the same coin. They also suggested that the quality of a pupil's learning was affected by a number of factors that were not of the pupil's making. Inappropriate assessment methods, over-rigid courses, an excessive amount of curricular material and unimaginative teaching had all been identified as important weaknesses that could act against the development of a sound learning strategy. Borg & Riding (1993) indicated that these factors could also have a significant effect upon how a pupil's dominant cognitive style could cope with the learning that was offered.

As mentioned in an earlier section of the review of the literature, employers have for some time expected formal education to develop certain general qualities of mind, foremost of which would seem to be intellectual flair. This Entwistle & Ramsden (1983) suggested was the ability to think critically, objectively, flexibly, and quickly, and to apply that thinking to a wide range of problem situations. This, they believed required a deep approach to learning and that this needed to be supported by appropriate teaching strategies. They explained that it was vitally important for students in Higher Education and pupils in schools to have *"... an intrinsic interest in their content area"*. They believed that pupils must have engaged with a subject to develop *"an intellectual passion to understand"*. They believed that teaching strategies which did not develop a 'deep' approach were more likely to produce pupils who were passive about their acquisition of knowledge and were unable to engage their active critical faculties to the task in hand (Entwistle & Ramsden,1983). Biggs & Moore (1993) suggested that a deep approach to learning could be encouraged where; the knowledge base was sound; the learner was motivated; the learner interacted with others; the learner was actively involved; the school, the classroom, the total processes and the educational outcomes were also in synch. Entwistle & Ramsden (1983) explained the crucial importance of basic concepts and skills being thoroughly taught to ensure that deep approaches could be undertaken by pupils. Although they explained that this had to be balanced with the need for pupils to experiment and experience the effect of being responsible for their own learning. Pupils needed to be encouraged to believe that learning was more than reproducing other people's facts and ideas.

Boag (1989) suggested that great teachers: enthuse their students; treat them as individuals; know their subject; are loving and warm; teach to learn; empathise with students; are firm, fair and flexible; are organised; prepare students for life; manage the classroom; have high self-esteem; have a sense of humour; need to be a complete person; and take risks.

The successful handling of teaching has been shown to be dependent on the development of a complex schemata founded on good theory and grounded in much practice. Mathias as early as 1981 reported that pupils had a distorted view of learning because of the teaching methods that had been adopted particularly at formal examination time. He suggested that teaching strategies had *"... inculcated an instrumental view of learning"*.

The type of learning demanded by different disciplines has been shown in the research findings of Entwistle & Ramsden (1983) to be clearly different. They suggested that in the arts pupils needed to be encouraged to search for personal meaning. This they suggested depended on empathy and openness from staff, informal teaching methods, freedom for students to explore their interests and yet because of that freedom they suggested that there must be clear setting of goals and standards. Whilst in the sciences good teaching was seen to depend more on pitching the information at the correct level and being alert to pupil difficulties. A deep approach to science depended more on operation learning, on related evidence and conclusion, and on the appropriate use of a certain amount of initial rote learning to master the terminology. Design and technology being a mixture of these two opposing aspects of the curriculum must therefore fall into both camps with teachers pursuing both free and operational learning strategies. The need for such a diverse mixture of teaching styles should therefore be taken into account when teachers plan the design and technology curriculum for their pupils.

Much of the research findings support the belief that teachers are often unaware of the effects that their assessment demands have on learning (Entwistle & Ramsden, 1983). They suggest that too many teachers are concerned with their own teaching methodology, (e.g.problems of delivery; methods of addressing their audiences effectively; ways of preparing resource materials; and how to run their lessons skilfully). They suggest that although these are important they have tended to detract from the crucial links between how teachers teach and assess, and how effectively pupils learn. Research suggests that there is a need for a shift away from concerns about teaching techniques towards helping teachers to understand the effects of their teaching on pupils' attitudes and approaches. Certainly this supports both the findings of the literature review and the professional experience of the researcher in the area of the curriculum associated with this research project. With regard to assessment and testing it is also of interest that Entwistle & Ramsden (1983) explained the importance of setting assessments which tested understanding and demanded independent thought. They were particularly condemning of testing in schools that rewarded the simple reproduction of facts. They believed that if factual reproduction of memorized information was implicitly encouraged and actively rewarded (through the marks given) pupils would shift accordingly to surface approaches.

Literature Review

Design and Technology Education

The Developing Design and Technology Education Philosophy

Confusion exists in schools regarding the nature of design and technology education and its place in the school curriculum. Boulter (1989) stated that fundamental changes to an education system were slow. He believed that the mechanism was such that the most innovative, wide reaching and important initiatives were less likely to reveal themselves in a form that resembled the original intent.

To understand the confusion that existed and still exists to a certain degree today, one needs to refer to the variety of meanings used to define technology itself. These range from equating 'technology' with machinery, to dealing with forms of social organization. The editors of 'Technology in Schools' showed their understanding of the conceptual confusion and gave their support to a variety of definitions (Cross and McCormick, 1986).

Naughton, one of the writers contributing to 'Technology in Schools', equated technology with machinery. He gave the example of a photograph of an expensive hi-fi system with a caption that stated 'Isn't technology beautiful?' On the other hand he also gave support to the definition of technology as a social process.

"Technology is the application of scientific and other organized knowledge to practical tasks by hierarchically ordered systems that involve people and machines" (Naughton, 1986).

Although Naughton believed that both definitions were valid he went on to state that neither was appropriate for every occasion nor were they necessarily interchangeable.

There has been much written regarding the quantum leaps that man has made in technological terms over the past few decades. However, Boulter (1989) suggested that it was misguided for us to believe that we were the first society to experience a technology boom. *"Man has never lived without 'technology', it is the proof of his existence."*

DES (1989), in trying to help clarify the confusion for teachers of design and technology defined technology as being *"concerned with the application of scientific and related knowledge to a problem, resulting in a solution which may involve the creation of a product"*. They went on to refer to design as the process through which a solution was envisaged, believing that this created the framework for the technological content.

The Design Council, with its beliefs firmly allied towards a design philosophy, stated in its report on Design Education at Secondary Level that design, associated with its concerns for the human environment, expression, identity and aesthetic considerations was *"an essential* *part of the liberal education of all children."* The report declared that design's main educational claim lay in its value as a process and an activity (Design Council, 1980).

In 1986 The Secondary Examination Council (SEC) in collaboration with the Open University and Kimbell provided a rudimentary perspective of the nature of design and technology education. *"... problems exist in the world - we help young people to identify them, tackle them, and thus to resolve them" (SEC, 1986).* They went on to highlight the distinct contribution design and technology could make because of the practical nature of the subject that set it apart from other areas of the curriculum. *"... for above all CDT encourages and requires young people to produce practical (and usually concrete) solutions to real problems" (SEC, 1986).*

Craft, Design and Technology from 5 to 16 (DES, 1987) described design and technology education as enabling pupils to be inventive. APU (1991) stated that it developed creative, discerning, caring and confident individuals. They suggested that it was on the *"cutting edge of social conscience"* where the concepts of *"needs"* and *"improvement"* were far from clear and often problematic because they were dependent upon an agreed set of values.

APU (1991) and Down (1986b) both referred to the integrated, cross curricular nature of design and technology education. Down argued that preparation for the technological society could not be left entirely to technological or design and technology subject areas of the curriculum. He took as one of his examples the discussions regarding urban and motorway planning, industrial change, energy resources and technology in developing countries to examine the importance of geographical knowledge in the equation.

The difficulties that have been encountered in defining the meaning of technology are evident throughout the literature. The lack of a clear and consistent definition of technology has had unfortunate consequences for those trying to establish and build upon design and technology as an important aspect of the school curriculum.

The terms 'design' and 'technology' can convey different messages to different people. These meanings are often deeply embedded through long usage in different working communities. As the 1988 Interim Report points out, even within one particular community meanings may be contested. Many in the technology community supported the reasoning behind the Technology Working Party decision not to strive for, or impose a succinct definition due to the lack of consensus. The result of this decision has been misunderstanding and controversy amongst teachers and educationalists.

Since the publication of the Interim Report, it has been considered necessary and helpful to have a working definition. There have been several attempts to achieve this, each with their own subtle nuances.

In National Curriculum documentation the following definitions can be found:

Technology is *"concerned with the application of scientific and related knowledge to a problem, resulting in a solution which may involve the creation of a product" (DES, 1989).*

"Design and Technology involves applying knowledge and skills when designing and making good quality products fit for their intended purpose" (DFE 1992).

"Technology is the creative application of knowledge, skills and understanding to design and make good quality products" (NCC September 1993).

The lack of clarity in defining technology continues. The latest documentation has separated Design and Technology and Information Technology and removed the all encompassing title of 'Technology'. It has also simplified the Orders by restructuring them to provide a more flexible framework within which teachers may work.

Since the introduction of the subject area into the school curriculum there have been three identifiable stages to the development of technology education. Craft courses, design courses and then NC led courses. In the first instance, craftsmen taught single material, craft skill based courses to the less able. This was followed in the late 1960's by the introduction of design based courses and then in 1990 by NC Technology.

Shortly after the introduction of design based courses the resistant materials, wood, metal and plastics amalgamated to form CDT. The rest of the subjects which eventually came under the umbrella of NC Technology continued to be treated as separate subjects. Teachers who had mainly been trained in teaching methods associated with craft skills found these design-based courses a radical step. Their craft training left many of them feeling vulnerable.

It was during this period of change, with the introduction of design based courses that the researcher began her teaching career. Her training had been spent in an Industrial Design Department, training to be a furniture designer. This was followed by a period at an Art College for her teaching qualification. This education gave her the design skills and the practical skills that she needed in order to tackle these new design courses in schools. She was fortunate that part of her developing philosophy of design which she had built up during her time training to be a designer included the need for designers, craftsmen and technologists to work together as a team. As a designer she already believed in the benefits that could be gained from working co-operatively with other curriculum areas within a school and even outside of it. But she found herself surrounded by many teachers for whom this was a totally new concept. They believed that they needed to be the fount of all knowledge and that to display a limited set of subject knowledge was a sign of weakness.

The new design courses caused these teachers considerable heartache. Many of them had to gain their understanding of the design process as they taught their pupils. Books on design methodology and Inset materials to help establish a sound philosophy to underpin teaching were virtually non - existent.

At that time, instead of CDT departments pulling together and working in teams to build a strong new subject base, an unhelpful split was occurring. Teachers were tending to divide into those who wished to teach 'hard' technology such as electronics, mechanics and fluidics and in many cases did no more than pay lip-service to designing, and those who used the design process as the vehicle for the majority of their teaching. The researcher understood the fear felt by both sets of teachers. They did not wish to expose their perceived inadequacies, either as non-technologists or non-designers. But at an important time in the development of education in general, design and technology presented a divided front, with conflicting messages being received by the rest of the teaching profession and beyond.

These divisions have, amongst other things, led to pupil and staff frustration when materials, equipment and expertise have not been shared for the benefit of all. The introduction of NC Technology set out to overcome these problems by forcing teachers from different disciplines to work together. However this was seen in many schools as a very unhappy marriage. The latest Orders, although still in the early days of interpretation seems to have provided a structure that will once again allow teachers to work independent of one another in a manner which will not necessarily produce co-operation between all disciplines.

The Effect of the National Curriculum on Design and Technology Education

The Government's first Statutory Orders concerning design and technology were published in April 1990. The foundation subject area referred to as NC Technology was made up of two 'profile components', Design and Technology, and Information Technology. It was intended that the two components should not be seen as discrete subjects but more a set of attainment targets that needed to be serviced by a wide variety of curriculum areas (DES, 1989).

One of the most far reaching effects of the NC was the fact that all pupils from ages five to sixteen would have to be taught the necessary information and skills. To be able to achieve the appropriate attainment targets the emphasis was to be on process rather than content. In the case of NC Technology, schools were no longer able to decide that they did not wish to provide that area of the curriculum. NC Technology was required by law to be taught to all pupils of all abilities, ages and interests up to the age of sixteen. No longer could it be taught just to those who chose the subject because they were interested in it, or to those who saw its relevance to their future occupations. The new law meant that NC Technology would need to become something quite different from the subject offered in the past as its content needed to be relevant to all. It needed to have broadly based, transferable skills in order to make it a preparation for life, not a vocation.

A number of working party reports were published for consultation before the Statutory Orders were finally written (National Curriculum Design and Technology Working Group, 1988; Department of Education and Science. 1989: National Curriculum Council, 1989). One of these reports, the Interim Report, set out to explain the new philosophy. It established that in order to deliver the NC the curriculum areas of CDT, Home Economics, Art and Design, Business Studies and Information Technology all had to work together as a team, being aware of and building upon knowledge gained in other curriculum areas such as Science, Mathematics and Humanities. Cross-curricular activities and links were essential to achieve many of the NC Technology programmes of study. The new curriculum required teachers who would be able to work as part of teams and teachers who were able to work in partnership alongside teachers who possessed differing skills and expertise (National Curriculum Design and Technology Working Group, 1988).

Information Technology (IT) was shown to have a special role to play in NC Technology, but it was not to be its only role. The Statutory Orders for NC Technology explained that like Design and Technology, IT was not a discrete subject. The aim was to use IT as a tool in whatever context it was needed. At the end of compulsory education no pupil should be afraid of computers and all pupils should be able to cope with future developments in computer technology (DES, 1989).

As with all NC subjects, progression was highlighted as an important issue. By adhering to the National Curriculum model it was hoped that pupils would not repeat aspects of work in a variety of curriculum areas nor when they changed school. It was anticipated that the NC would prevent pupils missing vital areas of knowledge or experience either because they had not been included in a subject area or because the school had chosen not to tackle them. It was also envisaged that knowledge gained in other curriculum areas, particularly in Science and Mathematics, would be put into context in design and technology.

The Case for Revision of the National Curriculum Technology Orders.
The relevance of NC Technology and the basic approach that underpined the Technology Order was welcomed by teachers, parents and employers (NCC, 1992). However, teachers did not find it easy to translate the new approach into effective classroom practice. Teachers, HMI, the Engineering Council (1992) and educationalists had all voiced their significant concerns regarding what was occurring in schools under the guise of NC Technology within one year of its implementation (Hendley & Jephcote,1992). In November 1991 the Secretary of State for Education asked the NCC to give their advice on the case for a revision of the Orders. The review he believed was needed as evidence had shown that teachers had experienced difficulty in interpreting the detailed statutory requirements associated with the attainment targets. The NCC published their recommendations in May 1992. They concluded that there was a case for a revision of the Orders. They stated that changes were needed if teachers were to deliver the principles that underpined the inclusion of Technology as a foundation subject in the National Curriculum. They explained that they found no argument with the principles that supported the existing Order:
"The conceptual approach to the technology process which integrates analysis, problem solving, practical capability and evaluative skills will make an essential contribution to the education of all pupils as we approach the twenty first century" (NCC, 1992).

They rejected the arguments of those who believed that problem solving skills should be at the heart of the Order and those on the other hand who argued for a return to traditional craft skills. They suggested that a balance between process and content should continue to provide the rationale for the Order.

The aspects that they felt needed fundamental revision were in the areas of the programmes of study and statements of attainment. They suggested that there was a need to: *"reduce the complexity and weight of the requirements in the Order, particularly at primary level; introduce greater clarity and precision in both the basic concepts and particularly in relation to practical skills; introduce more flexibility and choice, particularly at secondary level; strengthen the links to the other Orders" (NCC, 1992).*

In December 1992, in accordance with the provisions of the Education Reform Act 1988 the DFE published the latest proposals for NC Technology five to sixteen. The principle features of the report were: the reduction of the Attainment Targets from four to two; a substantial reduction in the amount of products a pupil must produce; greater emphasis placed on quality rather than quantity. The number of Statements of Attainment were reduced by fifty percent and DFE suggested that there should be 110 rather than the existing 158 Programmes of Study Statements covering Key Stages 1 and 2.

It was envisaged by the DFE that the changes would improve the manageability of the curriculum in the classroom, enhance the practical element, increase the teachers' expectations of the pupils' abilities and specify more clearly the skills and knowledge that pupils should acquire at each key stage so that progression could be secured (DFE, 1992).

In May 1993 Sir Ron Dearing as Chairman of NCC reported back to the Secretaries of State for Education with the preliminary findings of NCC and SEAC on the consultation process regarding the 1992 proposals for NC Technology. Both councils believed that the 1992 proposals represented a distinct advance on what was in existence. However, Dearing asked for an extension until September before they needed to submit their recommendations for the NC Technology programmes of study and attainment targets. They also pointed out that this would allow the new Orders to take into account the conclusions from the Review which the new School Curriculum and assessment Authority (SCAA) were conducting into the manageability of the National Curriculum as a whole.

In September 1993 these recommendations were published. The Council recommended that IT should be separated from Design and Technology in the National Curriculum and that pupils' attainment in the two should be reported separately. It also suggested that pupils should develop their design and technological capability through: focused practical tasks; investigating, disassembling and evaluating products; and assignments in which pupils designed and made products using a range of materials. The new recommendations kept designing and making as the core activity of NC Design and Technology at all key stages but it also emphasised to a greater extent the need for pupils to develop skills and understanding that would support that activity.

In May 1994 Sir Ron Dearing produced his proposals for consultation detailing all ten National Curriculum subjects. The overall aim of the review was to reduce the statutory content; clarify the knowledge and understanding to be taught; remove unhelpful overlap; make progression more explicit; establish a clearer relationship between the programmes of study and attainment targets; replace statements of attainment with level descriptions; extend access to pupils of all abilities; rectify any known weaknesses within the existing orders (SCAA, 1994).

After yet another period of uncertainty and wide consultation the Government released new provisional Orders in November 1994. The aim of this release was to aid planning for implementation in schools in August 1995. In January 1995 the final new Orders were published with a commitment not to change them for at least five years. DATA reported that they believed that the new Order provided *"... a challenge for teachers"*. They suggested that it would be important that a good balance was drawn between the process of designing and the quality of making. They also supported the widely held belief that the breadth of experience many pupils had received under the old Orders had been at the expense of depth and quality. The more structured approach suggested in the Orders was welcomed by the majority of teachers. Although there is concern that some teachers have seen the new Orders as supporting a return to the teaching strategies that were in place in many schools pre-National Curriculum.

The Effect of the National Curriculum on this Research Project

The year 11 pupils who were at the centre of this research project both during the Initial Survey and during Phase One were in fact not being taught NC Technology. Provisions relating to Key Stage 4 only came into force when pupils who were part of Phase Two were at the beginning of their GCSE courses. However, with the introduction of NC Technology in 1990, a progressively larger number of pupils have been taught NC Technology. It was therefore inevitable that even those pupils for whom NC Technology was not compulsory would find that the developments which were occurring in preparation for its introduction had an effect upon the teaching throughout the design and technology curriculum area.

From the researcher's personal perspective she welcomed the introduction of NC Technology. For far too long many teachers of design and technology had failed to deliver a curriculum which would meet the needs of all the pupils studying that area of the curriculum. There were too few schools where one could see examples of good practice.

For teachers in the few exemplar departments, NC Technology and NC Design and Technology has been taken in their stride. It has been planned as part of their on-going development. As a result of the researcher's frequent professional visits to schools she was aware of many staff who would have wished that progress could happen at a more leisurely pace, giving them time for reflection. There has also been an increased workload to contend with. This workload increase has been caused by a number of other educational initiatives which have occurred at the same time as the introduction of the NC Orders. There is a resigned understanding that educational change cannot take place without additional effort from all those taking part. An enthusiastic, hardworking, dedicated team with a belief in the importance of design and technology and a wish to make things happen has been the hallmark of these successful departments.

It is towards those schools who have struggled to implement NC Technology and its subsequent amendments that the researcher wishes to direct her attention. The Interim Report did not present a clearly defined message, it suggested an approach. Programmes of study should describe the means by which pupils are able to achieve the ends defined by the attainment targets. In NC Technology this did not really happen. The Interim Report offered flexibility to allow teachers to devise schemes of work tailored to the needs of individual pupils. When the first Technology Orders were published it was this flexibility, appreciated by 'good' schools, which caused other schools considerable difficulty.

The problem of interpretation has not been the only aspect of NC Technology to cause concern. Another major worry for teachers was the need for teachers of CDT, Home Economics, Business Studies, and Information Technology to work together in teams to deliver this area of the curriculum. This resulted in groups of subject specialists being thrust together to deliver a new subject that many did not wish to acknowledge or believe in. They perceived NC Technology as a subject that did not make use of their personal skills or expertise. Also it was a curriculum area which lacked any clarity of definition in order to help them understand why what they were being asked to do was better than what they had done in the past.

Teachers, HMI and educationalists strongly voiced their concerns. In reply to these concerns seven more publications have been released. The wide media coverage that followed the Smithers and Robinson Report prepared for the Engineering Council and headlines such as "Blue Peter Technology", did little to restore teachers confidence. Each new report or proposal leading up to the latest Orders for NC Design and Technology have sought to clarify the situation further but in doing so added to the overload and complexity. The flexibility, spoken of in the Interim Report, seemed to have virtually gone. However this was recognised by SCAA and the latest Order has been simplified and clarified and include greater flexibility particularly at Key Stage 4.

Design and Technology Examinations and Assessment

Examination syllabuses are designed to develop capability and test competence. Early public examinations in design and technology were like the subject itself, craft orientated (Aylward 1973). Their aim was to test pupils skills in a practical and written sense by the use of timed examinations at the culmination of the course. The various GCE Design and Technology examinations were, like all other GCE examinations, designed to cater for the top twenty percent of pupils. In design and technology the majority of candidates for the examinations were the less academic, practically orientated, male pupils who were destined to take up apprenticeships once they left school. The introduction of CSE examinations to cater for the next sixty percent of school children, came at an opportune time. Many schools were beginning to use a design approach in which the teaching of design skills and practical skills were integrated. The combination of the new approach and the new examination presented an ideal opportunity for the introduction of a coursework element into the examination which allowed pupils to demonstrate their competence in an aspect of the subject which could not be examined by the traditional methods.

This new approach continued to be developed by each of the examination boards. The result was a plethora of syllabuses which led to confusion and misunderstanding amongst prospective employers regarding which skills and understanding had been acquired by pupils during their examination courses.

It was hoped that the inclusion of coursework and other initiatives, for example, Girls into Science and Technology (GIST), Women into Science and Engineering (WISE) and Girls and Technology Education Project, would encourage girls to select design and technology at option time. The percentage of girls who choose to study design and technology for examinations remains, to this day, very small (Oxford Delegacy of Local Examinations Statistics, 1993, NEAB Statistics, 1995).

Today, examinations in design and technology display a greater sophistication of philosophy coupled with a heightened understanding of the processes involved in designing (NEAB, 1993). This understanding has been built up in parallel to the developments in subject philosophy explored in NC Technology and National Criteria for examinations.

The aims of design and technology syllabuses should be to provide pupils with the opportunity to: develop knowledge, skills and understanding; develop practical abilities (including visualisation and spatial awareness); develop the confidence to design, make and modify products; select and use resources effectively; encourage the consideration of effects and implications of technological activity; work both individually and as members of a team; develop critical faculties to enable informed judgements about appropriateness of outcomes; foster awareness, understanding and expertise in the area of creative thinking (SEC 1986; NEAB, 1993).

For the duration of this research project each Examination Board prepared its syllabuses in accordance with the relevant sections of the National Criteria for all GCSE examinations, the 1992 GCSE/KS4 Criteria for Technology and the 1990 Statutory Orders of the National Curriculum in Technology (NEAB, SEAG, MEG, LEAG, and WJEC). Through the use of these three documents differences that used to be evident in syllabuses from the various Examination Boards were minimised.

Assessment

"Discussions of assessment at any level must start with a definition of what is to be assessed" (Schools Council 1975).

The definition of assessment criteria can be quite clear when finite knowledge and skills such as materials, tools, processes and skills related to construction materials and component are to be examined (NEAB 1993). It is once this knowledge base is considered as a resource and inseparable from the practical activity of designing that definition of aims and objectives cannot be specified with any high degree of precision (Schools Council 1975). Individual examination boards have tried to address any ambiguities in as precise a manner as possible. In a situation where there are many answers and many routes to achieve each answer, criteria remain open to interpretation by individual teachers and by different schools.

As the General Criteria (para 19e) describes, *"The principle of fitness for purpose must be observed: all examination components and assessment procedures should reflect and be appropriate to the nature of the subject, its educational aims and its assessment objectives" (1992).*

The application of this principle has meant that design and technology, like the majority of subjects studied for GCSE, has at least one objective that is not easily tested through timed written examination. The National Criteria provided for GCSE examinations to include a significant element of coursework. As Newton & Hurn (1996) point out teacher assessment of pupils' coursework, in common with European and North American trends, has become a central part of the system. In design and technology this has been set at sixty percent coursework and forty percent end of course examination. The relative merits and implications of this decision are discussed in the section on teacher assessed coursework.

Design and Technology Facilities

The environment in which technological activities take place should not be underestimated as an influence upon the quality of work produced (DES 1986). A bright, pleasant and stimulating working environment can bring out the best in pupils (Catton, 1985; DES 1986). To set standards which demand quality in the work produced by pupils requires workshops that are clean, tidy and orderly and productive (Catton, 1985; Toft 1988). Creativity and imagination can be stimulated by the use of interesting and dynamic displays; these also have the potential to improve both teaching and learning (Catton, 1985; DES 1986).

Specialist rooms in a poor condition, cramped workshops, a lack of resources, can all de-motivate both teachers and pupils (Catton, 1985; Boulter, 1989; Webster 1993). Whilst dust, dirt and smell are all aspects of poorly thought out workshops which can have a detrimental effect upon, pupils particularly female pupils.

Successful coursework projects, principally at examination level, are more easily achieved if specialist equipment accommodated in a purpose-designed environment is available (Lewis, 1990). Design and technology rooms which are inappropriately furnished and those schools which have design and technology facilities widely dispersed through out the school have been factors which have tended to hinder the integration of the various subjects supporting NC Technology (HMI 1992).

Male orientated workshops that had been considered satisfactory for craft-based subjects have been shown to be inappropriate environments for the delivery of the activities concerned with National Curriculum Technology (DES 1986). However, many such workshops still exist today (HMI 1992). NC Technology requires flexible working areas capable of permitting work in more than one material and at the same time, capable of supporting design work (HMI, 1992). There also needs to be accommodation capable of taking large joint groups of pupils at certain times throughout a project (Webster, 1993).

In recent years the researcher has been aware of a split which has occurred between those schools who 'have' and those schools who 'have not'. Due to Local Financial Management and such initiatives as TVEI and more recently City Technology Colleges and The Technology School Initiative (TSI), certain schools have money to spend on resources, staff, facilities, equipment and materials. Other schools who only have money allocated by their Local Education Authority have tended not to be so fortunate in enhancing provisions for delivery of NC Technology. In many instances these schools have been unable to prevent a decline in the facilities that they provide for teachers and pupils. NC Technology has placed added pressure upon the resources of hard pressed design and technology departments. It is not surprising that in 1992 HMI highlighted the fact that consumable materials were inadequate in a quarter of the secondary schools that they visited.

Some highly motivated teachers can overcome this lack of finance and provide dynamic, creative environments in which pupils thrive and develop. Whilst others, depressed by the events surrounding the introduction of NC Technology, a lack of support from the declining LEA's and a lack of building and material resources, are unable to motivate themselves to provide the type of environment which will encourage their pupils to achieve levels of excellence.

In the context of this research, design and technology examination syllabuses have a major contribution to make with regard to what is delivered in design and technology at Key Stage 4. The aims of each examination syllabus have been carefully formulated. The corresponding criteria for assessment can provide pupils and their teachers with a framework within which to operate, although it can be a restricting element upon the work which can be carried out.

From the researcher's professional experience and observation as an examiner, at GCSE and A level, she would suggest that pupils are able to produce exciting, worthwhile projects, if they are supported during their examination work by teachers with a sound, refined and well-furnished design philosophy. For those teachers who struggle to establish a deep understanding of what is involved in design activity the examination framework does not provide enough guidance to prevent many pupils from producing design project work which lacks depth.

Team Work and Group Work

The importance of team work as part of the educational experience of pupils has been reported for a number of years. Within the context of design and technology, the Interim Report (1988) spoke of the need for pupils to experience what was involved in effective team work. The Technology Orders talked about *"... the quality of learning which takes place more than compensates for the disruption" (DES 1990).* The DFE (1992) referred to the opportunity to work with others which, they suggested, was likely to increase performance. Peacock, the research director of Phillips, stated that along with literacy and numeracy being able to work in a team was an important quality to be looked for in prospective employees. *"I know that team performance is infinitely higher than individual performance" (Peacock 1989).* However as stated earlier in the section on creativity, working in teams can have a stifling effect upon creativity. This is further supported by Pugh (1991) referring to extensive research by McGrath (1984) when he explained that at different times in the design process working in groups can either have a beneficial or detrimental effect upon creativity. He explained that concepts were often best generated by individuals, whilst concept selection and enhancement were often best performed in groups.

Pugh (1991), McGrath (1984) and Denton (1990) would support the belief that in certain circumstances, pupils working in groups can both learn and achieve far more than when they are working individually. Team work can be intended to achieve other things. It can develop the qualities of: value co operation; a responsibility towards other members of the team; a readiness to listen to others point of view; a willingness to support the view that seem to carry best hope of a solution; a willingness to lead or follow as appropriate; perseverance.

Certain aspects of the activities involved in design and technology education lend themselves to delivery through group work. There is evidence to suggest that groups of people, co-operating together, can produce more and better ideas than the same people working individually (Denton 1990). Certainly industry has learned this lesson and is increasingly using groups in both design and production (e.g. Nissan etc.).

Group work in schools has been shown to fall into two categories: pupils who work in groups; pupils who work as groups. Those who work in groups typically only shared resources, whilst individuals effectively worked independently (Denton, 1990). Research by APU supported Denton's findings and also suggested that pupils found it easier to make progress when they had the opportunity to use other people as a resource, "*... as a sounding board against which to test ideas, to encourage and criticize, to share ideas, skills, knowledge and particular expertise and help make decisions" (APU, 1991).*

Consistent with the requirements of NC Technology and the relevant sections of the GCSE/KS4 Criteria for Technology (1992), the examination boards stated that a design and technology syllabus should provide opportunities for pupils to work as members of a team (NEAB 1993). Although there is support for group work from the examination boards and educationalists, who have described it as an important aspect of a child's education, at examination level, group work tends to be avoided as the identification of an individual candidates' contribution to a group project can cause assessment problems (Denton 1990).

Equal Opportunities in Design and Technology

Equal opportunities in Education have been a major concern of educationalists for a number of years. In design and technology this has manifested itself particularly in the area of gender in-balance in design and technology classes (Riggs, 1993).

There has been disappointingly slow progress made in the percentage of girls participating in design and technology at examination level (University of Oxford Delegacy of Local Examinations, 1993; NEAB, 1995) in spite of much research, the introduction of comprehensive education, equal opportunity legislation, (Harding, 1982) many initiatives, (Gilligan, 1982; Smail, 1984) a willingness by teachers to tackle the in balance, and the increased participation of all pupils in design and technology at lower secondary level (NCC 1989).

Various writers, notably Kelly et al (1981), have suggested reasons why girls have not opted for science or design and technology. Many have believed that it was important that they did, not just because Britain needed their expertise, but for the sake of women themselves. Bryne (1978) suggested that the consequences of girls who failed to undertake studies in science and design and technology was *"their subsequent condemnation to jobs that were temporary, low-status and poorly paid."*

Since the beginning of the 1980's there have been many attempts to increase the participation of girls in science and design and technology. For example, TVEI, WISE (Women Into Science and Engineering), GIST (Girls into Science and Technology) and Girls and Technology Education Project. A common theme highlighted in each project was the need to link technology and its social implications (Gilligan, 1982; Smail, 1984).

Research results from the GIST project in 1984 showed that girls and boys had almost equal design and technology knowledge when they entered secondary school. However, Kelly et al (1984) explained that attitudes towards science were polarised by then. Newton & Newton (1992) in an article concerning young children's perceptions of science suggested that children acquired a stereotypical image of the scientist perhaps as early as six years old. Kelly et al (1984) in their report explained that by the time pupils had reached their third year, that boys acquired slightly better marks than girls but that boys' estimation of their own achievement was much higher than girls. The project results also showed that both at eleven and fourteen boys had more definite ideas about what girls should do and what boys should do.

The Girls and Technology Education Project 1981-1984 was concerned with the education of girls within design and technology at secondary school level. The project wrote a number of reports on its work and also commented upon educational topics within its area of interest. One study, 'Objectives of Design and Technology Courses: as expressed in Public Examination Syllabuses' reported that despite developments in Design and Technology education, changing social attitudes and legislation, participation in Technology activities by girls was minimal. 'The involvement of Girls in a National Design Competition' study, when analysed, indicated that girls were more likely to submit projects of a social nature.

The 1983 report was a response to TVEI. It looked at several aspects of the provisions made in the initiative and at the opportunities available for 'lower achieving' girls. The study, 'Improving the Access', recommended that *"organisational barriers"* to girls participation must be removed so that work could then be carried out on content, teaching method, learning resources and the hidden curriculum (Harding and Grant, 1984).

Literature on gender and education has pointed to the role teachers have played in *"thwarting the potential"* of girls (Riggs,1993). Sometimes this has been explicit, but often it was implicit and part of the hidden curriculum which meant that assumptions were not challenged and schools transmitted attitudes and values which reinforced sex-role stereotyping.

The prevailing notion that design and technology is about things and not people needs to be re-addressed (Newton, 1984; Riggs,1993). This is not only because girls can relate more easily to the social aspects of design and technology (APU, 1991), but also because the consideration of values should be seen as a central theme to a technological education for all (Layton, 1992).

Differences in intellectual ability are not necessarily an issue when considering the reasons for girls failing to study design and technology (Riggs, 1993). On the other hand, differences between boys and girls in terms of motivation (APU, 1991; Riggs 1993), interests (APU 1991) and perception (Riggs, 1993) are of greater importance (Riggs, 1993).

Teachers need to carry out regular school reviews on equal opportunity policies and examine classroom practices (Pratt, 1984). They need to respond positively to change and be wary of forming assumptions and expectations on the basis of a pupil's sex (Catton, 1985).

In the short term, single sex groups can give both teachers and girls the necessary confidence to attempt new areas of work. In the long term, single sex groupings are not the answer. It should be possible to re-define the planned and hidden curriculum to ensure that girls experienced genuine equality of opportunity in mixed groups (Millman, 1984). The interaction of boys and girls is a vital part of the development in all pupils of an understanding of technology and its implications on humanity (Riggs, 1993).

The attitude of teachers and their pupils need to be monitored. The attitude of male teachers can be one of the biggest stumbling blocks to improving opportunities for girls in design and technology (Pratt, 1984). Many male teachers are unsympathetic, or indifferent (Pratt, 1984). Some are reluctant to accept anti-sexist initiatives or can be unwilling to accept that they may be biased at all (Whyte 1986). Girls are generally very perceptive (Riggs, 1993) and are able to judge whether they are welcome in the design and technology environment or not.

Boys attitudes are reflected in their behaviour in workshops, where they tend to monopolise the equipment and taunt girls who make mistakes (Kelly et al, 1984). Boys prefer to be independent and competitive (Riggs, 1992) and are less likely to help one another, be it girl or boy (Sylva, 1992).

Girls need support in many areas of the work involved in design and technology (Catton 1985). They become easily depressed rather than frustrated when they perform poorly (Sylva, 1992). On the other hand, care has to be taken not to give too much help. Struggling girls are very willing to accept help and adopt the helpless female stance (Sylva, 1992; Riggs, 1993). This type of help can anger boys and reinforce the perceived image of the incapable female. It can also reinforce the lack of self-esteem in girls (Riggs, 1993).

It has been thought for some time that the choice of project has a bearing upon whether it is 'girl- friendly' or not. Research supports the researcher's belief that giving pupils freedom of choice will not prevent the development of gender stereotypes (Milner, 1988). Several books and reports have shown that girls work best if they are involved in satisfying human needs (APU, 1987; Millman, 1984). More recent research has shown that it is not only the context of the project but also the structure of the project that matters. Girls have been shown to prefer tightly structured, people orientated, reflective tasks (APU, 1991).

In assessment, teachers need to be careful to treat all pupils fairly. Research into the assessment of design and technology project work has found that *"Work attributed to a boy is rated higher than identical work attributed to a girl" (Spear, 1984).* Girls can achieve high standards in design and technology examinations, (University of Oxford Delegacy of Local Examinations 1993) but they lack confidence and under-estimate their own ability (Sylva, 1992; Riggs, 1993).

Care needs to be taken regarding assessment feedback. There is a tendency for teachers to give boys feedback in the form of performance evaluation which is helpful to the pupil's future progress. Research has shown that the feedback girls receive tends to be concerned with irrelevant characteristics of their work which does little to build up their confidence in areas of which they are unsure (Sylva, 1992).

Gender is not the only aspect of equal opportunities which needs to be addressed in the context of design and technology education. Government led, all encompassing statements on equal opportunities can be found in both the GCSE Criteria and in all NC Technology documentation. *"Experience in design and technological activity is an entitlement of all children, essential to enable them to achieve their full development as individuals and members of society" (NCC, 1989).*

With regard to Special Educational Needs NCC (1989), referred to having drafted the attainment targets and programmes of study so as to avoid the need for general dis-application. They suggested that cultural diversity had always been a feature of British life but they recognised that design and technology education raised problems that required perception and sensitivity from teachers. On the matter of gender, they stated that design and technology should provide equal opportunities for boys and girls and that in this context teachers must consider the expectations and attitudes of girls to design and technology. Activities that did not reinforce stereotypes and extended the range of interests beyond conventional horizons were important considerations.

Racial equality has received very little attention from researchers. Eggleston (1992) and Siraj-Blatchford (1993) suggested that there was an urgent need to address the problem of the underachievement of Black pupils in design and technology. In reviewing the evidence, Eggleston pointed to the tragic consequences of stereotyping and unintentional racism of teachers who did not challenge the popular assumptions surrounding the motivation, behaviour, language ability and cultures of their Black pupils.

Feedback from teachers, educationalists, industry and others to the DFE during the consultation process in 1992 recognised the fact that design and technology education had still not successfully addressed equal opportunities for all pupils, regardless of gender, cultural, intellectual or social differences (DFE, 1992).

Pupils Reasons for Choosing Design and Technology

Over a number of years concern has been expressed by many teachers of design and technology at the lack of pupils selecting design and technology once they are allowed to make option choices (Dodd, 1986; National Curriculum : Design and Technology Working Group 1988). This situation was thought to have been overcome when design and technology was included in the National Curriculum as a foundation subject. The first Orders stipulated that all pupils must study NC Technology till the end of Key Stage 4. However, the revision of the Orders allowed for choice between the strands identified within design and technology at Key Stage 4. This has once again meant an uneven distribution of pupils choosing the various strands associated with GCSE design and technology examinations. This is particularly noticeable as far as genderun-balance is concerned.

A case study by McCarthy and Moss in 1990 referred to the reasons why pupils had chosen design and technology to study at GCSE level in their school. Although giving an interesting insight into option choice the study was based upon a very small survey of forty pupils in the researchers own school. Being a case study, there is difficulty in cross-checking information and also a danger of distortion in the results (Bell, 1987). However it is interesting to note that they suggested that for the majority of pupils the choice of design and technology had been a positive one. They inferred that external factors had had little influence upon pupil's choice and yet by far the most popular reason pupils gave for opting to take design and technology was its future use to them. When looking at this result one needs to take into account the question of how much the result was influenced by teacher enthusiasm for design and technology prior to questionnaire completion.

McCarthy and Moss (1990) also indicated that they were surprised that peer group pressure and parents had had an apparently small effect upon the choice of design and technology as an option. The wording of the questionnaire *'... told to by parents'* may have had an influence upon the replies. Neither did they indicate whether they had taken into account the fact that parent and peer pressure can be very subtle and beyond many measuring instruments.

On further, thin evidence, they went on to suggest that although the majority of pupils stated that they had enjoyed their lower school experience only a small percentage indicated that this factor had had a strong influence on option choice.

The activities involved in design and technology education lend themselves to delivery through group work. Being able to work in a team is considered by educationalists and industrialists to be an important quality to develop, along with literacy and numeracy. NC Technology and GCSE criteria specify that all courses should provide pupils with the opportunity to work as members of a team. Group work can develop qualities of: co-operation; responsibility; perseverance; a readiness to listen to others; a willingness to support the best hope of a solution and a willingness to lead or follow as appropriate.

My own experience accords with the views expressed here, namely, it has been evident that design and technology pupils who work in groups can produce more and better ideas than the same people working individually. Even when pupils are working on individual projects, working together as a group at certain stages of the process is a valuable way of widening their perspective of the task in hand.

The need to address equal opportunities in design and technology is highlighted in NC Technology and GCSE documentation. It is stated that experience in the activity is an entitlement of all children. The aspect of equal opportunities in design and technology which has received considerable attention, with numerous initiatives and even legislation, is the area of gender in-balance. The slow progress made in encouraging Key Stage 4 girls to participate is particularly disheartening.

Intellectual ability is not an issue, but the difference between boys and girls in terms of interests, motivation, and perception are considered important. This belief is supported by various researchers active in this field.

The teachers role is felt to be considerable in influencing equal opportunities. The attitude of some male teachers and a lack of female role models are hindering progress. Equal opportunity policies, regular school reviews and examination of classroom practices are areas through which change could be instigated.

The way in which essential support is given to girls in design and technology is significant. Girls lack confidence (Riggs, 1993), easily acquire learned helplessness (Licht & Dweck, 1983) and under-estimate their own ability (APU, 1991). Given the correct support, girls will thrive and bring a new perspective to the work studied in design and technology

With reference to the disheartening number of girls participating in design and technology education at Key Stage 4, this is also a problem evident with boys, although to a lesser extent. With the introduction of NC Technology as a foundation subject for all pupils up to the end of compulsory education one could naively suggest that the problem of participation had therefore gone.

It is now the case that all pupils have to attend design and technology lessons up to the end of Key Stage 4. The underlying reasons for the non-participation of pupils in design and technology still needs to be addressed. Without a change in the content or delivery to accommodate these pupils how many will truly participate and how many will remain disenchanted or de-motivated and not benefit from engagement in the activity?

Literature Review

The Design Process

The Process of Designing and Cognition of that Process

The fundamental purpose of designing is the development of outcomes of various types. The aim of teachers should be to show pupils how to design effectively (Denton, 1993). Undertaking a technological activity requires pupils to exercise logical procedural strategies, often referred to as design processes. Traditionally, these have been described as a number of specific sub-activities such as researching, specifying the problem or need, generating ideas, making and evaluating. The relationship between these sub-activities and the whole process have been described in the form of a number of design process models (e.g. APU, 1991 see Figure 1.7).

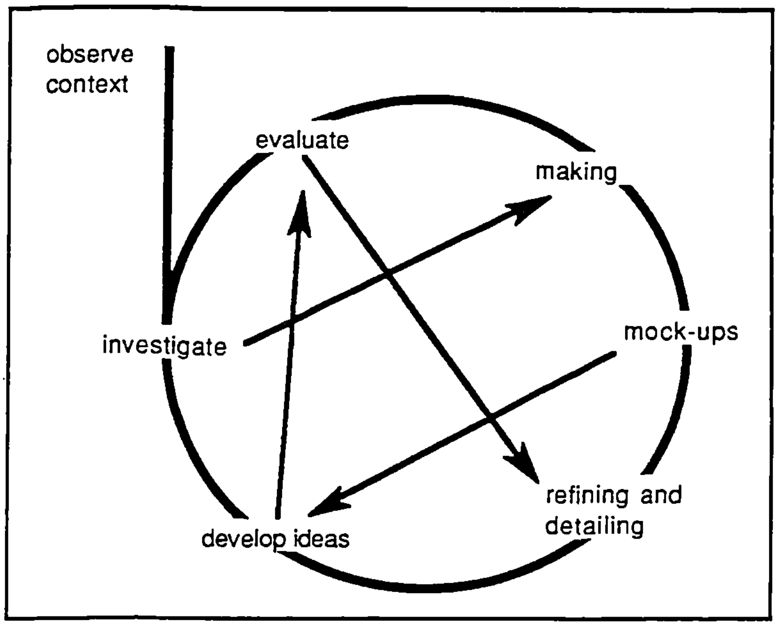


Figure 1.7 Illustrates an interacting design loop (from Kimbell, 1987, p.10.)

The simplest model describes the whole process as linear (Figure 1.8). This is a far too simplistic model to explain the highly complex procedure that one uses when designing. Indeed, some of the authors of literature concerning the process do acknowledge that their models are over simplifications of the real process involved. Elements of the process are interactive, they should not be thought of as a rigid framework to be applied in every case *"... but more as a set of reminders of what might be involved" (SEC 1986).*

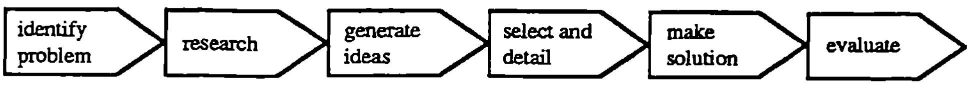


Figure 1.8 Illustrates a simple linear model of the design process

The notion that there was a general design process that could be used in a variety of situations had doubt cast upon it by Hennessy et al (1993), Chidgey (1994) and Shield (1995). In Hennessy et al's article "The myth of general problem-solving capability : design and technology as an example", they referred to the creation of *"a veneer of accomplishment"* that pupils generated when they tried to accommodate the teachers' aims by following the prescribed sequence of procedure. Whilst the literature has supported the belief that there is a logical approach to solving problems, it has also accepted the principle that pupils ought to be encouraged to use appropriate short-cut creative approaches and that these should be instinctive and emanate from intuition, guesses, inspiration or even accidents (e.g. Schools Council, 1986).

Archer & Roberts (1992) explained their belief that the process of designing was a problem-centred activity. They suggested that most real world problems encountered were 'ill-defined' and were therefore not resolvable by scientific or mathematical methods.

"The design act is one of discovering and elaborating and adapting requirements and provisions to match one another. The problem is obscurity about what the requirements might be, ignorance as to what sorts of provisions might be suitable and uncertainty as to how well the one might fit the other. The solution is the achievement of a requirement/ provision match that is both sufficiently described and demonstratably a good enough fit" (Archer & Roberts 1992).

In 1987 APU revealed the crucial relationship they believed existed between the activities that occurred inside and outside the mind during designing. This relationship was identified as interactive rather than sequential. They suggested that the total activity was cumulative, experiential and reflective, as ideas were tried out and then accepted, modified or rejected.

The Importance of Modelling Within the Design Process

The term 'model' has been used by scientists, mathematicians, technologists and designers to mean *"something that stands for something else"*. They have been described as *"information carriers" (Archer, 1986)* that allow the designer to *"... make a trial that minimises the penalties for error" (Judson, 1980).* Literature has also supported the notion that modelling was a fundamental capacity of the mind. It has been shown to be related to imaging in the same way as language was believed to be related to abstract thinking. Other writers have suggested that for human beings the 'capacity for imaging' was as important as language capacity (e.g. Archer, 1986; CBI, 1993).

The term in the context of this research refers to the externalisation of thoughts by means of drawings, diagrams and constructions. Baynes writing in 1992 explained that models were powerful because they isolated an aspect of reality and allowed one to represent, interpret, manipulate or control it.

With reference to cognitive modelling in relation to design activity, Archer (1992) explained that there were categories of perception (of space, form, object-coherence, colour, temperature, sound and others) which he believed were common to all human beings. Roberts et al (1992) suggested that rational thought stemmed from the labelling of the relationships between the conceptions and categories.

"... it was in the recognition of pattern, in and amongst conceptions and categories, that designerly thought sprang" (Roberts et al, 1992).

Research has suggested that the left half of the brain specialised in the art of categorisation and rational, sequential thought. The right half of the brain specialised in pattern recognition and the use of *"presentational symbol systems"* to construct images and other forms of spatial representation. Writers explained that the interplay between the two halves of the brain permitted the *"... pursuit of thought both to the highest levels of abstraction and to the furthest reaches of practical planning and design" (Roberts et al, 1992).*

The ability to generate and develop the optimum solution to a task using modelling has been shown to be central to task resolution (Down, 1986; APU, 1991). Models have been referred to as information carriers. However it was pointed out that if they were to be effective then they must be intelligible to the user. Research carried out by Liddament (1993) suggested that even when pupils constructed images themselves teachers tended to assume that they were more transparent to the pupil than was actually the case. He believed that models were often ambiguous and could easily mislead or confuse. He went on to explain that models contained information that was only accessible to those who were already in possession of the requisite concepts.

The National Curriculum interpretation of modelling has appeared narrow, unhelpful and restrictive. Murray (1992) and Norman & Roberts(1992) believed that a broad interpretation that acknowledged the source and development of ideas, and a wider range of representational forms was required. The weakness of the model Norman & Roberts (1992) suggested was that it had the effect of saying that pupils were not engaged in design and technological activity unless they demonstrated each of its *"stipulative and theoretic 'stages' " (Norman and Roberts, 1992).*

As early as 1978, APU pointed towards an inappropriate use of the design process by some pupils that could result in over-concern for *"doing all the stages in the process"* rather than utilising the design process in a manner appropriate to the task in hand.

Denton (1993) suggested that certain aspects of designing having become a *"stylised ritual"*, concerned with the production of endless visually attractive design sheets. The ritual he believed was caused by several factors. It stemmed from the need to have evidence for examination purposes, and an incomplete understanding by many teachers of both the process of designing and the functions of modelling, in particular, drawing. This theory was supported by Anning (1993) in her research into modelling techniques encouraged by teachers in primary schools.

The purpose of the cognitive model should determine its nature against which its usefulness can be evaluated (Harrison, 1992). However, the culture of schools has generally valued 'finished' and attractive work in all subjects. In both the literature review and during professional observation by the researcher this has been shown to have an unfortunate consequence in the case of design activity. This has been particularly noticeable during the initial stages when the rapid development of ideas has been required. As Denton (1993) explained such modelling does not need to be any more carefully done than is necessary to advance thinking.

The guidance document regarding major project work, received by schools taking the University of Oxford Delegacy of Local Examinations Advanced Level Design and Technology (Design) examination supported Denton's suggestion that inappropriate forms of modelling have been encouraged by teachers.

"We know that many candidates are unwilling to include what they regard as 'rough' work and insist on re-drawing it. This is of no value. ... What is required is clear, well-drawn creative work done at the time of thinking. ... An artificial, retrospective construct of how the candidate would like other people to think events unfolded is of no value. This type of activity is closely related to 'retrospective designing' which is a major problem in design coursework..." (University of Oxford Delegacy of Local Examinations, 1993).

Other writers have also highlighted the use of inappropriate forms of modelling. APU (1991) referred to modelling in the form of drawings as being less effective than mock-ups in certain circumstances. HMI's advice for teachers referred to the appropriateness of the modelling technique utilised. *"... do not encourage the representation in two dimensions of complex three-dimensional shapes" (DES, 1987).* They also suggested that too many pupils*"... responded in writing when three-dimensional modelling would have been more appropriate" (DFE, 1992).* A picture of an elephant is worth a thousand words (Hartley, 1986).

In the 1985-91 Design and Technology Project, APU's research pointed to the fact that pupils generally were confident in their communication. Yet the researcher would like to suggest that this is very often not the case. During her professional experience she has witnessed a large proportion of pupils that were aware that they had produced poor, ill-conceived drawings that were irrelevant to the task.

NCC (1992) in 'The Case for Revising the Order' supported the concern regarding pupil's poor communication and cited a lack of stimulus or resource material as being a major contributing factor. The researcher would suggest that it is also often a complex mixture of a lack of understanding of what is being communicated, to whom and why. Interwoven with this is the fact that pupils are seldom taught communication skills which are an essential part of the iterative process of clarifying and reconstructing ideas. There is a basic lack of understanding regarding simple drawing skills such as perspective linked to the concept of proportion. The poor teaching of form, function and constructional detail fail to provide pupils with a satisfactory knowledge base for their decision-making (DES, 1992).

Examination syllabuses and NC Technology, with a need for evidence to assess, have caused pupils frequently to spend too long recording a specified number of ideas on paper irrespective of the quality and nature of those responses.(DES, 1992).

Three Dimensional Modelling Within the Design Process

Making is not merely something that happens after the designing and before the evaluation" (APU, 1986).

Making is inextricably part of generating and developing ideas. Three dimensional modelling is a constantly developing reference point without which it is impossible *"to engage ideas in the mind with reality" (APU, 1991).*

The notion that a three dimensional model is a focused simplification of fact was suggested by Brown (1983). He stated that *"no model is ever a perfect representation of the real thing. If it were it would be a replica" (Brown, 1983).*

Reference has been made to three dimensional modelling by many writers dealing with the design process (e.g. APU, 1986; APU, 1991; HMI, 1992; Evans, 1992; Denton, 1993; Barlex, 1994). Three dimensional modelling has been shown to take on a variety of forms throughout the design process with the type of modelling adopted having depended upon the stage of the process that has been reached and upon who the model has been made for. Writers have explained its use as a means of clarifying a designer's thoughts for their own benefit or as a way of representing those thoughts to others. Evans (1992) referred to the importance of the speed of manipulation during the early stages of designing. Others indicated that early models only needed to contain the essential elements of reality; their function was shown to be to test out a theory or principle (Judson, 1980). The later in the process the modelling has occurred the more accurate and detailed the model has needed to become (Lawson, 1990).

Many writers have also shown their understanding of the time consuming nature of this form of modelling. Johnsey (1993) quite rightfully referred to the detrimental effect of producing three dimensional models during the early part of the design process whilst HMI (DES, 1992) have shown their concerns regarding the demands placed upon a pupil's time during the manufacture of the final prototype.

Part of technological capability is concerned with the ability to design in a predictive manner, rather than using trial and error strategy. Modelling in three dimensions has been shown to be an important factor in achieving this capability. As a rule pupils have tended to avoid designing in this manner. Although, as Harrison (1990) indicated, modelling in three dimensions was one of the most important ways to enable predictive designing skills to be acquired.

Evans (1992) supported the researcher's belief that wherever feasible, models should be made full size and not scaled down. He explained that this ensured an accurate evaluation of the product modelled. He agreed that it enabled a designer to understand more fully the complex relationships between components, cavities, interfaces and form. He also supported other writers concerned with the ergonomic features of a product when he explained that anthropometric data could be more efficiently checked on a three dimensional model.

" Being able to hold, move, and look inside a product concept can reveal discrepancies and possibilities not apparent whilst sketching in two dimensions" (Evans, 1992).

NC Technology specifically referred to three dimensional modelling capability. Throughout the development of NC Technology requirements between 1990 and 1995 the importance of giving all pupils the opportunity to explore and validate the effectiveness of their ideas in a material form was explicitly stated in each new document. In the 1990 orders, it was specified that pupils would be involved in the use of a variety of materials and that the manipulation of those materials was likely to improve performance. In 1993 whilst still referring to the necessity for pupils to work with *"... a range of resistant and compliant materials ..."* the NCC also stipulated the importance of 'quality' within both designing and manufacturing at each Key Stage. This belief in the importance of 'making skills' continued into the 1995 Orders. Although no where in any of the NC documentation has the importance of using three dimensional modelling skills whilst designing been mentioned.

Evaluation Within the Design Process

Evaluation has for a long time been considered an important, well established part of the design process (SEC 1986). Educationally it was seen on the one hand as a means of developing a pupils capability to reflect (APU, 1991) whilst on the other it was considered an ideal medium for teaching skills in written presentation (SEC, 1986). A thoughtful, summative evaluation was shown to enhance a pupil's response to the process of designing and provided an opportunity to expose and record progressive refinement of a pupil's understanding (APU, 1991).

It was recognised that successful formative evaluation was strongly linked to the ability to generate and develop ideas (APU, 1991). Whilst evaluating the efficacy of a final solution against the original need was accepted as one of the most demanding task within the whole design process. The difficulties, for some pupils, associated with the task of evaluating design activity were recognised by certain writers (e.g. APU,1991). Suggestions regarding the planning of evaluative activities explained that evaluating an end product could be a tight and therefore supportive structure within which pupils could achieve satisfactory outcomes.

However, set against the important reasons for requiring pupils to evaluate their design and technology projects problem areas regarding evaluation were identified during the review of the literature. Of prime importance was the fact that some writers suggested that pupils disliked having to write reports or annotate their sketches with evaluative comments (e.g. White, 1988; Grieve, 1993). This supported the researcher own belief, established during her professional activities, that pupils did not respond to this important part of the design process in a positive manner. HMI (DFE, 1992) suggested two reasons why the problems concerning evaluation occurred. Firstly they suggested that it was because pupils rarely considered or recorded criteria appropriate to the evaluation of their solution. Secondly they indicated that a considerable number of pupils produced non-working models of their ideas and that in many instances these models prevented the pupils from assessing the effectiveness of their designs. The researcher believed that these reasons were only part of the story and looked forward to addressing this aspect of the process during the data collection phases of the research project.

Literature Review

Approaches to the Activity

Problem Solving Approaches in Design and Technology Education

Problem-solving processes have been used as an important method of delivering technological education for a number of years. They continue to be advocated, by some as essential core skills that would improve industrial performance, and by others as a means of motivating pupils through the encouragement of active and meaningful learning (McCormick et al, 1993).

Although the terms problem solving and open-ended problem-solving have been used to describe pupils experiences in design and technology education since the 1970's, in this educational context these terms have often been misused (Harahan,1978). There has been a great variation in the extent to which teachers directed pupils or left them to *"bridge the gap"* between their initial understanding and the production of a solution to a given problem (Harahan, 1978; Schools Council,1985; Down 1986; Interim Report 1989).

In the area of problem solving a considerable amount of time has been spent examining designers' behaviour and methodology (Harahan, 1978). Fourteen years later, Roberts et al (1992) believed that much research still needed to be done in this area in order to come to terms with the intricacies of the process involved.

Initially problem solving was understood by practitioners to consist of a sequential step-by-step process. Harahan was one of those who believed that it was not as simple as that. He suggested that the steps would be better termed patterns that did not appear to be automatic or mechanical. He believed that they should be applied flexibly, according to circumstances, with alternatives available at every step.

The researcher's own experience as a student of Industrial Design in the mid-1960's lead her to believe in a design philosophy which required a flexible approach. This suggested that design could not be categorised into a problem solving activity or be defined as an art but, as supported by Harahan (1978) and Pye (1978), that it was both.

"All arguments about what designers ought to do seem to be bedevilled by the habit of a mind which links 'either... or' : either all invention or all logic, either all artist or all problem solver. This is extremism, and extremism in any cause whatever, good or bad, is evil" (Pye, 1978).

Archer and Roberts (1992) defined the activity utilised in design and technology as *"problem-centred"* and suggested that it was distinguishable from some other sorts of problem-solving activity by the fact that it was chiefly concerned with *"ill-defined problems."*

The Schools Council Design and Craft Education Project stated in the introduction to 'Education through Design and Craft' that the development of problem solving approaches suitable for secondary schools had been the pivotal feature of their project. They defined problem solving as, identifying design problems, investigating them, producing and realising solutions and finally evaluating the end product. They published a book titled 'You as a Designer' (Schools Council 1974) aimed at disseminating directly to pupils their understanding of the problem solving approach. The book detailed in terms that pupils could relate to the factors that needed to be considered at various stages of the process.

In a pilot study of pupils problem solving processes, McCormick et al (1993) spoke of the use of problem solving to develop pupils general practical capabilities in order to enable them to handle complex problems in their personal and working lives. Their research, up to that point in time, had indicated little empirical justification for the idea of a general transferable problem-solving process. Assumptions about what processes pupils learned during problem solving tasks and how they used their knowledge, they suggested, were rarely based upon close observation of pupil behaviour in the classroom.

The use of 'real' problems for pupils to solve has been advocated by many (SEC, 1986; DES, 1987; Design Council, 1987) as a way of motivating pupils.

The rhetoric of design and technology education which has assumed that pupil motivation was provided by posing 'real' problems is ill-founded. The use of 'realistic' problems is possibly nearer to the truth. In their article, Hennessey et al (1993) supported this when they suggested that their research indicated that *"... aspects of everyday culture could not be readily transported to the artificial and constrained environment of the classroom"*.

In 'Learning to Design, Designing to Learn' Jungck et al (1992) argued that scientific investigation was a practice much closer to the traditional processes used in designing than was commonly recognised. They explained that there were two types of scientific problems; analytic and synthetic. They indicated that these were interwoven in the process of designing.

"The process begins from a set of tentatively accepted theories (resources and constraints) and seeks to understand a phenomenon. Understanding (expressed as a hypothesis) is the product to be created. The goals are fuzzy, very fuzzy, when compared to the concise statements that will ultimately be published in the scientific literature, and the nature of the goals is refined (even 'discovered') during the process of pursuing them. The decision that the goals have been reached is subjective, decided by the scientist. This may be based on external constraints, such as available time, but preferably is based on personal judgement

that the hypothesis is convincing, defensible, reproducible, parsimonious, and, in some sense, elegant" (Jungck et al, 1992).

The broad similarity which Jungck et al and others have suggested exist when problem solving is tackled in different areas of the curriculum is not supported by Layton (1993). Layton believes that it is in the differences in approach to problem solving that the different disciplines defined themselves.

Project Work in Design and Technology Education

Project work, in the form of long term tasks were used to deliver and examine technological capability as early as the mid 1960's. This new approach coincided with the introduction of design related activities into a subject area that had until then been concerned with skill based activities (Harahan, 1987).

From their inception all design and technology CSE examinations syllabuses incorporated coursework in the form of long term design projects. In the early days, the activity was often referred to as problem solving. By the time the Interim Report was published it had been recognised that design and technology was more about *"identifying needs and opportunities"* and not so much about having to find problems to solve (Interim Report 1988).

Project work has been a central activity in design and technology (Design Council, 1980; DES, 1988; NCC, 1989; DES, 1990; DFE, 1992). Designing, making, applying knowledge and evaluating should be interwoven in each project so that learning derived from each serves to reinforce learning in the others (DFE, 1992).

It is evident that pupils are often most productive when projects related to their own interests. This view is supported by Schools Council in the Design and Craft Education Project and 'Modular Courses in Technology' (Schools Council, 1975, 1986). They also gave examples that suggested project work developed:
"Skills in the application and use of knowledge and expertise in solving particular problems; the ability to work with others; divergent and convergent thinking by giving due consideration to intuitive inspiration, guesses, and accidental developments as well as those achieved by means of a logical step-by-step progression; self-discipline and responsibility, as the success or failure of the project is pupil-centred; creative abilities and encourages enterprise and dedication; speculative thought and exercises ingenuity" (School Council, 1986).

Project work is made up of a complex set of activities which were specific, inventive, effective and evaluative, *"specific - because they relate to a particular need; inventive -*

because they call for a creative response; effective - because the end result should reflect a better fit or match between need and provision than existed formally; and evaluative because the designer is called upon, through the process, to exercise value judgements of many kinds when arriving at a proposed solution" (APU, 1987).

This view was supported by SEC (1986) who postulated the notion that project work provided the source of motivation that gave focus and direction to learning. The Schools Council in 1975 also referred to motivation in the context of project work. They referred to open-ended approaches that offered pupils the opportunity to develop their own interests. *"The mere possession of abilities gets us nowhere unless we are motivated to use them" (Schools Council, 1975).*

Few practitioners in the design and technology curriculum area would disagree that in education, motivation is an important condition for learning (Stables, 1993). However, the extent to which motivation within project work in design and technology is dependent upon intrinsic or extrinsic factors is not always clear. Stables suggests that motivation is sparked off by something more fundamental than satisfying a personal interest or acquiring a new knowledge; it is marked by an intrinsic desire to achieve a goal for an extrinsic purpose, to use materials and tools to resolve a need.

The motivational role of project work is seen as vital to successful learning, although it is felt that it could be at the expense of coherence in the subject and the teaching of knowledge and skills (Down, 1986). Down also suggests that although project work by itself provides pupils with insight into how technologists work, it can leave them ignorant of the range and scope of technology and its relationship to manufacturing industries.

Qualities Enhanced by Design and Technology Project Work

Project work in design and technology has been cited by many writers as being an area of the curriculum that gives pupils the opportunity to develop a wide range of qualities, some of which are not easily developed in other areas of the school curriculum.

The CDT Committee of HMI in 1983 referred to project work developing in pupils analytical and intuitive powers as well as manipulative skills. They believed that the constraints of a project helped pupils to develop self discipline, to recognise their own level of ability and pointed towards the importance of organisational and management skills. Stress was placed on the fact that the activity required pupils to constantly appraise and re-appraise. In addition, HMI indicated that the activity should place demands on pupils that were proportional to their level of ability.

Project work has also been linked to developing an awareness of the way in which human needs, social concerns, aesthetic factors as well as technical data and skills affect the final product (Down, 1986). Projects give pupils the opportunity to compromise and reconcile differing views and values relating to a wide set of factors (Standen & Cromac, 1990).

The Need for Quality of Output in Design and Technology Project Work

As the subject area of design and technology has progressed from single material, craft-skill based courses to the complex thinking, feeling doing activity, the conflict between the need for breadth and depth has grown.

In 1980 The Design Council referred to quality of experience as being of fundamental importance rather than any ability the pupil may acquire in a specific competency. They saw design as a holistic experience where both the process and the sum of the individual learning activities were more than the whole.

Further, the quality of the end product can only be seen in relation to the overall experience and reasoning that has lead to its development (Harahan, 1978). Decision making and evidence of process are important factors in relation to manufactured output.

HMI added their support to the belief that although much time and effort is directed towards a finished product, the quality of the processes leading to that end are also of major importance. *"One reason is that the quality of each stage determines to a large extent the quality of the whole."* Teachers largely agree with this philosophy but frequently find it increasingly difficult to balance the requirements to work with a broad based range of materials in an ever expanding context, with the need to ensure that pupils produce outcomes of quality. During the first year of implementation of NC Technology there developed a general consensus amongst educators that the pendulum had swung too far away from the need to obtain quality in the work produced in design and technology lessons.

Support for this concern was shown by NCC in their case for revising the Technology Orders, when they highlighted three areas regarding quality. First, in 'making skills', where they stated that breadth of experience had been emphasised at the expense of specialisation, causing a lowering of standards. Secondly, they felt that few teachers were clear about what they should expect of pupils and found they were often complacent when pupils produced a poor standard of work. Thirdly, they blamed the integrated Technology courses where teachers from contributory subjects had to work outside their specialisms. Concern was also expressed concerning low standards that went unchallenged, work that lacked rigour and pupils who were poorly motivated. They found that too much time was spent on written work. Design and practical activities were often narrowly focussed and progression was weak (NCC, 1992).

The concern of NCC regarding integrated Technology courses was supported independently by the work of other researchers (McCormick et al, 1993). They suggested that what was expected of teachers from contributory subject areas failed to take into account the potential conflict between the teachers understanding of, or commitment to, the task in hand.

The Relationship between Knowledge and Process in Design and Technology Project Work

"Only in education - never in the life of the practical man - does knowledge mean a store of information aloof from doing" (Down, 1986 (b)).

As early as the Dainton Report of 1968 the complex relationship between the content of design and technology, the procedural demands of the activity, and the individual learning by pupils, had been recognised.

" When there is a body of received knowledge to be acquired before speculation and imagination can be given free reign, then curiosity and enthusiasm will surely be quenched. ... It is most important not to equate intellectual rigour with excessive reliance upon the commitment to memory of large quantities of factual information" (Dainton, 1968).

The notion that knowledge acquired for the sake of knowing is never as useful, or as well remembered as knowledge acquired for some specific purposes has been identified as a key factor in design and technology activities. This was confirmed by the report of SEC (1986) in its GCSE Guide for Teachers. The Interim Report added its support to the theory when it suggested that knowledge was a resource inseparable from action and that it was not *"a commodity to be stockpiled"* before action could begin (DES, 1988).

To pre-determine the knowledge and skills needed to tackle a task frequently denies the nature of the activity (APU, 1987). APU highlighted a key point that professional designers understand intrinsically, namely that a designer does not need to know all about everything in a particular task. They needed to know what to find out, what form the knowledge should take and what depth of knowledge is required. The *"need to know"* axiom is the bridge that gives access to external knowledge and skills. APU felt that it was the *"need to know"* that motivated pupils to proceed beyond their existing capabilities and resources. Furthermore, they concluded that it was the interaction of the pupil, aided by the teacher, with the task that should create the demand for knowledge.

It is clear that educationalists do not suggest that pupils should not learn skills. Pupils need to be taught appropriate skills to enable them to develop and produce their solutions, a view supported by HMI (DES, 1987). They went on to suggest that the best way of learning these skills was by seeing and then doing. However, McCormick (1995) in his research into problem solving in design and technology education at key stage 3 points out the difficulties involved in pupils using and developing their understanding of scientific and technological concepts whilst engaged in design and technology project work.

Nicholson (1990) indicated that teachers needed to retain control of the delicate balance between the knowledge base and design activity. He suggested that planned open-endedness would need to rule.
"Those who advise lead lessons and then unconstrained designing and making, with inputs on demand by children will discover this to be a recipe for chaos."

The DFE added a further dimension to the equation (DFE, 1990). They referred to the interaction between mind and hand but added that design and technology was equally dependent on the pupil's ability to understand and apply concepts, as well as knowledge and skill.

The Nature and Number of Design and Technology Projects

When this research project began the relevant GCSE Design and Technology syllabuses specified that coursework must include at least one substantial task which addressed the attainment targets in an integrated way. This was very similar in concept to the existing GCSE examinations that had been based upon CSE and 16+ Examination practice.

The 1992 NC Technology proposals suggested that pupils must tackle twenty three full projects between Key Stages 1 and 4 (DFE 1992). It would be left up to schools to decide how long each project would last. The DFE also reported that they were confident that the number of projects specified for each key stage would be manageable for teachers and pupils. However consultation with teachers during 1993 indicated that there was considerable concern regarding the demands that were to be placed upon pupils (NCC, 1993). The most recent Orders have taken this criticism on board and do not specify the number of design and make tasks that must be attempted (DFE, 1995).

In 1986 in a survey of ninety schools HMI reported that the poor work they had seen had usually been associated with major project work. They highlighted the reasons as being: projects too far outside the range of pupils experience; too little time for pupils to produce satisfactory research or acquire the additional knowledge and necessary skills; a lack of specialist equipment for pupils to use in order to complete their tasks (HMI/DES, 1986).

The need for progression from simple projects, having few parameters for investigation, to those of a greater complexity are essential if semi-open ended projects are to be tackled successfully in the fifth year. Failure in project work, particularly at Key Stage 3, is often the result of teachers presenting ill-considered briefs. It is an important requirement for briefs to be clearly defined, challenging, achievable and aimed towards arousing pupil excitement and curiosity (Schools Council, 1986; DES, 1987).

Where freedom of choice of project has been given to pupils from an early age, planning for progression has been observed to be problematic. On the other hand the need for older pupils, who have gained some experience of structured project work, to be given more opportunity to identify their own tasks is educationally important. It has been recognised that Key Stage 4 pupils must be given the chance to use their knowledge and skills to make products that are more complex and satisfy more demanding needs (DES, 1989).

Concerns regarding the demands placed on the teacher, by the nature of the tasks given to pupils, have been highlighted by HMI. At the same time they also suggested that at one extreme tasks given were beyond the pupils experience and ability or they were too trivial to stretch understanding and skill levels (DES, 1992).

The Role of the Teacher in Design and Technology Project Work

In 1983 Hicks(HMI) in the APU Newsletter No.4 expressed the view that:
"Teaching facts is one thing; teaching pupils in such a way that they can apply facts is another, but providing learning opportunities which will encourage pupils to use information naturally when handling uncertainty, in a manner which results in capability, is a challenge of a different kind" (Hicks, 1983).

With the constant developments and changes in design and technology education, the design and technology teachers position is regarded in a vulnerable light. Further, this aspect of teacher motivation is frequently underestimated as the transition from one style of activity to another takes place (Down 1986 a). Down suggested that teachers had to be willing to expose their ignorance and learn from their pupils in certain circumstances. He voiced his concern regarding pupils who needed information beyond the skill and knowledge level of the teacher when they tackled some major projects. This is a frequent problem with project work that is largely identified by pupils and in terms of the breadth and depth can make significant demands of the teacher or team of teachers. The result can frequently be seen with pupils who are allowed to undertake projects that betray a lack of understanding of technological principles by the teacher (NCC, 1992).

The traditional arrangement, where the flow of information was from teacher to pupil, has been augmented by one in which the pupil and his experience can provide a source of new information. Schools Council (1975) suggested that both the teacher and pupil had found themselves *"... in a new partnership - as learners"*. This could be seen as a rather naive interpretation of the situation. A more accurate assessment would be that at times pupils and teachers are able to seek out and learn new information together, ideally in an atmosphere of constructive, co-operative learning.

Reference to a learning partnership was also made by SEC (1986) when they suggested that design and technology required the active collaboration between teacher and pupil in negotiating and agreeing the substance of the learning experience. Other agencies talked of a need to communicate with and not at a pupil, and the need for the teacher to act as a consultant, with trust and respect for one another (Schools Council, 1986). They also referred to the teacher needing to be careful not to stifle the pupils' *"natural sense of wonder and curiosity."*

This dilemma for teacher of design and technology was highlighted in Curriculum Matters 9, where it was suggested that teachers had two conflicting demands upon them: they needed to provide a productive balance between giving pupils maximum freedom and yet provide structured experiences within which the pupil would feel secure and achieve the learning objectives (DES 1987).

A small scale investigation conducted by Boulter (1989) concluded that when considering the development of the design and technology curriculum heed must be paid to the position of the teacher. He confirmed the view that there was considerable concern felt by a significant proportion of teachers who believed that educational values had been undermined by the new initiatives that were affecting design and technology.

It is therefore perhaps not surprising that many teachers have experienced problems integrating the approaches used in CDT with the more *"cerebral and reflective"* requirements of the Technology Order (NCC, 1992). NCC indicated that this was partially due to the fact that the Order was about *"more than simply adding an intellectual ability to being good with one's hands"*. Support for this belief was provided by McCormick et al (1993) who referred to the highly complex and demanding role which teaching NC Technology represented.

Teachers need to be good listeners and avoid dominating discussions in a way that would take the initiative away from the pupil. Successful design and technology lessons are more frequently found in schools where staff plan work together but contributory subjects are taught separately by specialist teachers (DFE, 1992).

With much course work that is project work considerable reliance is placed on organisation if an effective learning experience is to be effected. The organisational efficiency of teachers is therefore a crucial key factor in this type of work (APU, 1987; NCC, 1989). Those teachers who support and structure their whole courses to ensure an appropriate mix of experience are likely to provide a high quality learning experience (APU, 1987).

With regard to pupil choice in projects, particularly the final one to be tackled for the examination, Down (1986a) suggested that examination syllabuses lacked the structured build up of knowledge to successfully support open-ended project briefs. This is a common concern amongst industrialists in the technical and technological fields who are looking towards staff recruitment, largely but not exclusively highlighted by the communications of the Engineering Council.

In guidance material to teachers, the Joint Matriculation Board stated that teachers should advise pupils in design and technology to select projects that showed promise of success, given the time and facilities available (JMB, 1986). They went on to suggest that teachers should judge what the project would involve in order to eliminate the impossible or over-ambitious elements of a project and at the other extreme to avoid the frivolous. Project choice, which relates closely to the maintenance of motivation, was a factor where the teacher played a significant and vital role. Teachers have a strongly positive or negative influence on the future levels of pupil motivation depending on their advice concerning project selection. On the same subject, the Schools Council (1986) indicated that teachers should not abdicate all responsibility and allow a *"general free for-all"* although they believed that pupils should be encouraged to define the parameters of the project for themselves.

The choice of project is also seen as a vital factor. Dillon and Davies(1993) identified the tension that exists, particularly in project work, between the need for pupils to accept increased responsibility for their own learning as their skills base and confidence developed, and the security that many pupils derived from being directed.

Planning for progression if pupils are given complete freedom of choice in their project work can become a significant problem (DES, 1987; Hendley & Jephcote, 1990; DFE, 1992). Furthermore, progression can be inhibited unless pupils are taught appropriate skills and knowledge. If these are taught they will then enrich more open-ended tasks that follow.

The need for varying degrees of teacher involvement with each individual project is evident through observation and participation in this style of working (Down, 1986a). Down agreed that teachers should not give solutions or direct a project, explaining that they must take care to see that pupil motivation was maintained. The crucial role of the teacher was highlighted further when he suggested that at times teachers needed to take the initiative to *"re-motivate"* the pupil.

SEC (1986) believed that as far as possible teachers needed to encourage pupils to be their own judges; to set out suitable criteria according to the task; to develop a vocabulary that enabled them to organise their opinions succinctly; to consider fairly the views of others; and in general to recognise that evaluation is part of a creative process and essentially constructive.

This style of working from the teachers' perspective places considerable demands upon them. Dillon and Davies (1993) referred to the need for teachers to develop flexible learning strategies as they believed the qualities and characteristics inherent in flexible learning were particularly pertinent to technological activities. The change in terms of subject knowledge, delivery and underlying philosophy indicates the very considerable demands placed on teachers during the implementation of NC Technology.

Teacher/Pupil Management of Design and Technology Projects

In the GCSE Guide for Teachers, SEC (1986) explained that it was the active negotiation between teacher and pupil that was a crucial issue in the management of coursework. They stated that it was educationally valid for teachers to give the pupils the responsibility for researching and finding out underlying technological principles. Although they showed an understanding that limits must be placed on pupils in terms of time, materials and resources.

The planning of time has been highlighted as one of the most critical aspects of project management. It is interesting to note that in their advice to teachers, SEC firmly placed the responsibility for decision making and organisation upon the pupils themselves although they did suggest that teachers should provide planning strategies to help pupils in their coursework (SEC,1986).

The importance of this aspect of project work is frequently underestimated by staff in schools. In CDT 5-16, HMI suggested that decisions regarding the approach to a problem, or the sequence in which work should be carried out were often harder tasks than the actual production of the finished product (DES, 1987).

The Ability of the Pupil in Relation to Design and Technology Project Work

"While practical problem solving seems central to the notion of CDT objections can be heard concerning its value as a teaching method, particularly for the child of average or less than average ability " (Down, 1986 (a)).

Schools Council added their support to Down's concerns regarding ability and project work. They referred to the problematic, active elements of analysis and synthesis. Although, in addition, they hastened to point out that there were exceptions to the rule, particularly when pupils were interested in engineering activities and therefore highly motivated. It was also highlighted that the more able the pupil, then it was more likely that they could progress more quickly to open-ended project work. In contrast, the less able the pupil required more detail and care when setting project briefs and identifying achievable parameters. Concern was highlighted over open ended major projects and it was suggested that pupils below CSE grade III standard would be unable to cope with the nebulous nature of the work involved (School Council 1986). The tighter requirements of structure, the increase in support and direction that are required for the benefit of low-ability pupils are acknowledged by practitioners (APU 1991).

As a general rule, more able pupils are less affected by the details of a task and more able to generalise their capability, whilst the context of the task affects how it is received and understood by low ability pupils (APU, 1991). APU also mentioned the feature that the unsupported development of ideas leaves the less able more exposed.

Evidence from the questioning of pupils led APU to the conclusion that three specific aspects were shown to be helpful to pupils during their project work: verbal instructions that lead pupils through the activity; discussion sessions; and the opportunity to use resources. The high ability pupils questioned in the survey put discussion top followed by resources and then verbal instructions. Medium ability pupils put instructions and discussion equal followed by resources whilst low ability pupils put verbal instructions top, followed by discussion and then resources (APU, 1991).

Active and Reflective Activities Within Design and Technology Project Work

The activity that occurs during project work is considered as being made up of active and reflective aspects (APU, 1991). APU revealed that 'identifying and clarifying' and 'appraising' were principally reflective domains and that 'generating and developing' was predominantly active. In addition, they suggested that 'investigation' could be both active and reflective. The balance between active and reflective capability in design and technology was seen as important. Design and technology is *"... generally dependent on holding a balance of active and reflective capability" (APU, 1991).*

The task itself is a crucial feature. This was highlighted by APU, who referred to the fact that tasks could be biased towards being reflective or being active and that this could be further affected by the context in which the task was set (APU (1991). They suggested that pupils found 'people context' tasks that were reflective easier than 'industrial context' tasks that were reflective. In tasks that they referred to as active or balanced they stated that the opposite was the case.

"The details of the task itself, and its procedural structure appear to affect performance more than the context itself" (APU, 1991).

As a result of its work looking at school based design work, APU put forward the theory that a pupil's high level of active or reflective ability was not sufficient to be sure of a high overall mark in a task. Pupils with both high active and reflective ability were likely to have achieved good overall marks whilst pupils who integrated active and reflective ability with appraisal were most likely to have achieved high overall results (APU, 1991).

The abilities they believed helped pupils to produce work of a high standard were also considered. Reflective abilities that supported a good overall performance were evident when pupils: had understood what the 'outcome' must do; were able to identify both user and product issues of their own accord; could focus development on both product and user issues; could raise issues beyond the information given in the brief; were prolific in raising issues that were wide ranging, detailed, explained and justified and worked on most of the issues they raised.

Active abilities that supported a good overall performance were evident when pupils: were able to tackle the central issue with a high level of understanding (having decided what it must do, they did something about it); made proposals for how things worked, would be used, and what they looked or felt like and did so with a high level of understanding; focused their proposals on user and manufacturer; brainstormed lots of starting points; were prolific in making significant progress towards a solution; showed significant evidence of to-ing and fro-ing between thought and action; showed evidence of being divergent thinkers; were systematic and rigourous, pushed at good ideas remorselessly and ideas approached a working reality taking into account both users and manufacture.

The ability of pupils to appraise was highlighted as being of significance in terms of successful task outcome. Good overall performance was evident when pupils: appraised the central purpose of the task with understanding; having done something, saw how it would stand up to what they said needed to be done; identified strengths and weaknesses in their proposals and did so of their own accord and with a high level of understanding; justified their judgements in terms of economics, aesthetics, technical success; identified tensions between strengths and weaknesses and were prolific in making judgements that focused on both user and manufacturing issues.

Motivation in Project Work

Little has been written with regard to motivation or demotivation specifically in the context of design and technology. One piece of relevant research carried out by Atman (1992), a motivation specialist at Pittsburg University, concerned *"conation"*. Conation she explained was a term associated with the conative domain - a psychological domain of behaviours linked to striving and volition. In support of this researcher's belief she too expressed her concern regarding the fact that pupils *"... in an academically structured environment were choosing to avoid the challenge of working within that structure to meet rigorous academic standards"*. With regard specifically to design and technology her research indicated that inherent in the technological process utilised in project work were two assumptions: first, that students were able to identify and solve problems; secondly that students were able to set and accomplish goals. Atman suggested that to *"solve"* and *"accomplish"* meant to move ahead with determination. *"The personal will to get on with a task"* she believed was a vital ingredient in the general development of pupils and in particular during the type of work carried out within the design and technology curriculum area. However, her research added support to the widely held belief that not all pupils were equally adept in managing their own solving and accomplishing behaviours, nor were they all motivated to do so. Although she did point out that the nature of design and technology project work was particularly suited, given the right teacher, to help pupils develop these important life skills (Atman, 1993).

Although as mentioned previously little has been written specifically about the links between motivation and design and technology education, much has been written about motivation in other areas of the curriculum. Particularly in other areas of the curriculum that are concerned with practical activity. A literature search into motivation within sports education has uncovered various factors which would seem to be relevant to this research project. Roberts and Treasure (1992) making reference to their findings concerning American children and motivation suggested that in a sports context the desire for enjoyment and fun were major reasons for young people to be motivated whilst a lack of enjoyment was seen as an important determinant in pupils giving up. Other relevant factors that they highlighted indicated that on the one hand pupils were attracted to activities in which their competence could be demonstrated whilst on the other many pupils were easily dissatisfied and frustrated by their lack of ability that stopped them from achieving good results.

Gender Differences in Design and Technology Project Work

In their 1991 project report, APU provided some conclusions regarding the differences between the genders with regard to project work. Their research lead them to suggest that girls excelled in tightly structured, people orientated, reflective tasks. Correspondingly, they came to the conclusion that boys excelled in open-ended, active industrially set tasks.

In terms of the whole design task, APU suggested that more often than not, projects ended up balanced. The example which they gave to illustrate this point was a moving toy for babies and toddlers. Initially, they believed that this project appeared to favour girls, but, because it was also an active and procedurally open structured project they suggested that it favoured boys too. Having been introduced to the work of Durey (1992) who's research findings support his belief that gender, as far as learning is concerned, is on a continuum rather than one or the other would support the researcher's concern regarding the APU conclusions. The APU research project has lead them to identify tendencies but they have failed to point out that variations in these tendencies could be large. For instance some boys, may be de-motivated by industrially set tasks, whilst some girls enjoy active proceduarally open tasks. The researcher therefore looked at the rest of the conclusions from APU regarding gender more as learning tendencies on a continuum rather than as characteristics of biological gender.

APU (1991) have suggested that boys would appear to be governed by the process they have been encouraged to follow (think, design, choose an idea, draw it and make it), supported by a willingness to *"tinker with gadgets and bits of material"*. They identified boys as having a competitive rather than collaborative approach to their work. Boys they also suggested tended to be concerned with the production of ideas that were different to others involved in the same task and they were therefore less likely to change their plans after discussion (APU, 1991).

Girls, APU pointed out, were less likely to work on their own and were more positive in their support of others. They seemed more concerned to view the task as a whole rather than to 'home in' on one particular aspect.

"Whilst studying the minutiae they were constantly seeking to keep the implications of the whole in view, for some this complexity became intolerable to the point where they gave up" (APU, 1991).

When starting out on a project boys could frequently be seen to be comfortable working without knowing too much about the detail of a task, and were prepared to work on specific parts of it without considering the whole (APU, 1991).

Girls appeared to work fundamentally from human needs dealing predominantly with issues. They were often cautious at the beginning of a project, wanting to know why, how and who it was for. Further to this, APU (1991) suggested that generally girls appeared better at identifying tasks, investigating and appraising. Boys seemed better at generating and developing ideas.

The balance between different ability levels in relation to gender provide some interesting characteristics. When divided into low and high ability, APU found that high ability boys out-performed high ability girls in modelling, whilst high ability girls out-performed high ability boys in evaluating products. Also, they identified that low ability girls did fairly well in evaluating products, whilst low ability boys did fairly well in the modelling aspects of a task. A key feature, that surprised APU was the extent of the gender imbalance in the evaluating phase of design activities. The evidence from their research showed that low ability girls almost out-performed high ability boys in evaluating tasks.

At the heart of design and technology education is the activity of designing and making. There are many approaches to the activity. Terms such as problem solving and project work have been most commonly used to describe it. The purpose of the activity is the development of concrete outcomes, manifest in a variety of different forms. Its general educational advantages and disadvantages have been discussed in an earlier section of this literature review.

Designing requires pupils to exercise logical, procedural strategies which are often referred to as design processes. The complex relationship between the sub-activities such as researching, specifying the problem or need, generating ideas, making and evaluating, and the whole design process has been described in the form of a number of design models.

The educational aims of teaching this activity are to help pupils to achieve competence in doing and making, judging and choosing, inventing and implementing, and to make all pupils aware of the ideas, values and problems of the material world around them. The researcher would support the suggestion that designing is a fundamental capacity of mind equal in importance to literacy and numeracy.

Teachers largely agree with the philosophy that the quality of the end product can only be seen in relation to the overall experience and reasoning that has lead to its development. The notion that it is the interaction of the pupil, aided by the teacher, with the task that should create the demand for knowledge puts considerable stress upon the teacher. The balance between working with a broad based range of materials in an ever expanding context with the need to ensure that pupils produce outcomes of quality are becoming increasingly more difficult.

Those who use the design process should understand the role and the intrinsic value of the activity in order to design effectively. The researcher believes that there is a lack of understanding by many teachers of design and technology of the theoretical underpining of the activity . This has been generally accepted by other researchers active in the fields of design education and design methodology.

From a personal perspective, through active engagement in both designing and teaching design an understanding of the difficulties which face the research community is easy to acknowledge. That these activities provide learning situations which are crucial to cognitive development is not in dispute, but the theoretical foundation which underpins design activity is difficult to observe in a methodological framework and consequently is beyond reach of current, incomplete models.

For teachers of design and technology, there are a plethora of support materials available regarding what pupils should do when they are engaged in designing. Without a clear, balanced understanding of the activity of design the process used is often misunderstood, misused and hollow.

Examination syllabuses which affect Key Stage 4 pupils largely utilise the sub-activities of the process as their assessment headings. This has tended to lead to a situation where many pupils have become over-concerned with the production of evidence to meet each assessment heading, often to the detriment of an honest design procedure.

Modelling is the means by which designers can externalise their thoughts during the activity of designing. It may be two dimensional, three dimensional, mathematical, computer, verbal or written. In an educational setting the teacher has a vital role to play in the education of young designers. The models chosen need to be appropriate in order that they operate as effective information carriers.

Modelling techniques allow pupils to represent, interpret, and manipulate their thoughts. From the researcher's observations of design activity, supported by other researchers she would suggest that pupils find certain aspects of modelling easier than others. Pupils, particularly at Key Stage 4, expect that the images they produce will represent reality. This aspect of modelling will need to be researched more thoroughly as indicated in the Literature Review.

Evaluation is an integral part of the process. It is the method by which a pupil can reflect upon their thoughts and ideas throughout every stage of the activity.

A summative evaluation of the process and the outcome are an important aspect of designing. If thoughtfully tackled this evaluation can provide the pupil with an opportunity to expose and record refinements of their understanding of the process itself, building up an intrinsic understanding of the activity which will then feed back into more successful designing and making.

Literature Review

Skills Used During the Activity

Drawing Skills

The processes and skills involved in communicating ideas and reasoning are an integrated and essential part of designing (NEAB, 1995). When one refers to drawing skills in the context of this research one has to remember that design drawing is drawing to explain rather than drawing to depict (Egan, 1995). Potter (1980) in support of the role of drawing during the design activity cited Terrence Coran's important recipe for good design work, which was *"... keep it simple, and draw it clearly"*.

Many influential designers have believed that design drawing has provided a profound and diverse resource for the designer (Garner, 1989). Drawing has been used to forward, prompt, order, and regulate creative thinking (Potter, 1980). It has been seen as vital to the organisation of thought (Rawson, 1969) and was considered by Tipping (1985) to be the single most important factor in developing any general design ability. Garner (1989) suggested that drawing had immense scope, for not only could it communicate precise intentions as in a technical drawing but it could also encompass mood or feeling. Fluent drawing ability has been shown to facilitate exploratory and manipulative activity during the early stages of the design process and also enable the designer to produce a precisely rendered image as the final act in the process (Garner, 1989).

Confirming the importance of drawing skills as a method of communication for the designer, Potter (1980) compared the work produced by the fine-artist with that of the designer. He suggested that a fine-artist usually worked directly with his materials, or with a *"... very close visual analogue to the final work"*, whilst the designer had often to make do with drawn images as the only *"... tangible embodiment of his ideas"*.

Potter (1980) also suggested that drawing skills could not just be allowed to happen, they needed planning and nurturing in order that they could be developed. Garner (1989) believed that although there had been much written to clarify and develop the role of drawing within design, he believed there was little evidence to support its actual development. Gray (1979) in an article in Design magazine supported the lack of development when he wrote *"... the skill of drawing is so low on the list of priorities in design education that people now have to be reminded that drawing is, after all, a fundamental element in the design activity"*.

In support of the use of drawing by young pupils Fisher (1990) endorsed the widely held belief that drawing could be a most successful means of making thinking visible for the both the participator and the observer. He believed that young children usually found it easy to express their thinking visually and that they found that visualisation helped them to sort out and understand things more easily.

Fisher (1990) also explained that the development stages in children's drawings were closely related to the whole process of cognitive growth. He believed that the speculative designing of young children was a valuable preparation for the later stage of the child's development when creative ideas need to be constructed from suitable materials in a 3D form.

Egan (1995) who had also carried out research into young children's design activities suggested that in an attempt to encourage children's drawing for designing teachers had predominantly been concerned with pictorial drawing rather than *"narrative"* drawing. This had reinforced the concept of drawing for itself rather than drawing to inform the subsequent task of making. In her research into how infant school children perceive the activity of drawing she observed that many of the pupils were pre-occupied with task-management whilst they were drawing. An important suggestion as far as this researcher's project is concerned was her argument that until pupil's felt confident in their mastery of the management tasks (management of drawing techniques and the media used) they were unlikely to be able to concentrate on the wider aspects of designing. This ties in with Powell's (1990) belief that for any designer drawing was the basic tool of the trade. He suggested that without the ability to draw too many designers were forced to design only what they could draw, rather than draw what they could design. This researcher would wish to add that from her professional experience these two points can also be applied to secondary school pupils for whom drawing is not an activity with which many of them feel comfortable. This is particularly the case when they are trying to represent inventive, creative thoughts and yet also answer a need, be aesthetically pleasing and most importantly, in their eyes, be feasible for them to make at a later stage of the process.

Anning's (1993) research findings into technological capabilities in primary classrooms, suggested that the acquisition of literary skills were dependent upon models of literary behaviour surrounding the child at home and at school. Unfortunately, she found that there was no such parallel during the acquisition of drawing skills in a Primary School situation. She pointed out that her research findings suggested that primary school teachers rarely demonstrated drawing skills to young pupils. She believed that drawing was not seen as a useful tool for organising or representing ideas even at this early stage of a pupil's development. Her findings suggested that on the one hand many primary teachers believed that teaching pupils to draw in a formal sense was in opposition to the primary school culture of encouraging creativity. Whilst, on the other hand many teachers believed that when designing pupils should be encouraged to draw accurate, carefully considered solutions. Unfortunately 'Scribbling' down ideas was considered, by these teachers, to be a taboo activity.

At the opposite end of the educational spectrum, and yet particularly pertinent to this research project, were the findings of Schenk in 1993. Her research concerned the role of drawing within the design process used by first year BA Media Studies students. Her findings suggested that not only was it necessary for designers to be able to produce a wide range of drawing types (she identified twenty-five types of drawing used during the design process) but that they also needed to be able to combine these strategically according to the circumstances of the particular design procedure in which they were involved.

With regard to the drawing skills of the Key Stage 4 pupils targeted in this research study, little research evidence has been sourced. Some evidence was found in GCSE examination boards documentation. The following references were found to be pertinent to drawing skills and the conceptual skills that are inextricably linked to them. General assessment objectives explained that pupils should be able to: generate and develop designs; communicate and model ideas using a range of media and methods, as a means of developing, refining, recording, reviewing and presenting ideas and proposals. The documentation also explained that the examination project should demonstrate the following drawing techniques; annotated sketches; drawings of the overall concepts of each idea; perspective drawing; part drawings; assembly drawings; exploded drawings; working drawings; plans; elevations.

When it came to the specific assessment criteria for designing, at Grade A* communication skills were referred to under several of the assessment criteria for that grade. It was interesting to note however that the ability to sketch and tease out early design ideas or principles was strangely missing from the specified list. The criteria stated that a pupil must have used a range of media and methods to show how possible outcomes had been identified, improved, refined and ultimately used in the solution; communicated clearly and attractively to a particular audience(s) their thought processes, and provided sufficient detail for the outcome to be made by a competent third party; used a variety of media and presentation techniques, including technical and symbolic representation, correctly and appropriately and communicated thoughts and ideas, accurately, clearly and precisely through written, numeric and graphic forms; and have demonstrated flair and imagination throughout the design process.

On the other hand at Grade G the only reference made to drawing was that a pupil must have presented their design thinking using notes and simple sketches and a limited range of written communication skills.

Recently, many text books have been published with the design and technology key stage 3 and 4 pupil in mind (e.g. Yarwood & Orme, 1983; Dunn,1986; Tufnell,1986;

Toft,1987; Fowler & Horsley, 1988; Chapman & Peace, 1988). Aspects that referred to drawing skills within these books could be categorised into two types. Firstly those that aimed to encourage pupils to develop creative, innovative design work (e.g. Burden et al, 1988), and secondly, those that aimed to develop design skills by improving communication skills (e.g. Tufnell, 1986). The majority of these books were geared towards improving pupils grades in the various Design and Technology GCSE examinations (e.g. Rees,1989).

Writing Skills

There is a distinct lack of research literature evident with regard to the skills involved in communicating words on a page during the activity of designing. This was disappointing to find as there has been much evidence to support the need for analytical evaluative thinking within that process since design education was first established (Hanahan, 1978). Toft (1987) and others (e.g. Burden et al, 1988; Dunn, 1986) have vaguely suggested that words were useful to describe design ideas. Whilst Tufnell (1986) was a little more explicit in his suggestion that annotations could provide extra information or explain unclear drawings. In a more formal context the revised National Curriculum for design and technology (1995) stated that even at Level 1 pupils should "*... use pictures and words to convey what they want to do.*" At each of the other levels of attainment the use of the written word was found to be implicit rather than explicit.

Several writers who have produced texts to support the design activity in schools have referred to the importance of keeping lettering tidy and developing a personal style (e.g. Tufnell, 1987; DATA, 1995). In books used to teach communication skills information on techniques were found regarding the construction of lettering used in formal drawings and titles. In the main these were developed out of industrial practice where such drawings had to conform to B.S. 308. However, with regard to the informal annotations which pupils were encouraged to carry out in order to give evidence of analytical evaluative thoughts, there is no indication in any reference books of how this form of communication should be accomplished. Nor has the effect of poor performance by many pupils in carrying out this aspect of the process been addressed.

Manufacturing Skills

The importance of quality within manufacture, in the form of craftsmanship, has long been recognised (Jones, 1970). Craftsmanship Pye (1968) defined as "*... workmanship of the better sort*". Although he admitted that no one was prepared to say where craftsmanship ended and ordinary manufacture began. For many years in a school situation the main thrust of craft teaching was to enable pupils to achieve quality outcomes through skill based training. However, as early as 1968 the Schools Council suggested that craft teaching was backward-looking and must include design activities and the new technologies which the world needed to depend upon. Pye (1968) and others (e.g. Baynes, 1976) recognised this dilemma but believed that craftsmanship should remain a central issue if products of the future were to be valued and craft skills were to be passed on to future generations.

During the late sixties and early seventies some forward thinking schools involved pupils in designing and making activities rather than teach them to craft products from given drawings (Roberts, 1978; Harahan, 1978). The move from craft training towards designing and making in schools continued to spread throughout the 1980's. Although, by the time the first National Curriculum documents were published there were still a number of schools for whom the craft route was still the teaching strategy adopted. These schools tended to have traditional craft teachers on their staff who were either afraid of change or were finding the changes difficult to manage. In support of these teachers it must be pointed out that these changes were considerable. As Mitcham (1994) explained if a person was to be involved in the total process they must become a designer/engineer - *"the person with ideas and action"*, a scientist - *"who knows and discovers new facts and develops new theories"*, a technician - *"who specialises in draftsmanship, is a cost estimator, a salesman, and a trouble shooter"*, as well as a craftsman - *"who uses his hands more than his head, tools more than instruments, and mathematics and science rarely"*. The complexity of this range of activities meant that teachers and pupils were required to develop new teaching and learning strategies in order to address the differing philosophies, knowledge and skills required to fulfil the tasks set.

Nothing in the NC documentation, produced at that time (DES, 1990), stated that quality, particularly of the final product, was to be ignored. In fact schools of good practice continued to produce work of a high standard as well as address all the new areas demanded of them (DES, 1992). However two factors seem to have caused the demise of the quality of outcome that has been witnessed in many schools. The first was the breadth of experience expected of the pupils within the time allocated to design and technology within a school's curriculum (Grieve, 1993). The second was staffing and timetabling strategies adopted in the newly established departments of design and technology. Many teachers found themselves teaching aspects of design and technology with which they were totally unfamiliar. Teachers became de-skilled and pupils produced outcomes of which neither they nor their teachers were proud. As mentioned in an earlier section of this literature review, after much consultation the pendulum has swung back and the most recent NC documentation (DFE, 1995) has re-addressed the balance. It has reduced the volume of material to be taught, given teachers more flexibility over what they must deliver and has both implicitly and explicitly required there to be quality of output at all stages of the process.

In the context of this research project the targeted sample for discussion was those pupils who were involved in their GCSE examinations. It was therefore pertinent to research what examination boards were expecting of the pupils as far as manufacturing capability was concerned. NEAB(1995) specified that pupils must be able to make an outcome that was well presented and an accurate representation of the solution; the pupil must also demonstrate the use of appropriate materials, skills and techniques. At Grade A* this specifically meant that a pupil must produce a complete and high quality outcome which satisfied all the demands of the specification using appropriate techniques, processes and resources skilfully, accurately, safely and imaginatively. Whilst at Grade G a pupil must construct a simple work schedule based on time and available resources; select, from a limited range, suitable tools, equipment and processes and use them appropriately and safely; produce at least part of a recognisable outcome having attempted to use the constituent materials in appropriate ways, paying some regard to waste, cost, accuracy and finish.

Literature Review
Summary and Synthesis of the Literature Review

Issues and Themes Explored During the Literature Review

The issues and themes that have been explored during the literature review have been:

* An Historical Perspective of Design and Technology Education
* National Intervention
* Project Work
* Teacher Assessed Coursework
* Problem Solving Approaches to Education
* Motivation in the Context of this Research
* Creativity
* Approaches, Strategies and Styles of Learning & Teaching
* The developing Design and Technology Education Philosophy
* The Effect of the National Curriculum on Design and Technology Education
* Design and Technology Examinations and Assessment
* Team work and Group work
* Equal Opportunities in Design and Technology
* The Process of Designing
* Problem Solving and Project work in Design and Technology Education
* Skills used during the Activity of Designing

The Review of the Literature has revealed, confirmed and suggested several key factors which relate to causes of demotivation amongst Key Stage 4 pupils studying design and technology. Some of these key factors are pupil dependent others are teacher dependent. There are also a number of aspects which relate directly to these key factors.

	Key factors which relate to de-motivation amongst Key Stage 4 pupils studying Design and Technology	Issues which relate to the key factors
Pupil dependent	Intellectual ability Creative ability Goal orientation Cognitive Style	Educational changes Historical perspective of Design and Technology Education
Teacher dependent	Pupil's design capability Pupil's manufacturing capability The process used in designing and making Relationship of the knowledge base to the process Balance of time given to aspects of the process Teaching strategies	NC Technology / Design and Technology Examination requirements Accountability

Figure 1.9 Lists the key factors that relate to demotivation amongst Key Stage 4 pupils and educational issues that relate directly to those key factors

Potential Key Factors

The key factors which seem to relate to causes of demotivation amongst Key Stage 4 pupils studying design and technology are difficult to categorise in terms of their relative importance to this area of study at this stage, although they can all be said to have an effect upon design and technology education at Key Stage 4. Once these key factors had been highlighted through the search of the literature they were placed in two categories, those that were **pupil dependent** and those that were **teacher dependent.** Figure 1.10 illustrates the inter-relationship between the identified potential factors on the basis of reasonable speculation. It is hoped that the study might reveal how valid this speculation is.

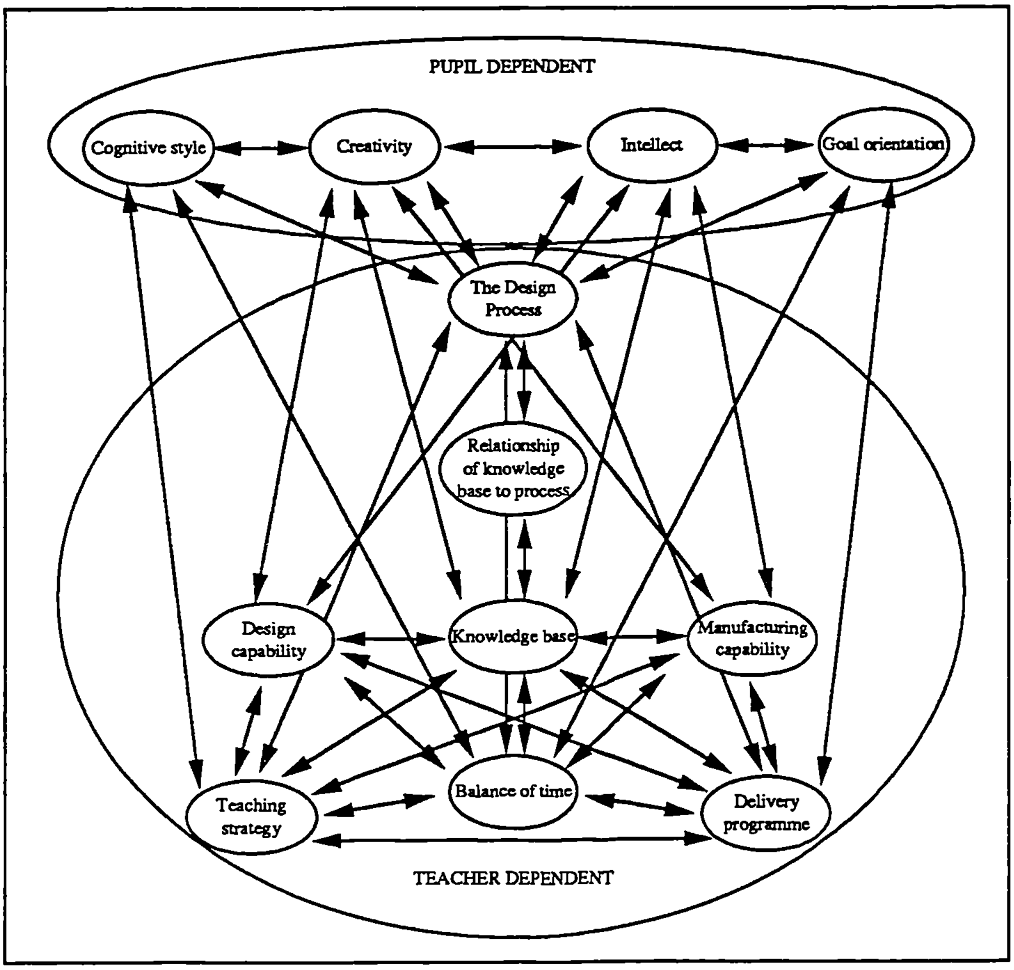


Figure 1.10 Illustrates the inter-relationship between potential key factors

Teacher Dependent Factors

At the heart of design and technology education is the design process - the activity of designing and making. Its relevance in relation to the aim of this research project has been highlighted in the review of the literature. Projects, using a design process model, have been the main method through which teachers have delivered the content of this area of the curriculum since the introduction into design and technology education of design activities. The fundamental purpose of designing is the development of outcomes of various types. Designing is an intellectually demanding process. There is a basic logical procedural strategy required when designing. The problem that teachers face is that for each new task this procedure should vary in emphasis and on the amount of time needed for each stage. In fact, even when a group is set a single task, each pupil's process should be determined by the individual nature of the developing solution. GCSE examination syllabuses have tended to interpret the process in a narrow, unhelpful and restrictive manner. The weakness of their models lie in the assumption that pupils are not engaged in designing unless they undergo and demonstrate each of the stipulated stages of the process. There is a tendency, therefore, for pupils to learn that designing is concerned with jumping through hoops in a pre-determined order whether it is appropriate to the task or not.

Across education in general, project work and problem solving activities are seen as an important aspect of teacher assessed coursework at Key Stage 4. In the design and technology curriculum area project work is the term used to describe the designing and making activity which is used throughout both primary and secondary design and technology education. At Key Stage 4 it is considered that this type of work has the potential to develop in pupils skills which are difficult to assess by traditional methods.

Design and technology teachers accept that project work is the most suitable method of assessing the process which is at the heart of design and technology education. They have, however, found it increasingly difficult to balance the requirements to work with a broad based range of materials in an ever expanding context, with the need to ensure that pupils produce outcomes of quality based on sound manufacturing skills.

For pupils, project work is recognised to have a motivational advantage over other forms of classroom activity. However, it is also recognised that project work can cause other pupils significant, motivational problems. The nature of the tasks set can have a dramatic effect upon pupils. The review of the literature supports the theory that there are gender differences in how pupils will relate to a project and that teachers need to take these differences into account when identifying suitable projects for groups or individuals.

The motivational success of project work can be its own downfall. Project work can significantly increase the work load on pupils. This increase can be caused by the conscientious pupil themselves or by a teachers inappropriate level of expectation.

The complex relationship between the knowledge base and the procedural demands of the activity has been identified as one of the other key factors. To pre-determine the knowledge and skills needed to tackle a task frequently denies the nature of the activity. Research supports the belief that knowledge acquired for a specific purpose is seen as more useful and more easily remembered. Using the 'need to know' method motivates pupils to push themselves beyond their existing capabilities but the resourcing, the teacher's own knowledge base and teacher management of such a method are crucial to its success. Professional designers understand intrinsically that they do not need to know all about everything in a particular task. They need to know what to find out, what form the knowledge should take and what depth of knowledge is required. From the researcher's experience in the classroom and observing others teach design in this manner, pupils are seen to move happily into the unknown because they trust that the teacher has the answer and the capability to overcome any problem encountered.

In preparation for GCSE examination work much has been written regarding the structuring of delivery programmes and the development of teaching strategies suitable for use with pupils studying design and technology. However during the literature search, little evidence could be found relating to the motivational effect that such models have had upon pupil performance and pupil learning. Even though from both the researcher's own professional experience and the experience of other teachers of design and technology this has become an area of considerable concern.

Pupil Dependent Factors

With regard to factors which are pupil dependent academic research would support the researcher's view that pupil motivation or the lack of it is woven into each of the key factors identified within the review of the literature. It is a pivotal feature of this research project. Attitudes towards success and failure have a significant bearing on motivation. This view has been supported in the review of the literature by various authors. To identify which attitude has caused motivation or demotivation and then determine whether it is internal or external, stable or fluctuating and whether it can be controlled or is uncontrollable will be a difficult task. The complex relationship between all these and external forces such as culture, context, parental and teacher expectations has a powerful bearing upon the situation. There are gender differences to be taken into account. Helpless and mastery patterns of behaviour vary in boys and girls. In design and technology where many girls are lacking in confidence the literature would suggest that the potential for them to acquire learned helplessness is high.

Although motivation is not a pre-requisite to achieving success, success can bring about motivation, which in turn can then lead to more success. The cause of demotivation is complex. Little is written regarding its causes specifically in design and technology other than to suggest that demotivation may be caused by project work itself or by the choice of project to be tackled. The personal will to get on with a task has been identified as a vital ingredient in the general development of pupils and in the context of this research project. During the literature search the identification of a goal orientation index and a review of the work of Atman was seen as particularly helpful in indicating a possible method of determining pupil's motivational levels in the next phase of this research project. When looking for possible causes for demotivation specific to the subject area the researcher would like to suggest that it is concerned with any one or combination of the following: inherent intellectual ability; levels of creativity; cognitive style; conceptual skills regarding the process; acquired modelling skills in two and three dimensions.

The intellectual capacity of pupils can become a key factor in the demotivation of Key Stage 4 pupils. All pupils can, if motivated to do so, become successfully involved in design and technology project work. On the other hand, it has been observed by the researcher, and documented in the literature review that a significant number of both low ability and high ability pupils become de-motivated in design and technology. This demotivation may occur because of a variety of complex reasons. When these reasons can be linked specifically to the work undergone in design and technology then in the case of low ability pupils the suggestion is that they cannot cope with project work because of the nebulous, analytical nature of the work involved. For those of high ability it is suggested that it is often the nature of the task itself which causes the demotivation. Supporters of the use of project work for the less able suggest that this method of working allows pupils to tackle areas that interest them and which they can become enthusiastic about. It has also been shown to be feasible to structure projects to provide the necessary support and direction that will allow these pupils to succeed.

The importance of creative ability for those who wish to create new and inventive solutions is well evidenced in the literature. Although, the importance of creative ability in order to achieve good GCSE Design and Technology results is not so well documented. Creativity has been shown to come from the ability to combine existing knowledge in a new form. One might therefore expect that those who have acquired a wide range of knowledge and skills would have a greater chance of being creative. However, historical studies indicate that gifted children are not necessarily creative. Even for those with creative tendencies something extra has been shown to be essential. The review of the literature suggests that this is the ability and motivation of the creative to work extremely hard.

Creative ability and true cognition in the activity of designing are intrinsically supportive of one another. However, the literature review has reinforced the researcher's professional belief that, when a methodological approach to designing is utilised by those who are not creative, innovative designerly solutions are rarely produced. This has been shown to be the case even when the adopted design approaches have been sound. In the context of this research project regarding pupils involved in GCSE Examination Project work, literature would support the researcher's professional opinion that at Key Stage 4 a pupil's approach to designing is mainly dictated by the examination assessment criteria and that this is one of the factors that will need to be taken into consideration during the data collection stages of the research.

Modelling is the means by which designers externalise their thoughts, it is fundamental to the design activity and has been highlighted as a possible key factor which relates to causes of demotivation amongst Key Stage 4 pupils.

The ability to generate and develop the optimum solution to a task using modelling is central to the process. There are various forms of modelling, two dimensional, three dimensional, mathematical and computer, all of which need to be used appropriately throughout the process. Evidence of the difficulty encountered by pupils tackling the various forms of modelling are numerous and referred to in the review of the literature.

Whilst modelling during the various stages of the design process three main categories of 'doing' skills are utilised. These are skills involved in drawing, writing and manufacturing.

One imagines that pupils are taught to draw from an early age. However, the literature would not support this assumption. The evidence presented suggests that drawing skills are rarely demonstrated to pupils in Primary school where to do so would oppose the primary school culture of encouraging creativity. However, from both primary school and higher education sources there is support for the belief that when representing design thoughts on paper pupils' and students' attention will be turned towards the mastery of drawing techniques to the detriment of their creative freedom.

The importance of providing evidence of having completed all aspects of the design process thoroughly, particularly at GCSE level, has lead to an increase in the use of the written word. There is little evidence of research into this aspect of the activity, although the conceptual skills involved in evaluating and the techniques involved in producing large lettering tidily, are explained in several school based text books. The literature search has also failed to find research into the high order skills involved when analytical thinking is used during the design process, although some evidence of research into skills used during the summative evaluation stage of the project has been identified. Rather surprisingly no evidence of research into the de-motivating effect of poor performance, in the written aspects of the process, has been found.

Much has been written about craftsmanship in the past although with the demise of craft education came a lack of emphasis on quality of product outcome. The process became all important. Against many teacher's better judgement and in a belief that they must conform to the new philosophy if they were not to be seen as backward looking teachers forsook the time consuming quality craftsmanship of the past. Recently a backlash has been evident in the literature but for the pupils involved in this research project this came too late. Basic building blocks that would have established an understanding of what was expected in order to achieve quality outcomes had been missing from earlier stages of their education.

Cognitive style has been researched in a wide variety of contexts although none was found in the specific context of demotivation in design and technology project work in schools. Evidence from various writers would suggest that cognitive style is the qualitatively distinct and consistent way in which one encodes, stores and performs and that it is mainly independent of intelligence. The two principal categories of cognitive style identified by Riding relate well to this research study. In the context of the Wholist-Analytic cognitive style dimension the design process is seen by many writers as needing both a holistic and an analytic approach. The other orthogonal dimension, Verbaliser-Imager in which one's ability to represent information during thinking verbally or in images is particularly pertinent in a process where imaging of thoughts is central to the activity and at the same time written evidence is essential for explaining certain thoughts which are held in high esteem during the assessment process. During the literature search it was therefore with great interest that the computer presented Cognitive Style Analysis Test developed by Riding was identified and reviewed.

One of the aims of education is to prepare our children for the technological uncertainties of the twenty first century. It is envisaged that through the requirements of the NC pupils will be enabled to develop a technological capability. NC Design and Technology is fairly unique in that it provides the opportunity for pupils to develop designing, making and evaluative skills in a context which allows them to produce outcomes of a concrete nature. Human beings take pleasure from improving their environment it is therefore of significant concern that there are a growing number of pupils who do not enjoy the activity of designing and making which is at the heart of design and technology education.

Issues That Relate to the Key Factors

The pace and extent of educational change has been considerable, both for the school curriculum as a whole and for design and technology as a subject area in particular. These changes have impinged directly upon the teachers who plan and deliver the curriculum.

The major changes that have occurred have on the whole been based on sound educational philosophy. Given time for refinement they should have a beneficial effect upon the education of our children. We live in a dynamic world where change is a necessary part of the continuum. For teachers in schools it has been the number of initiatives and the speed at which they have occurred that has left them in an almost continuous state of change, with little by way of an opportunity for consolidation or continuity.

From the design and technology teachers' perspective the vary nature of the subject, its delivery and its assessment have undergone a period of radical development. Within the review it has therefore been important to establish a historical perspective of how design and technology education has evolved. Inseparable from this has been the introduction of NC Technology and NC Design and Technology and the effect that these two orders have had upon the education of young pupils in school today.

Compared with other subject areas in the school curriculum design and technology is still in its infancy. The importance to the nation of developing the design and technology curriculum has been recognised by teachers, educationalists and the government. A lack of clarity in defining what is meant by technology and therefore what is expected of design and technology education has caused the development to be haphazard. National initiatives have generally had a beneficial effect upon design and technology education, although many teachers would say that the benefits of the National Curriculum have yet to be felt in many design and technology curriculum areas. In the main, this is due to the tortuous path of the initiatives and the problems concerning interpretation of the Orders. This has led to a general undermining of confidence felt by many design and technology teachers. Beliefs that have been held, skills that have in the past been shared with pride have all been brought into question. It is hoped that the latest Orders which are now in place for the next five years will go a long way to re-building the confidence lost during the earlier developments of the National Curriculum. The new Orders which separated Design and Technology and Information Technology have reduced the content; restructured and simplified the programmes of study; reduced the prescription and increased the flexibility so as to give teachers more scope for professional judgement.

The GCSE examination system plays a significant role in determining the curriculum delivered to pupils at Key Stage 4. It therefore has a marked bearing upon the factors which have been highlighted in the review of the literature.

Educational philosophy would have us believe that the assessment used to judge pupils work should not dictate the curriculum content. Examination syllabuses should be designed to develop capability and test competence. Because of the importance of the examination results to pupils and teachers alike, the nature of assessment and its criteria tend to influence what is learnt and how it is taught. The GCSE Examination system can therefore be said to have a marked effect upon the nature of the work carried out by Key Stage 4 pupils. It is also the case that many teachers interpret the examination requirements in such a way as to lead to inappropriate use of the design process. This may be because of a lack of teacher cognition of the process of designing, and/or the current need for evidence of assessment causing inappropriate modelling to be used by many pupils. Those charged with responsibility for the design of design and technology examinations therefore have an important role to play in helping to develop a valid design philosophy for both teacher and pupil alike.

Additionally, accountability has played an important role in determining whether teachers have provided a valid design philosophy for their pupils. The importance to schools of their position in the League tables cannot be denied. However the consequence of this would seem to be a vicious circle. Poor results mean adverse publicity leading to the possibility of less new pupils. This could then equal less income to the school and therefore greater pressure on teachers to enable their pupils to achieve good grades in examinations. In design and technology this has lead to some teacher's pre-occupation with addressing assessment criteria to the detriment of pupil learning.

Chapter Two

Methodology Overview

Approaches to Research

Research is a combination of experience and reasoning (Cohen & Manion, 1985). It is a means of contributing knowledge (Drew, 1980; Robson,1993) and is regarded as the most successful approach to the discovery of truth (Cohen & Manion, 1985). Howard and Sharp (1983) define it as *"... seeking through methodical processes to add to one's own body of knowledge and, hopefully, to that of others, by the discovery of non-trivial facts and insights"*.

Research is carried out for numerous purposes and in a wide variety of contexts. In order to accommodate legitimate differences three basic approaches have developed, each with its own tradition, style, terminology, and methodologies. These approaches are referred to by Cohen & Manion (1985) and by Robson (1993) as experimental, quasi-experimental and single-case research.

Experimental research is usually carried out in laboratories. It is a controlled approach in which the choice of a random sample from a known population, and the random allocation of subjects to different experimental conditions enables the experiment to provide quantifiable evidence regarding causal relationships. The results are then used to provide generalisable conclusions.

The essential difference between the experiment and the quasi-experiment is in the choice of the sample. In the quasi-experiment the sample is selected by various means or 'found' and not always random. It is also most likely that the experiment will be carried out away from a laboratory environment.

This approach which until fairly recently was seen as radical (Coolican,1990; Cohen & Manion, 1985; Robson; 1993) was developed when researchers realised that there were instances where experimental methodology was not appropriate or possible (Robson, 1993). Doubts were raised over the narrow, artificial and sometimes useless knowledge of human experience and behaviour that was collected using traditional experimental means (Coolican, 1990). Supporters of the new methods explained that in many instances investigations involving people in 'real life' situations needed to be researched in a field setting that included the complex pattern of variables that were normally found in the world at large.

Researchers understand that there are problems inherent with the use of these new approaches, particularly with regard to internal and external validity. It is openly recognised that in field studies it is extremely difficult to achieve either representative sampling from a known population, or random allocation to different experimental conditions. It is also understood that the practical and ethical problems in trying to do so are almost impossible to overcome (Robson,1993).

Within the quasi-experimental approach there are two distinct methods of collecting data, these are termed quantitative and qualitative. Qualitative methods tend to be used in situations where research is concerned with understanding individuals' perceptions of the world (Bell, 1987), with predicting effects rather than finding causes (Robson, 1993), with seeking insight rather than statistical analysis (Cohen & Manion,1980). The data collected in such research are usually in a non-numerical form. At the opposite end of the research spectrum there are scientific quantitative methods where facts are collected and the relationship of one set of facts to another is studied using statistical analysis.

Quantitative methods whether they are used in experimental or quasi-experimental conditions have been shown to have three characteristics, firstly they are systematic and controlled (Kerlinger, 1970; Mouly, 1978; Drew,1980; Robson, 1993), basing their operations on the inductive-deductive model (Cohen & Manion, 1985; Coolican, 1990). Secondly they are empirical, explained by Kerlinger (1970) as *"... subjective belief ... checked against objective reality"* and thirdly they are self-correcting, having in-built mechanisms that protect the researcher from error and through publication of findings allow public scrutiny of results (Cohen & Manion, 1985; Robson, 1993). The individual methodologies associated with these approaches to research have variously been labelled as: empirical; positivistic; natural science-based; hypothetico-deductive; scientific-hypothesis testing; as well as quantitative.

The very different emphasis of these two methods has led to mistrust between quantitative and qualitative researchers. Quantitative researchers because of a perceived lack of rigour involved in qualitative methodologies. Whilst qualitative researchers see their methodologies as the most appropriate method to use in complex real world situations. At the same time they have tended to shroud their methodologies in mystique believing that the complex intangible methods could only be used by experienced researchers after a lengthy apprenticeship (Robson, 1993).

The third and final approach referred to by Cohen & Manion (1985) as single-case research, involves the continuous assessment of some aspect of human behaviour over a period of time. This approach is able to provide a technique for evaluating the effectiveness of interventional procedures on a single subject. However, there are problems associated with this approach regarding ambiguity and generality of results from a single case to that of a population.

This research project, concerning pupils in an educational setting, has through analysis of the relevant literature, been set in a social science paradigm. Cohen & Manion (1985) suggest that early developments in the field of education depended more upon experience than upon an application of sound research principles. Although, the researcher's reading would suggest that since the mid-nineteen seventies there has been a move towards applying more exacting social science methodologies to the study of education and its problems. This development has produced much educational research that has been both worthwhile and rigourous. However it has also resulted in controversy and debate, for by adopting a social scientific orientation, educational research has at the same time needed to use the two competing views of the social sciences, the normative/interpretive paradigms. (Robson, 1993). Cohen & Manion (1985) explain that these two generic terms stem from different conceptions of social reality and of individual and social behaviour.

On the one hand, the traditional normative paradigm supports the notion that human behaviour is essentially rule-governed (Cohen & Manion, 1985). It suggests that the social sciences are the same as the natural sciences in that they are concerned with discovering *"... natural and universal laws regulating and determining individual and social behaviour" (Cohen & Manion, 1985).* In contrast the interpretive paradigm, whilst sharing the traditional science wish to describe and explain human behaviour in a rigorous manner (Cohen & Manion, 1985), emphasises that people differ from inanimate natural phenomena and also from each other (Robson, 1993). This alternative view has necessarily lead to a re-design of some research methods in order that the style and approach adopted is entirely appropriate.

The continuum with 'true' experiments at one end and qualitative approaches at the other continue to evoke much debate. Those researching in the mid-range of this continuum, which includes this researcher, can see the value of both quantitative and qualitative methods. Neither approach should be seen as mutually exclusive (Cohen & Manion, 1985; Coolican,1990; Robson, 1993) for in many instances they are complementary and overlapping (Bell, 1987). It has amply been proved to this researcher that quantitative techniques are needed to support ones theories whilst qualitative methods enable one to describe complex situations in more detail (Robson, 1993).

Developing the Proposal

Deciding on the Research Questions

"... the selection of innovative research questions is not a single act or decision. Significant research is a process, an attitude, a way of thinking" (Campbell et al., 1982).

There is no foolproof way of generating research questions. A number of writers on research methodology suggest that a successful method is to first decide on the general focus for the study and then refine this down into a series or a single question to be answered. Robson (1993) in a study of 'Milestone' research projects indicates that much innovative research has been lead by the identification of a specific problem to be solved. Within this research project the identification of research questions has been driven by a combination of both of these methods.

Firstly the general focus of the study was easily identified. It came from a personal and professional interest in the activity of designing and making. The researcher accepts the widely held view (e.g. MacKinnon, 1978; Osche 1990) that humans have a natural desire to know and take pleasure from exercising their creative and cognitive skills. This belief was combined with the researcher's active support of the notion that a major goal of education is to develop people *"... who are capable of doing new things, not simply repeating what other generations have done - men who are creative, inventive and discoverers" (Piaget, 1929).*

Secondly, with regard to research questions being developed out of a specific problem to be solved, in this instance the problem was identified during visits to schools as part of the researcher's professional activities. The problem concerned the observed lack of enthusiasm amongst a growing number of pupils for the creative activities found in design and technology project work. The accumulated evidence fuelled the researcher's desire to identify the causes of that demotivation. This in turn enabled three specific questions to be formulated.

* "How many pupils are de-motivated?"
* "What is causing the demotivation?"
* "What can be done about it?"

The researcher would also have to agree with Robson (1990) and others who suggest that research questions involve, intuition and an element of luck. This researcher's wish to provide answers to the three identified questions coincided with teachers in schools also identifying the problem of demotivation amongst their pupils. This occurred at a time of considerable change in design and technology education. The National Curriculum, new GCSE examinations, and accountability in schools all contributed to increased pressures upon teachers. However, there was found to be a willingness by the teachers to contribute to the research project as the demotivation of their pupils concerned them greatly.

During this stage of defining and refining the research questions the researcher also took note of Robson's (1993) suggestions that to avoid pitfalls one must not pose questions that could not be answered, ask questions that have already been answered, or pre-determine the method or technique which would be used to collect evidence. On this later point

Robson inferred that it was all too easy to utilise a known technique rather than select a new method that would be more appropriate.

Review of the Literature

In order to establish which approach, precise methods and techniques would be applicable to use in this research project, a thorough review and analysis of literature regarding research methodology was carried out at a very early stage of the process. A study of literature concerned with areas of subject interest was also carried out at the same time. This included publications concerning: motivation; creativity; design activity; and aspects of education both past and present that affected the teaching of design and technology in schools. Previously executed research pertinent to the topic being studied was also sought, as it was seen as important to learn from earlier endeavours and place ones own work in context (Cohen & Manion, 1985). In the relatively new subject area of design and technology this was found to be particularly difficult as a research culture in this area of the school curriculum is still in its infancy.

In traditional experimental research a literature survey is considered to be the fundamental starting point for any research project. Whereas in educational studies the subject specific literature whilst still being considered an important preparatory stage of the project, may be seen more as providing a background resource than forming the only legitimate starting point (Bell, 1987; Robson, 1993).

A combination of methods of acquiring background information was found to be essential during this study. The direction of the project was considerably influenced by contact with what was happening within the school context as well as by the literature read. Rather than just taking place only at the start of the project the literature review became an on-going activity as relevant publications evaluating curriculum change were published. Evidence for this can be found in the literature review.

Research Questions and Hypotheses

The majority of research projects concerned with the social sciences set out to test one or more research question or hypotheses by showing that differences or relationships between people already exist, or that they can be created through experimental manipulation (Coolican, 1990). The development of these questions and hypotheses can be achieved through interim (Robson, 1993), or educated guesses (Cohen & Manion, 1985) as to what lies behind the 'how' in any research questions posed.

In the case of this study three tentative research questions were developed during the early stages of the project. They were achieved through an amalgam of personal experience, involvement in schools and a knowledge of both educational research and subject specific literature.

At first they were seen simply as three separate questions in which there was no prediction as to the direction of the results. They were:

* Does a pupil's design and technology capability affect their motivation in design and technology project work?

* Does the approach to designing adopted by a school have an effect upon a pupil's motivation in design and technology project work?

* Does a pupil's inherent capabilities affect their ability in design and technology project work?

However, careful analysis suggested that each of these questions encompassed too many variables to make them useful. Each one included several questions that needed answering separately. Having read that designing questions could help both in establishing a framework for the enquiry and in choosing research strategies the researcher decided that the most appropriate route forward was to develop the questions and methodology together as suggested by Cohen & Manion (1985).

It is relatively easy to visualise concepts in diagrammatic form so a question and methodology tree was developed (see Appendix 5.1). In order to construct this, the factors described earlier that related to pupil demotivation were used. These factors were drawn together out of the analysis of the literature review and experience in the field. Questions pertaining to each of the factors were then teased out. A relevant research method for obtaining an answer to the question was identified which in turn lead to appropriate data analysis methods. Several new branches and even twigs were added as complex questions were refined and split into a number of smaller units affected by fewer and fewer variables.

Ethical Considerations and Negotiating Access

One cannot avoid the issue of ethical considerations when one is engaged in collecting data for the purposes of carrying out research, particularly when that research involves collecting data from human beings. (e.g. Bell, 1987; Coolican, 1990; Robson, 1993) Helpful guide-lines on ethics have been laid down by the British Psychological Society (BPS) in a statement "Ethical Principles for Conducting Research with Human Participants".

Robson, (1993) suggests that one of the first ethical questions that need addressing at the start of a research project concerns how the researcher's 'right to know' is to be balanced against the participants' right to privacy, dignity and self determination. The nature of this study was looked at in detail and it was felt that the dignity and self-determination of the participants would not be adversely affected either by any of the data collecting instruments that were to be used, or the uses to which that data would be put. However, the researcher was aware that privacy and confidentiality were factors that could not be avoided during each phase of the project. It was therefore considered important that from an early stage the ethical consequences of the involvement of participants, be it individuals or organisations, were considered and not left to chance. In the initial stage of the project when fifty schools were selected as a sample, head teachers each received a letter which explained the nature of the research project and how the collected data would be used. The letter requested permission for the researcher to contact the Head of Technology and it also gave a clear undertaking regarding confidentiality both for the school and individuals within the school. (see Appendix 2.1 for a copy of the letter).

This confidentiality of participants has been maintained throughout the project. In order to do this the fifty schools that formed the sample and all the participants involved in any data collection were given coded numbers. It is interesting to note that not only did this afford privacy for those involved, but it also had a benefit in research terms. Pupils were able to give honest replies when it was pointed out to them that they would not be personally identified. In the case of the coding of the schools not only did this protect the schools from being recognised, but it also protected the individual heads of department from being identified.

During the second phase of the research when a smaller sample of eight schools had been selected from the original fifty, each Head of Technology was contacted. They were each asked whether they were willing to take part in the next stage of the research. Once again undertakings were made regarding confidentiality. In fact, with each data collecting instrument, teachers and individual pupils were given written assurances as to the confidential nature of the information they were divulging. They were also given a verbal explanation of how that data would be used within the research project framework.

Robson (1993) refers to the teachers need to be convinced of the researcher's integrity before they decide whether or not to co-operate. Previous professional contact with these schools was believed to have helped in building up trust between the researcher and the teachers at the initial stage. However, as the project progressed it became obvious that the teachers were able to relate to the findings and continued to be supportive of the value of the project and its outcomes. At the end of each identifiable phase of the research when data had been analysed the overall results were explained to the teachers and permission to involve their pupils in the next stage was requested.

At each phase of the project the researcher also believed that it was important for the chosen pupils to be asked if they were willing to take part. In order to do this the intention of their participation was explained to them in detail. Only one pupil, in one school, queried the aim of one of the tests, the Cognitive Style Analysis test. It became obvious during a discussion with him that he had misunderstood the purpose of the test, and that once this was re-explained he quite happily tackled it. He had thought that the result of the test would affect his GCSE mark.

The researcher, having once been a teacher of examination classes in design and technology herself was well aware that any intrusion by an outsider during lesson times has the potential of causing an inconvenience. In this case the inconvenience could be said to be both to the pupils trying to meet examination deadlines and to teachers trying to help those pupils meet their deadlines. A combination of professional judgement and early trials during the field study period identified the length of time that could be taken from a lesson without it impinging unacceptably. The researcher was also very careful not to arrive at a school without prior warning. Visits were either organised by telephone or were arranged at the time of a previous data collecting session.

Choosing the research strategies

Human behaviour at both the individual and social level is characterised by great complexity, Cohen & Manion (1985) explain that it is *"... a complexity about which we understand comparatively little"*. They suggest that several strategies and numerous techniques have been devised to try to help the social science researcher to come to a fuller understanding of human behaviour. Robson (1993) in explaining the distinction between strategies and techniques (which he refers to as tactics) suggests that strategies are *"a broad orientation - the style"* whilst tactics are *"the specific methods used"*. It would seem from analysing the work of a variety of research methodologists that there is a consensus of agreement over the number of basic strategies that exist. These are, the experiment, the survey, and the case study. Within a research project these strategies may be used, in a combination of all three, any two or as a single strategy on its own.

However, the picture is not as simple as this, for not only may enquires be classified in terms of their research strategy but they may also be classified in terms of their purpose. A tripartite classification is commonly used (Robson,1993) in which the terms exploratory, descriptive and explanatory are used to describe the purpose of an investigation. As with the choice of strategy a study may be concerned with more than one purpose. It may also be that the purpose may change as the study progresses although, more often than not one particular purpose will predominate. The link between strategies and purpose becomes clear when the hierarchical relationship between each strategy is examined. Robson (1993) suggests that case studies are appropriate for exploratory work, surveys for descriptive studies, and experiments for explanatory studies.

There are other factors such as the degree of control the investigator has over events and whether the focus of the study is on current or past events which may also have a bearing on which strategy(s) will be most appropriate. However, research methodologiststend to agree that it is the type of research question that is most likely to assist the researcher when it comes to choosing which strategy to adopt. In the case of this study where several research questions have been identified the appropriate strategy for each individual research question suggests a mix and match situation with a combination of strategies being applicable.

The Three Research Strategies

Experimental Methodology

The experimental strategy was not utilised in this research project as it was not considered to be an appropriate tool for investigating the research questions posed in this study. However, it is the intention of the researcher to utilise experimental methodology for testing teaching and learning materials that are to be designed once the study is complete. This follow-up project will be carried out in conjunction with NEAB and HMI who have both shown considerable interest in the research as it has developed and been published (Atkinson, 1993; 1994; 1995; 1996). It is intended that the materials will help to address the problems of pupil demotivation witnessed during the research study. Experimental methodology utilising control and experimental groups are seen as an applicable and useful verification tool for testing the effectiveness of these materials before publication can be considered.

Survey Methodology

Surveys were utilised as one of the appropriate methods of seeking both exploratory and explanatory information in each of the phases of this research project. Research methodologists describe surveys as the most commonly used descriptive method in educational research (Cohen & Manion, 1985; Coolican, 1990; Robson, 1993). However, they also strongly support their use for analytical purposes as well.

The main emphasis of a survey is to fact find. If they are well structured and piloted, they are a relatively cheap, quick method of obtaining information. The typical features of a survey are, the selection of a fairly large (Cohen & Manion, 1985; Coolican, 1990), representative (Bell, 1987; Robson, 1993), non-biased (Cohen & Manion, 1985; Bell, 1987; Coolican, 1990; Robson, 1993) sample from a known population. That sample leads to the collection of relatively small amounts of data in a standardised form (Cohen & Manion, 1985; Bell, 1987; Robson, 1993) at a given point in time (Cohen & Manion, 1985), using either questionnaires or interviews. The body of quantifiable data, in respect of a number of variables, can then be examined to discern patterns of association (Bryman, 1989).

A survey can be formal, less formal or completely informal (Cohen & Manion, 1985). Formal surveys are usually found in questionnaire design rather than in interviews, less formal or loosely structured surveys may be found in both questionnaire and interview design, whilst completely informal surveys are normally only suited to interviews. Coolican (1990) points out that in the case of informal, loosely-structured interviews each respondent's replies can almost be said to form a small case study.

With regard to the mode of questioning there are three obvious ways of communicating with the respondents: face-to-face, by telephone or by post. Interviews use interaction between the respondent and the researcher therefore communication by post is confined to questionnaires. Whereas the other two methods are equally appropriate to both questionnaire and interview procedures.

The aim of a survey is to obtain information which can be analysed and from that analysis patterns can be extracted and comparisons made (Bell, 1987). The results of surveys can aid the exploration of a situation or they can seek explanations. Surveys are also able to provide data for testing or developing hypothesis (Cohen & Manion, 1985; Coolican, 1990) although there is normally no attempt to manipulate variables, or control conditions. Causal relationships can rarely if ever be proved by the survey method (Bell, 1987). Usually the interest is not in individuals per se, but on profiles and generalised statistics drawn from the total sample. If the sample has been carefully chosen the results of a survey can be generalised to the population under scrutiny (Bell, 1987; Coolican, 1990; Robson, 1993).

Generalisability is not only an important feature of survey design it is an important aspect of any research enquiry. It is crucial that researchers can persuade themselves and their audiences that their study is both believable and trust worthy. Any measure must be seen to be reliable, and if it is not then it must also lack validity (Bell, 1987; Robson, 1993). It is essential that the findings are, as Robson (1993) explains, *"... 'really' about what they appear to be about"*.

The audience must be confident that any relationships established in the findings are 'true' rather than due to the effect of something else. Subject and observer error and subject and observer bias need to be avoided at all cost. Subject error, and observer error have been shown to be possible sources of unreliability, whilst subject bias and observer bias are more problematic from a validity point of view.

This need for 'validity' in a research project is a key issue (for example: Campbell and Stanley, 1963; Le Compte and Goetz, 1982; Robson, 1995) and particularly so when surveys are being used as a data gathering technique. The difficulties in achieving a representative, unbiased sample can lead to external validity problems and scepticism as to the trustworthy nature of the survey (Cohen & Manion, 1985; Bell, 1987; Robson, 1993). On the other hand if questions are incomprehensible (Robson, 1993), ambiguous, imprecise, or presuming (Bell, 1987; O.U. 1979) it is the internal validity of the survey that is brought into question. Care always needs to be taken to avoid questions that ask the respondents for information they may not have readily at hand or may not easily remember. Double questions, leading questions, hypothetical questions, offensive questions or ones covering sensitive issues can all be problematic. Piloting and thorough testing of each change in the design of individual questions can help to overcome these forms of validity problem.

One method of supporting findings from surveys is by the use of triangulation (Cohen & Manion, 1985; Robson, 1993). Defined as *"... the use of two or more methods of data collection in the study of some aspect of human behaviour" (Cohen & Manion, 1985).* A multi-method approach can avoid the bias or distortion that may easily occur if a single observation of a phenomena is used. It also follows that the more the methods contrast each other, the greater can be the confidence in the researcher's findings.

The details regarding the varied use of survey methodology within this research project are discussed at the relevant points within each of the three separate chapters on the Initial Survey, Phase One and Phase Two of the project.

Case Study Methodology

The case study approach to contemporary social science and educational research has become an extremely popular research strategy. In support of Bromley (1986) Coolican (1990) suggests that case studies can be the *"bedrock of scientific investigation"*. Although in line with other research methodologists he provides a cautionary warning when he explains that unless carefully considered the rich, unstructured nature of case studies can be unreliable and suspect in terms of their scientific use.

During the design of a case study it is the level of attention that has been given to data collecting methods, their analysis, their interpretation and methods of reporting the results that equally affect its acceptance as a sound research tool. In the context of this research study, in order to address the problems associated with reliability and validity, the researcher took great care over the selection criteria for the schools and the pupil sample as well as the design of the specific case study approach to be adopted.

Case Studies are the development of detailed, intensive knowledge about a single case, or a small number of cases (Robson,1993). In this instance there were a large number of case studies taken from eight schools. The information was collected using a range of data collection techniques. These included such methods as observation, interview, questionnaire and documentary analysis.

In contrast to a survey where relatively small amounts of information are gathered case studies tend to collect an abundance of data. Evidence would suggest that this is most frequently in the form of qualitative data, although as with other qualitative methods it is essential to devise appropriate checks by means of triangulation to provide rigorous research findings. In the case of this research project both quantitative and qualitative methods were seen to be appropriate. This supported Cohen and Manion's (1980) theory that a combination of both qualitative and quantitative strategies during a case study would complement rather than compete with the experimental stance.

The wide use of the case study approach has been marked by an equally diverse range of techniques employed in the collection and analysis of data. However, whatever the problem or approach, at the heart of each case study has laid the method of observation. Cohen and Manion (1985) suggest that this observation may be separated into two basic types, participant observation and non-participant observation. In the context of this research study a non-participant approach was adopted. The researcher was careful not to influence or intervene in the teaching and learning strategies adopted or the design process utilised by the pupils or their teachers. However, during each session there was contact between the researcher, the teacher and the individual pupil. This took the form of informal interviews that were used to clarify or support the observations made.

It was recognised by the researcher and others (for example: Bell, 1986; Coolican, 1990; Cohen & Manion, 1985) that information collection of this type is prone to interpersonal variables. The very depth of the long lasting relationship between the researcher and the individual pupil can on the one hand produce a wealth of useful information whilst at the same time seriously interfere with the objectivity of the findings. However, with regard to this research project it was believed that the use of quantitative analysis of data collected during the case study provided support for the reliability and validity of the qualitative evidence gathered. The researcher was aware that subjectivity can also become a problem in relation to the publication of case studies. As case studies produce an inordinate amount of data the researcher is forced to be selective in the final report. The problem arises when as Coolican (1990) reports "*... we do not know how many cases did not deliver the kind of information the researcher wished to present*".

Further details regarding case study methodology pertinent to this particular research project appear in the methodology sections of each of the relevant chapters concerning Phase One and Phase Two.

Sampling Methodology

Sampling considerations pervade all aspects of research. They cannot be avoided no matter which research strategy or technique is to be used (Robson, 1993). The most important aspect of the sample in a research study is that it is typical of the population about which the researcher wishes to generalise. Coolican (1990) suggests that a truly representative sample is an abstract ideal that is un-achievable in practice. In the case of the single researcher it is certainly impossible, for it is through the use of a very large random sample that this can be accomplished. However, a single researcher can remove as much sampling bias as possible. This is achieved by attempting to make the sample as representative as possible and by considering the sampling methods used when interpreting results and evaluating the research findings.

Many strategies have been devised that allow the researcher to obtain a representative sample. These methods can be divided into probability and non-probability sampling. Probability sampling includes: simple random sampling where each member of the chosen population has an equal chance of being selected; systematic sampling where subjects are selected from a population list in a systematic rather than truly random manner (Cohen & Manion, 1985); stratified sampling where subjects of a specific type are selected in proportion to the number of that type appearing in the population being researched (Coolican, 1990); cluster sampling which is done on a geographical basis to avoid administrative problems (Cohen & Manion, 1985); stage sampling (Cohen & Manion, 1985) which is an extension of cluster sampling and involves taking samples from samples.

However, small scale research projects tend to use non-probability samples because, despite the disadvantage of being non-representative (Cohen & Manion, 1985), they are less complicated to set-up, less expensive, and adequate as long as the researcher does not intend generalising beyond the sample in question. Such methods include: convenience, opportunity (Coolican, 1990) or accidental (Cohen & Manion,1980) sampling that involves choosing convenient individuals that are easy to get hold of; quota sampling that is popular with market researchers (Coolican, 1990) and described by Cohen and Manion (1985) as the non-probability equivalent of stratified sampling; dimensional sampling (Cohen & Manion, 1985) which is simply a refinement of quota sampling; snowball sampling (Coolican, 1990; Cohen & Manion, 1985) where interviewees provide further contacts to be interviewed; self-selecting sampling (Coolican, 1990) where the sample is made up of volunteers; and purposive sampling where the researcher hand picks the cases to be included in the sample based on the researcher's judgement of their typicality. This last method, which was used in the initial and later stages of this research project, allowed samples to be built up that were satisfactory to the researcher's specific needs (Cohen and Manion,1980).

The size of the sample is also problematic for the small scale researcher. There is a conflict between validity and manageability. This researcher was all too aware that a sample needed to be as large as possible in order to achieve validity of results, however, it also needed to be as small as possible in order that the researcher could resource it both from the point of view of time and money (Coolican, 1990). Coolican (1990) suggests that a sample size of between twenty-five and thirty is required if some form of statistical analysis of the collected data is to be carried out. Cohen & Manion (1985) are a little more conservative as they believe that a sample size of more than thirty is needed. However as has been found to be the case in this research project, it is not just the total sample size that is important. The small size of subgroups within that sample need to be taken into consideration. For it is the size of these sub-groups which control the types of statistical test that can be used when exploring the relationship of variables at a later stage in the study. The larger the sample the less chance there is of sampling error while small samples fail to accurately represent the population under scrutiny.

Data Collection and Analysis

The specifics of data collection are bound up with the different methods of investigation chosen and at the same time with the methods of analysis proposed. Bell (1987) and Robson (1993) support this point of view when they refer to the importance of planning the analysis stage at the same time as designing the data collection methods in case the point is reached where the data collected are unsuitable for the method of analysis required. Robson (1993) also suggests that advice on statistical analysis should be taken at the design stage of the project if the researcher proposes to use computer software packages in order to assist in the analysis of the collected data. The literature would suggest that quantitative statistical packages are very thorough whilst qualitative packages, that help to cut out some of the drudgery experienced in qualitative research, are not seen to be as efficient at producing replicable, valid results (Robson, 1993).

Coolican (1990) although supporting the notion that analysis must be kept central to planning, gives the warning that thoughts regarding analysis should not be allowed to stifle creativity. Whilst Robson (1993) warns that there is a tendency for researchers to become familiar with a small number of analysis techniques and then to use those techniques whether they are suitable or not. Although, he also explains that it would be foolish to expect everyone carrying out an enquiry to have the full array of analysis techniques at their finger tips.

Whatever data collection methods are used there is a need for a systematic (Robson, 1993), professional (Cohen & Manion, 1985), caring and committed (Robson,1993) approach to the task. There is no general best method. The selection of methods should be driven by the kind of research questions that are being asked. A multi-method approach is considered by many to be a sound choice as all methods have strengths and weaknesses. Robson (1993) supports the notion that by choosing different methods one is matching the strength of one method against the weakness of another, and vice versa.

If a variety of data gathering approaches are employed then there will be a variety of different types of data to deal with. For example: test results; responses to questionnaires; diary entries; reports of meetings; documents; audio- and video-tapes. However Robson (1993) explains that these fall effectively into two categories - words and numbers. Or, as he goes on to suggest, they can, without too much difficulty, be turned into words or numbers. In research terms these are referred to as qualitative and quantitative data.

Research methodologists have developed different methods of dealing with these two types of data. The literature (for example: Hammersley, 1989; Fielding & Fielding, 1986; Robson, 1993) also indicates that for many researchers the contrast between these two strategies goes beyond just a difference in method and data type. Although Cohen and Manion (1985) suggest that, as more and more researchers come to use a combination of approaches, acceptable means of dealing with both types of data within one research project have become evident.

Bell (1987) refers to the two broad categories into which statistical methods fall as: descriptive and inferential. Descriptive statistical methods she suggests provide 'pictures' of the group under investigation. These pictures may be in the form of charts, tables, percentages, averages and so on. Inferential statistical methods she explains have a very different purpose. They may involve the use of descriptive analysis however their prime aim is to *"... draw implications from the data with regard to a theory, model or body of knowledge" (Bell, 1987).*

Robson (1993) referring to the work of Tukey (1977) and others, explains that there is an influential modern approach to quantitative analysis which breaks down this distinction between descriptive and inferential statistics. It is known as exploratory data analysis (EDA). This approach can be identified at two levels. Firstly, several ingenious ways of displaying data diagrammatically are used, although these are not perceived to be controversial. Secondly and more revolutionary is *"... the centrality EDA places on an* *informal, pictorial approach to data" (Robson, 1993).* EDA has its critics because of the implication that pictures are all that are needed in statistical analysis. However proponents of EDA acknowledge that there is also a need for confirmatory data analysis using the more formal processes of statistical hypothesis testing at appropriate points throughout the analysis of the collected data (Robson, 1993).

Qualitative data analysis has in the past been considered to incorporate intangible methodologies although its attractiveness as an approach is considered to be *"undeniable"* by many researchers (Miles, 1979; Robson, 1993). Robson (1993) suggests that qualitative data can have a quality which *"lends verisimilitude to reports"*.

There is no clear and accepted set of conventions for the analysis of qualitative data corresponding to those observed for quantitative data. In fact many qualitative researchers would resist the development of such systematic approaches believing that their methodologies are more of an art than a science (Robson, 1993).

Lincoln and Guba (1985) suggested that there were four questions which must be addressed in any systematic enquiry into humans and their ways: truth value; applicability; consistency; and neutrality. Robson (1993) referred to these concepts as: internal validity; external validity; reliability; and objectivity. However Robson (1993) supported Lincoln and Guba's (1985) belief that the conventional criteria were inappropriate when dealing with qualitative data. They proposed four alternatives, which Robson (1993) believed reflected more faithfully the assumptions behind the strategy - credibility, transferability, dependability and confirmability. Robson (1993) suggested several techniques to enhance credibility. These included: prolonged involvement; persistent observation; triangulation; peer debriefing. All of these techniques were carried out in this research project. In the case of transferability Marshall & Rossman (1989) stressed the need for a full description of the theoretical framework on which the study was based. This they suggested then helped those designing other studies or making policies within that framework to determine whether or not the cases described could be transferred to other settings. Robson suggested that dependability was analogous to reliability. He believed that just as reliability was a necessary though not sufficient condition for validity, so that a study that was valid must needs be reliable, then dependability was necessary, though not sufficient, for credibility. Hence a study that was shown to be credible was also dependable. With regard to confirmability, Robson explained that the researcher must explain enough in their study not only for the reader to be able to judge the adequacy of the process, but also to assess whether the findings flowed from the data.

Although Tesch (1990) has identified a total of twenty-six different kinds of approach to qualitative research, the collection of the data, mainly in the form of words, is often very straightforward. However the ease with which the data can be assembled has also been shown to be its downfall. Data overload is seen as a constant danger. Another major problem associated with this approach is in achieving rigorous, trustworthy methods of analysis. In recent years these have been systemised and made more widely accessible. Helpful routines and procedures which are less technical and differentiated than much statistical analysis are now available. Although in comparison to quantitative analysis techniques, many researchers would support Robson's (1993) suggestion that those used for qualitative analysis are closer to codified common sense. It is also firmly believed that the quality of the analysis depends very much on the clear thinking of the analyst.

In the age of multi-method approaches to research it is seen as most likely that one or more of the methods used in a research project will generate qualitative data This was found to be the case in this research project where qualitative data was gathered during Phase Two of the project. As has also been suggested in the literature (Cohen and Manion, 1985; Bell, 1987; Coolican, 1990; Robson, 1993) it was seen to be appropriate for much of the data to be converted into quantitative data for analysis purposes. However, there were instances where the qualitative data was used to supplement and illustrate the quantitative data gathered from such research tools as questionnaires.

The traditional model of analysing data has been for it to take place once all the data has been collected. However with the introduction of such strategies as the Case Study approach, researchers have found that it is often more appropriate for the analysis and interpretation of case study material to begin whilst data are still being collected.

Once the data has been collected then analysis of that data are necessary. As Robson (1993) suggests *"... generally speaking data in its raw form does not speak for themselves"* This important process and the product of that analysis provide the bases for the researcher's interpretation of the results in the light of the research objectives set out earlier in the project.

Before any analysis can be contemplated the collected data needs to be edited in order that interviewer or respondent errors can be eliminated. The editing is carried out by checking for completeness, accuracy and uniformity (Moser & Karlton, 1977).

Whichever approach to data collection has been adopted data reduction is the next important stage in preparation for analysis. The collected evidence needs to be made manageable and meaningful. This generally consists of coding the information that has been collected. Coding has been defined by Kerlinger (1970) as the *"... translation of question responses and respondent information to specific categories for the purpose of analysis"*. Data reduction is done by hand in the case of small samples and by computer when the numbers are larger (Cohen & Manion,1980).

When data has been collected by means of certain types of questionnaire or interview, coding can be built into the construction of the questions themselves in the form of pre-coded answers. This has been shown to be appropriate when the questions asked required closed answers, for example in rating scales and check-lists where the responses can be immediately and directly converted into a score in an objective manner (Cohen & Manion, 1985). However, it is not always a possible option in the case of open ended questions. Sometimes pilot studies can allow predetermined coding categories to be established. Alternatively the data must be postcoded. In this instance coding frameworks are designed once the relevant data has been collected and summarised. In the case of data collected from interviews evidence is usually in a written format or as verbatim tape recordings. Summaries of this type of data will either happen during the interview, if the task is simple and pre-coded, or the researcher will need to subject the recorded evidence to content analysis using a variety of scoring approaches. These procedures used such methods as: scaling, scoring, rank scoring, and response counting.

Robson (1993) supports the belief that *"... analysis covers a wide range of things, from simple organisation of the data to complex statistical analysis"*. Statistics are used in research terms to describe and to help draw conclusions that others will accept as the truth (Clegg, 1990). It is in conveying information about, and in trying to interpret large sets of numbers in an efficient and convenient manner that descriptive statistics are used. Whilst statistics used to arrive at conclusions about the effect of events upon a situation is called inferential statistics. Clegg (1990) suggest that using statistics is rather like using a tool box in which the tools selected are those which are appropriate for the task.

Robson (1993) and others (e.g: Cohen & Manion, 1985 ; Coolican, 1990) strongly advise that researchers should make use of the software packages designed to statistically analyse data. The use of computers they, and others, suggest can speed up the process and help to eliminate the potential for error seen when such analysis are carried out by hand. In relation to this specific research project the software package StatView was used in conjunction with Filemaker Pro, a powerful, computerised, data base.

Due to the complex and specialised nature of statistical analysis, Robson (1993) recommends that *"... prior acquaintance with the basic concepts and language of statistical analysis"* is of paramount importance before such packages are used. Analysis is seen by all researchers as full of pitfalls. The negative aspect of readily available analytical software is that it has become that much easier to generate elegantly presented rubbish. Robson, (1993) and Coolican (1990) explain that it is very easy to carry out an analysis which is simply wrong, or inappropriate for the data or the researchers purposes " *'GIGO' - Garbage In, Garbage Out" (Robson, 1993; Coolican, 1990).*

When using computers to assist the analysis stage of the process visualising the structure of the data is a very important first step in creating a dataset (Haycock et al, 1992). Whatever the type of data collected it has been shown to be almost always possible to have some sensible arrangement of data in rows and columns. Although, it should be noted that some qualitative data does not conform to this model and needs its own separate approach[1]. Typically, each row corresponds to a record representing a distinct case (observation) and each column contains a variable. A record consists of cells which contain the data. There are two basic classes of information placed in the cells that are each treated differently in StatView: continuous and nominal. Continuous data can assume any numerical value over a given interval; nominal data identifies the group an observation belongs to.

As with all transcribing of information it is essential that once the data has been entered it is 'proof read' and checked for errors. After this has been accomplished the researcher is then in a position to find out what the enquiry has thrown up by exploring the data using a variety of statistical analysis methods. In this research project both qualitative and quantitative approaches have been adopted. Numerous data collection techniques, methods of coding, and approaches to analysis have been utilised. These have provided the bases for the interpretation of the results in the light of the research objectives which the researcher set at the start of the project. The details regarding each chosen strategy are discussed separately at their appropriate point within the thesis in order to achieve clarity for the reader in what has been a complex research project.

Evaluation and Conclusions

Bell suggests that the conclusion should be a brief simple summary of the main conclusions made in the analysis and discussion sections of the thesis. Only conclusions that can be justifiably drawn from the findings should be made. The temptation to *"... drop in an opinion for which no evidence is provided in the report" (Bell, 1987)* must be avoided. Phillips & Pugh (1990) warn that it is important to be clear that the summary and the conclusions are quite separate tasks. They suggest that *"... the researcher needs to have a concept of what purpose the conclusion performs: namely, to demonstrate how the background theory and the focal theory are now different as a result of the study".*

The reader who wants a quick idea of what the research is about will look at the abstract, possibly the introduction and almost certainly the summary and conclusions. The final

[1] *Where such alternative methods have been appropriate to this research project these have been discussed in the relevant chapters describing the specific methodology utilised during that phase of the research.*

section should be sufficiently succinct and clearly expressed to enable readers to understand quite clearly what research has been done and the conclusions that have been drawn from the evidence (Bell, 19987).

However, Robson (1993) and Coolican (1990) do not include a 'Conclusion' in their format for writing up research reports. Coolican explains that it is because in Scientific Journals there is no section called Conclusion although he supports the inclusion of "*... summarising comment in terms of overall findings, their relationship to the relevant model or theory and implications for the future*".

Reporting the Enquiry

Robson (1993) suggests that the aim of writing is to communicate. The Golden rule, according to Coolican (1990), regarding writing up research projects is that one needs to write in enough depth and clarity for a complete stranger to repeat exactly what you did in every detail. Bell (1987) explains that whatever structure has been selected for the report, the readers will wish to be quite clear why the investigation was carried out, how it was conducted, what methods were used to gather evidence and what was found out from the collected data. Clegg (1990) simply suggests that there are only four vital questions to bear in mind when writing up the research project. Why? How? What? and So What? Phillips & Pugh (1987) refer to the importance of formulating coherently in writing ideas which the researcher has got to know well but which will be new to the reader. They suggest that "*... assumptions have to be made explicit and ideas expressed clearly*". Robson (1993) highlights the importance of having a clear sense of the audience in relation to the style, length and general approach adopted in writing up the thesis.

All writers regarding this aspect of the process refer to the importance of not leaving all the writing to the end (Bell, 1987; Barzun & Graff, 1977; Phillips & Pugh, 1987; Coolican 1990; Clegg, 1990; Robson, 1993). The importance of tackling easy sections first (Coolican, 1990), setting realistic deadlines (Bell, 1987), having sufficient uninterrupted time (Robson, 1993), writing regularly (Barzun & Graff, 1977) and allowing time for re-drafting and even re-writing(Phillips & Pugh, 1987) are all important considerations. The final transcript Robson suggests should be a polished jewel. The use of computer software packages to assist in this part of the process have considerable advantages although as a person concerned with graphic design I am also well aware of the pitfalls too. Robson (1993) also explains that there is no substitute for painstaking proof-reading, preferably by someone else because of text familiarity once the writer believes they have completed their task.

Figure 2.1 Illustrates the conventional format for a doctorial thesis.

The format for a thesis is conventionally seen as: Introduction, Method, Results, Discussion and Conclusion (Figure 2.1). However, after considerable thought the conventional model appeared not to be the most suitable method of presentation for this research project. The quantity and complexity of the data favoured an integrated and progressive approach in order that it remained meaningful and coherent to the reader. The brief resume which follows supports the researchers choice of format as illustrated in Figure 2.2. The methodology used throughout the study is then treated in depth on an individual Phase basis at the appropriate place in each chapter .

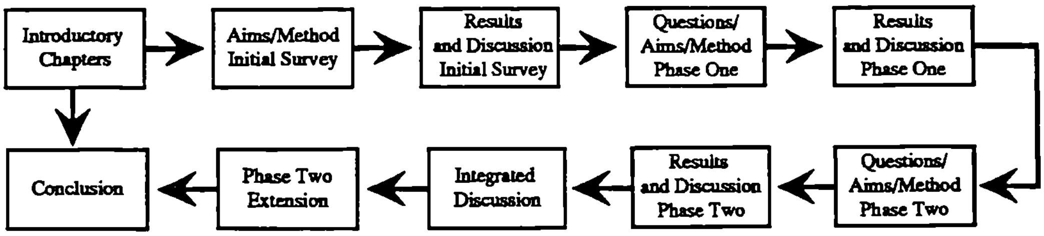


Figure 2.2 Illustrates the integrated format selected for this thesis

Resume of Research Methods Used in This Project

This research project has set out to identify some of the causes for a lack of motivation noted amongst pupils in Years 10 and 11 whilst they followed courses in design and technology (Atkinson, 1993; 1994; 1995; 1996 - see Appendices 6.1 - 6.6 for published papers).

The complexity of the task has meant that careful planning over a four year period of data collection has been essential. In order to plan, implement, analyse and come to conclusions in a systematic manner the project has been split into three phases, the Review of the Literature and the Initial Survey, Phase One and Phase Two. The Review of the Literature and the Initial Survey occurred during the academic year 1992-3, Phase One during 1993-4 and Phase Two during 1994-5 with a follow up extension to Phase Two in 1996.

It was vitally important at an early stage of the process to have a clear understanding of what the research project was setting out to prove (Cohen & Manion, 1985; Bell, 1987). There was on the one hand a need for rigour and for principles - both in the sense of following agreed practices and in having sensitivity to ethical implications (Cohen & Manion, 1985). Whilst on the other hand there was a need for flexibility as the research was to be carried out in the real world, and not in a laboratory, situation (Robson, 1993).

As Robson (1993) and others suggested there is no foolproof, automatic means of generating research questions. In this instance the aims of the project, the research questions, the methods for collecting answers and interpreting results were all dealt with at the same time (e.g. Bell, 1987). The overall aims of the research project and how those aims were to be addressed during the various stages of the project can be seen in Figure 2.3

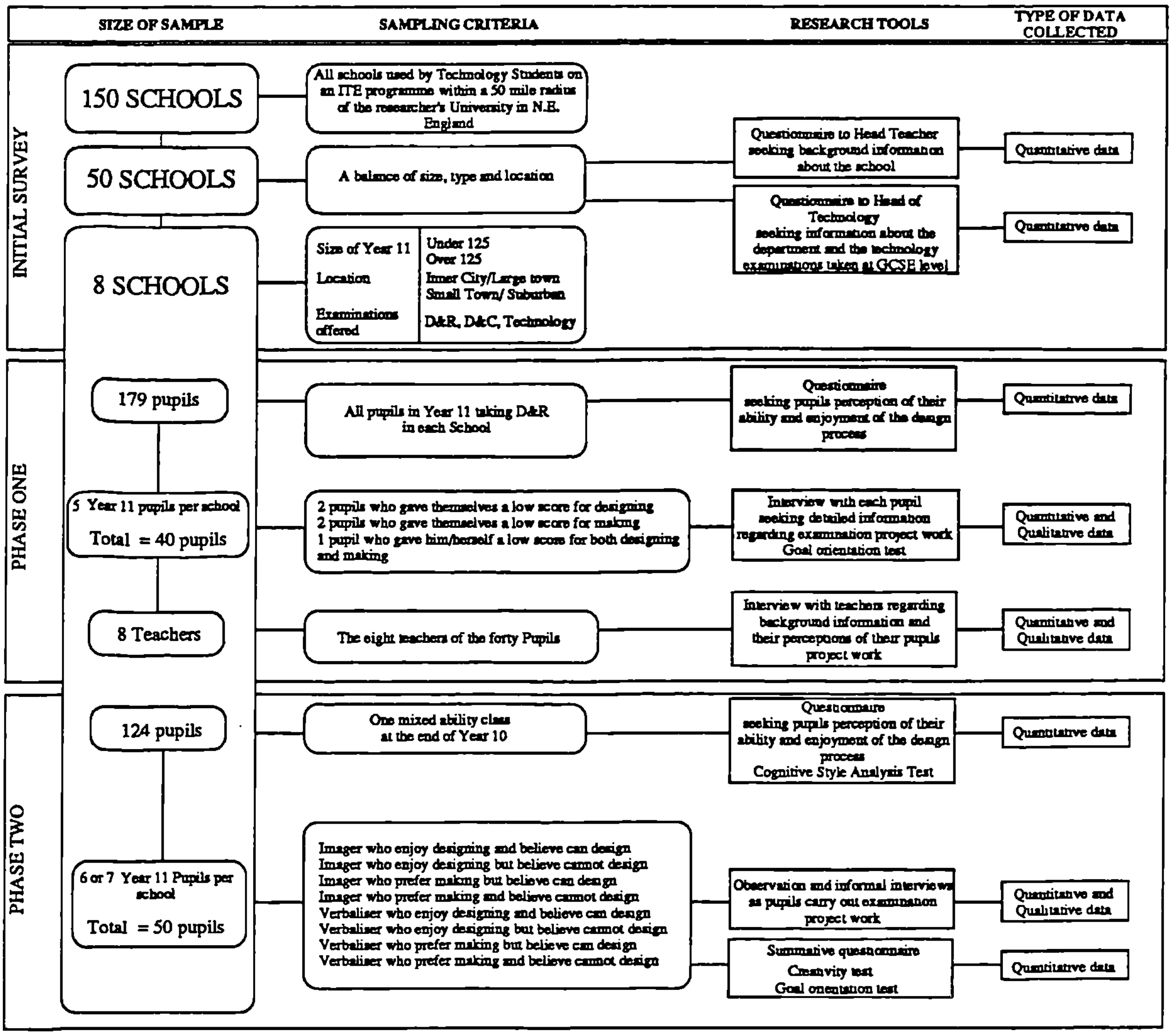


Figure 2.3 Illustrates the model of the adopted research process

The complexity and number of questions that needed to be asked in order to identify some of the causes for a lack of motivation noted amongst pupils during Years 10 and 11, was recognised from the outset of the project. This was further amplified during the review of the literature. It was at this stage that the researcher decided to design a question tree in order that a sound structure for the project could be developed (see Appendix 5.1). As a starting point questions were based upon the analysis of the review of the literature, the data collected during the initial survey and the professional judgement of the researcher. The appropriate research and analysis tools were also designed into the system at the same time. This followed advice taken from research methodologists, all of whom emphasised the importance of doing so in order to avoid a variety of problems at later stages in the research process (e.g. Cohen & Manion, 1985; Bell, 1987; Coolican, 1990;Robson, 1993). As each set of questions were answered and the collected data were analysed a check was made on the questions still to be answered. In some instances this scrutiny of the question tree led to new questions being added or established questions being re-defined.

The structure of the research study was designed to be dealt with in three stages, the Initial Survey, Phase One and Phase Two. The purpose of the Initial Survey was to select representative schools from which a suitable sample of Key Stage 4 pupils could be identified in order that the proposed research study could be carried out.

Through the use of a variety of research tools Phase One set out to unravel some of the causes of demotivation which the researcher had identified through her professional experiences and the review of the literature.

Phase Two was separated into three sections. The first section was a continuation and development of the process begun in Phase One. The second section was targeted at re-assembling the complex jig-saw in an attempt to quantify the interplay between the various factors associated with the demotivation which had been identified.

The final stage of research in Phase Two set out to add support to the proposals the researcher wished to make in order to alleviate the demotivation witnessed amongst pupils involved in technological activities.

As stated earlier the conventional format for a thesis was not considered to be appropriate in the case of this study. After teasing out several designs the researcher chose a different approach. A conventional start to the thesis can be found within the opening chapters. These follow the scientific journal approach. However, the central portion of the thesis has been broken down into chapters which correspond to the different phases of the project. This was particularly successful as each phase of the study targeted certain groups of questions. The phases were also designed to build upon the experiences gained during the previous phase in a cohesive, informed manner. This enabled the writing of each phase to add to and confirm the steadily growing picture which emerged as the research progressed. It was hoped that because of the quantity and complexity of the data, the use of a integrated and progressive approach would allow the study to remain meaningful and coherent.

Chapter Three

Aims of the Research Project

Identification of The Aims of the Research Project

As Campbell (1982) intimated the selection of innovative research questions is rarely carried out as a single act or decision. The process by which the questions and therefore the aims of this research project were established took place over several years. The general focus for the study had been easily identified. It came from a personal and professional interest in the activity of designing and making. Whilst for the researcher, an awareness of a problem concerning design and technology project work, particularly at Key Stage 4, had developed over several years during the researcher's observation of classroom practice.

The accumulated evidence from both the observations and the literature review fuelled the researcher's desire to identify the causes of the demotivation of pupils whilst they were engaged in design and technology project work. However the wish to establish reasons for the lack of motivation was not seen as an end in itself. The researcher also believed that it was an essential part of the research project to predict strategies that could help to improve that situation.

Through the analysis of the literature review it was recognised that a complex matrix of questions needed to be answered in order to fulfil the two overall aims of the research project. As a result, the study was designed in three sections: the Initial Survey; Phase One; and Phase Two. Athough the major aims for each phase of the research were identified at the start of the project, it was also the intention that each phase would build upon the experience gained as the research study progressed. New aims or details of existing aims were altered as appropriate. This usually occurred when analysis of each phase was carried out.

The individual aims for each phase can be found in Figure 3.1. Whilst an explanation for the need for each specific aim within each phase has been dealt with at the beginning of Chapters 4, 5, 6 and 8.

AIMS OF THE RESEARCH PROJECT

OVERALL AIMS

* To identify some causes of pupil de-motivation amongst Key Stage 4 pupils studying Technology with special reference to design and technology.
* To predict strategies that could help to improve the situation.

AIMS PHASE BY PHASE

INITIAL SURVEY

To select eight representative schools from which data can be collected in order to identify some of the causes of pupil de-motivation amongst Key Stage 4 pupils in studying Technology with special reference to design and technology.

PHASE ONE

To develop a greater understanding of pupil perception regarding:

their enjoyment of their studies in Design and Technology;
which aspects of the design process they enjoy and why;
which aspects of the design process they find difficult and why;
which aspects of the design process they find boring and why;
which aspects they feel they need most help with and why.

To develop a greater understanding of teacher perceptions regarding:

pupils level of enjoyment within their studies in Design and Technology;
the difficulties pupils have within their studies in Design and Technology;
which aspects of the design process pupils find difficult and why;
which aspects of the process pupils find boring and why;
which aspects of they feel they need to help pupils with and why.

PHASE TWO

To explore whether a pupil's motivation is affected by internal dependent factors such as:

creative ability;
goal orientation;
cognitive style;
design ability;
manufacturing capability.

To explore whether a pupil's motivation is affected by externally dependent factors such as:

the design process specified by GCSE Examination Boards;
the relationship between the knowledge base and the design process taught;
the balance of time given to the various aspects of the design process;
the teaching strategies adopted by the individual teachers during project work;
the delivery programmes devised by the schools;
the relationship between the teacher and their pupils;
the teachers design ability, knowledge base and creativity;
the teacher's motivation.

To analyse the data collected in order to predict teaching and learning strategies that could help to improve the situation.

Figure 3.1 Lists the overall aims of the research project and the aims of each phase

Chapter Four

Initial Survey

Introduction

As the research topic was targeted at the design and technology curriculum area schools were selected for the initial survey from the schools used by a North East of England's trainee teachers programme for design and technology students. It was considered necessary to select the sample from local schools within a fifty mile radius of the researcher's place of work. It was recognised that for small scale researchers there is a conflict between validity and manageability (Coolican, 1990). However the resources of time and cost needed to be taken into consideration. The sample therefore had to be kept to a manageable size, without being too small in order to avoid sampling error (Cohen & Manion, 1985). This was considered to be most important as it was intended that statistical analysis would be used on collected data at later stages in the study. It was also understood that in selecting the schools the sample must be kept as representative as possible (Coolican, 1990) in order to avoid sampling bias associated with some non-random samples.

Aim of the Initial Survey

* To select eight representative schools from which data could be collected in order to identify some of the causes of pupil de-motivation amongst Key Stage 4 pupils in studying design and technology.

Method

Methods of Examining the Issues

The Initial Survey sought to examine the issues raised in the introduction and review of the literature through the following means:

* use of documentary sources, such as school prospectuses, examination results, examination syllabuses etc.
* questionnaires

Data Collection Methods

Data was collected in the following manner:

From an original list of one hundred and fifty schools in seven Local Education Authorities (L.E.A.'s) in the North East of England, fifty were selected as a non-probability, purposive sample (Cohen & Manion 1985). The fifty were chosen in order to achieve a balance of size, type and location. A postal questionnaire (Figure 4.1) that had been appropriately trialed, and a letter (Figure 4.2) that explained the nature of the research project, were sent to the head teacher in each of the fifty schools. The letter explained the nature of the research project and how the collected data would be used. The questionnaire requested information regarding age range, type, location of school, the total number of pupils on role and the number of pupils in year 11. At the end of the questionnaire each school was asked for a copy of their examination entries for that academic year in order that

Please could you complete this short questionnaire to help me in my research. The information that you provide on this form will be strictly confidential and will only be used for statistical analysis in my research.

1 Please tick the appropriate box to indicate the type of school you teach in.

a) 11-16 ☐ 11-18 ☐ 13-18 ☐ other please specify ☐

b) Rural ☐ Suburban ☐ Inner City ☐ other please specify ☐

c) All girls ☐ All boys ☐ Co-educational ☐ other please specify ☐

2 Number of pupils on roll in the school ☐

3 Number of pupils in year 11 (5th year) ☐

4 Please could you attach a copy of all your year 11(5th year) GCSE examination entries for 1993.

The information required is:

Pupil	Examination Title	Examination Board
Pupils names will not be used Pupils may therefore be identified by number	*Please indicate specific syllabus. e.g. Technology A Technology B etc.*	

e.g

Pupil	Examination Title	Examination Board
Pupil One	Mathematics English Language English Literature Technology B Physics	NEA NEA NEA NEA MEG
Pupil Two	Mathematics English Language English Literature Design Biology etc.	NEA NEA NEA MEG MEG

Thank you for your co-operation in filling in this questionnaire and providing me with statistical information for my research

E Stephanie Atkinson

Figure 4.1 A copy of the postal questionnaire sent to the head teachers in the fifty schools selected from a possible one hundred and fifty schools in seven LEA's in the North East of England

6th January 1993

Dear

I am writing to you in connection with the educational research which I am carrying out for a doctorate at ...... University. The area of my research is:

"The identification of the causes of demotivation amongst key stage 4 pupils studying National Curriculum Technology with special reference to Design and Technology."

In my capacity as course leader for the 4yr B Ed (Hons) degree in Design and Technology in the University of ...., I have observed over the last few years the lack of enthusiasm amongst a growing number of key stage 4 pupils with project based technology education. An initial field study gave clear evidence to support this concern.

As the subject area of technology is developing so is the use of project work throughout secondary education. Based upon professional experience and from the initial field study it would appear that these long term pieces of coursework, fundamental to the delivery of technology are causing some pupils problems leading to pupil demotivation and staff dissatisfaction. It is hoped that analysis of a variety of collected data will lead to strategies which could improve the situation.

At this stage I am carrying out a survey of 50 local schools requesting information which will help with one aspect of my research. I have identified a short list of questions which I would be grateful if you, or an appropriate member of your staff could answer.

With the collected data from the 50 schools and examination board documentation I intend to compare coursework loading on GCSE pupils. In particular, a comparison between the loading upon an average GCSE pupil across all their GCSE subjects with a pupil who has chosen to take Design and Technology related subjects as part of their portfolio of examinations.

I would also be grateful for your permission to ask your Head of Technology for some data specific to Design and Technology related GCSE examination sylabuses studied in your school. If I do not hear from you to the contary within the next fortnight I will assume that it will be acceptable for me to send a questionnaire direct to your Head of Technology.

The data received from your school will be treated in strict confidence. The serial number at the top right hand corner of the questionnaire are there to allow me to match the two questionnaires for your school together. Individual pupils will not need to be identified therefore pupils names are not required. Likewise all reference to the general data regarding your school will be dealt with in such a way as to give complete anonymity.

I will be very happy to send you a short abstract of the major findings when the analysis of the data is completed.

I enclose a stamped addressed envelope for your reply and thank you in anticipation for your support with my research.

Yours sincerely

Figure 4.2 An edited copy of the letter which was sent to the head teachers in the fifty schools selected from a possible one hundred and fifty schools in seven LEA's in the North East of England the coursework loading on individual candidates could be assessed. The final paragraph of the questionnaire was a message thanking them for their co-operation and stating the fact that the collected data were to be used for statistical purposes only.

A sound understanding of typographical design based upon previous professional experiences supported research findings that referred to the importance of the appearance of a questionnaire (for example: Cohen & Manion, 1986; Bell, 1987; Coolican, 1990; Robson, 1993). Clear instructions, clarity of wording and simplicity of design were stated to be essential factors in securing a good response rate, particularly in the case of postal questionnaires. The design of the questionnaire took into account the need for the contents to be arranged in such a way as to maximise the co-operation of the individual respondent. The straight forward, unambiguous nature of the questions themselves allowed each one to be treated in a fixed-alternative format (Cohen & Manion, 1985) thus allowing for quick easy replies from the respondent and also simplifying the coding for the researcher. The methods that were adopted to analyse the data are shown in Figure 4.3 below.

Sample	Source	Question Type	Analysis Technique	What data was collected
Schools (50)	Questionnaire			
	1a	classification	nominal scale	Background data - age range of school -
	1b	classification	nominal scale	Background data - Geographical position of school
	1c	classification	nominal scale	Background data - sex of pupils in school
	2	classification	ratio scale	Number of pupils on roll
	3	classification	ratio scale	Number of pupils in Year 11
	4	classification	ratio scale	Numbers of pupils entered for each GCSE examination.

Figure 4.3 Illustrates the source, question type, analysis technique and what data was collected from the head teachers' in the sample of fifty schools

A letter was included with the questionnaire, indicating the aim of the survey, conveying to the respondent its importance and relevance, assuring them of confidentiality (Bell, 1987; Coolican, 1990; Robson, 1993), encouraging their reply and requesting their permission for the researcher to contact the head of the design and technology department regarding further research at a later date. These were sent to each school along with a stamped addressed envelope for the reply.

Although Robson (1993) suggested that one should not expect a high response rate from a postal survey, Cohen & Manion (1985) believed that the myth regarding poor response rates of postal surveys was not borne out by the evidence. In the case of this research project a 90% reply rate overall was obtained. There was an initial 56% reply, with a further 34% of the questionnaires returned after a follow up telephone call. The slow response was found partially to be due to the original request having arrived in some schools before they had finalised their databases for examination entries.

No	Ref	ages	place	sex	On Roll	yr 11	D&R	D&R	D&C	D&C	Tech	Tech	D&R per	D&C per	Tech per
1	1	A	I	C	700	110							0.00	0.00	0.00
2	2	A	S	C	1311	219							0.00	0.00	0.00
3	3	B	R	C	1138	176							0.00	0.00	0.00
4	4	B	LT	C	1050	180							0.00	0.00	0.00
5	5	B	S	C	1179	182	17	17	0	0	15	15	100.00	0.00	100.00
6	6	A	S	C	1087	200	20	14	12	10	8	8	70.00	83.33	100.00
7	7	A	B	C	1122	222	12	11	22	21	28	28	91.67	95.45	100.00
8	8	A	LT	C	700	125	27	27	0	0	7	7	100.00	0.00	100.00
9	10	A	I	C	430	80	25	7	0	0	0	0	28.00	0.00	0.00
10	11	A	LT	C	800	120	11	11	0	0	0	0	100.00	0.00	0.00
11	12	A	ST	C	630	130	15	15	9	8	0	0	100.00	88.89	0.00
12	13	z	z	z									0.00	0.00	0.00
13	14	A	S	C	788	153	14	12	16	14	11	9	85.71	87.50	81.82
14	15	B	ST	C	816	146	45	42	26	24	0	0	93.33	92.31	0.00
15	16												0.00	0.00	0.00
16	17	z	z	z									0.00	0.00	0.00
17	18	A	R	C	612	116	41	39	0	0	23	23	95.12	0.00	100.00
18	19												0.00	0.00	0.00
19	20	A	ST	C	1165	221	32	25	0	0	25	25	78.13	0.00	100.00
20	21	B	R	C	712	127	30	28	45	41	18	18	93.33	91.11	100.00
21	22	A	S	C	1170	235							0.00	0.00	0.00
22	23	B	ST	C	722	129	20	18	21	20	13	13	90.00	95.24	100.00
23	24												0.00	0.00	0.00
24	25	A	S	C	694	120	16	13	16	15	0	0	81.25	93.75	0.00
25	26	B	R	C	950	161							0.00	0.00	0.00
26	27	A	I	C	1174	189	32	21	0	0	0	0	65.63	0.00	0.00
27	28	B	S	C	700	108	17	17	6	6	0	0	100.00	100.00	0.00
28	29	B	I	C	980	130	0	0	17	17	20	18	0.00	100.00	90.00
29	30	B	I	C	874	119							0.00	0.00	0.00
30	31	B	S	C	1520	247	18	18	70	70	56	56	100.00	100.00	100.00
31	32	B	S	C	1250	340	52	48	51	48	40	40	92.31	94.12	100.00
32	33	B	I	C	679	138							0.00	0.00	0.00
33	34	A	S	C	710	100	20	19	0	0	36	29	95.00	0.00	80.56
34	35	C	S	C	1092	275	18	18	18	18	32	32	100.00	100.00	100.00
35	36	C	ST	C	918	236	55	40	53	47	16	16	72.73	88.68	100.00
36	37	C	ST	C	632	138	42	40	37	35	22	22	95.24	94.59	100.00
37	39												0.00	0.00	0.00
38	40	z	z	z									0.00	0.00	0.00
39	41	A	LT	C	940	127	0	0	37	34	42	40	0.00	91.89	95.24
40	42	z	z	z									0.00	0.00	0.00
41	43												0.00	0.00	0.00
42	44	A	S	C	1391	240							0.00	0.00	0.00
43	45	z	z	z									0.00	0.00	0.00
44	46	A	I	C	620	116	12	10	9	8	0	0	83.33	88.89	0.00
45	47	B	I	B	1071	148	32	16	37	37	15	14	50.00	100.00	93.33
46	48	B	I	G	1236	174	12	11	0	0	0	0	91.67	0.00	0.00
47	49	B	S	C	1265	189	32	31	17	17	10	10	96.88	100.00	100.00
48	50	A	I	C	1505	294	52	36	0	0	36	36	69.23	0.00	100.00
49	51	A	S	C	1131	199							0.00	0.00	0.00
50	52	A	S	C	1021	206	65	60	40	36	61	58	92.31	90.00	95.08

Code:
z = replied but did not wish to be involved.
Ages: A = 11- 16; B = 11 - 18; C = 13 - 18;
Place: I = Inner City ; S = Suburban; R = Rural; ST = Small Town; LT = Large Town;
Sex: C = Co-educational; G = All Girls; B = All Boys.
On Roll: Total school population
Yr 11: = Total number of pupils in Year 11
D&R: = Number of pupils taking Design and Realisation as an option
D&R2: = Number of pupils taking the Design and Realisation GCSE examination
D&C: = Number of pupils taking Design and Communication as an option
D&C2: = Number of pupils taking the Design and Communication GCSE examination
Tech: = Number of pupils taking Technology as an option
Tech 2: = Number of pupils taking the Technology Examination
D&R per: = Percentage of pupils entered for the Design and Realisation GCSE Examination
D&C per: = Percentage of pupils entered for the Design and Communication GCSE Examination
Tech per: = Percentage of pupils entered for the Technology GCSE Examination

Figure 4.4 Raw data from Head Teachers and Heads of Technology in the fifty schools selected from a possible one hundred and fifty schools in seven LEA's in the North East of England

The five schools who failed to reply even after a number of follow up telephone calls were checked in the schools directory for the area. They were found to come from a cross section of LEA, school size, type and location. It was therefore believed that the returns from the ninety percent who did reply gave a sample which was representative of the initial sample of one hundred and fifty schools.

Once received all the data from the initial survey was entered into a database (Rubin, 1993; Robins, 1993). The database was also designed to include the information which would be received at a later date from each school's technology head of department (raw data from the two sources can be found in Figure 4.4).

Out of the forty five replies from the head teachers, forty indicated a willingness for the researcher to use their schools for further work into the chosen topic. The five who refused all gave an excessive work load as their reason for refusing to take any further part in the research. In one instance this was because of an Inspection, in another two cases it was because of staff changes within the technology department and in three cases the work load upon technology teachers with the introduction of NC Technology was cited for the refusal. An examination of the nature of these schools and their design and technology provision showed them to be similar to the forty willing schools, it was therefore concluded that the sample was still representative.

The second questionnaire, was developed through a number of trials. The researcher found the first question a particularly interesting design challenge as two quite different answers with their own sub-sections could be given by the respondent. The problem of the complexity of the expected replies was overcome by the use of a graphic flow chart design. (see Figure 4.5) The most applicable methods for analysing the data were also designed at this stage of the process (see Figure 4.6).

The questionnaire was then sent to the Heads of Technology at each of the forty schools left in the original sample. Seventy-five percent of the heads of department replied. The ten schools that failed to return the questionnaire even after several requests, both written and telephoned, were not considered to be a problem to the validity of the results acquired from the questionnaire nor to the sample selection for the next stage of the research when eight schools were to be chosen from those who had replied.

Figure 4.5 A copy of the postal questionnaire sent to the heads of technology in the fifty schools selected from a possible one hundred and fifty schools in seven LEA's in the North East of England

Please could you complete this short questionnaire to help me in my research. The information that you provide on this form will be strictly confidential and will only be used for statistical analysis in my research.

1 Is your school organised into faculties? Please tick the appropriate box.

Yes ☐ No ☐

2 If you have answered yes

a) What is the name of your faculty?

b) Which departments are included in your faculty?

Departments	Number of Staff

c) On the above list please can you indicate how many staff there are in each department.

If you have answered No

a) What is the name of your department?

b) How many staff are there in your department?

3 What is your title?
e.g Co-ordinator for Technology, Head of Craft,Design and Technology etc..

page 1

4 Tick in column A which subject areas work together to deliver 'National Curriculum Technology' in your school.

Subject Areas delivering Technology	A ✓	B ✓
CDT		
Technology		
IT		
Home Economics		
Business Education		
Art		
Textiles		
Graphical Communication		
others please specify		

5 Tick in column B on the chart above which subject area(s) you are professionally responsible for

6 How many year 11 (5th year) pupils are taking GCSE subjects in your faculty/department?

	Exam Board	Subject	Number taking subject	Number taking the exam
1		Design and Realisation		
2		Graphical Communication		
3		Technology		
	other subject titles please specify:			
4				
5				
6				
7				
8				

page 2

Cont.

7 Listing the examination syllabuses in the same order as question 6, what is the percentage balance of assessed course work to end of course examinations ?

	Subject	Percentage of Assessed Coursework	Percentage of Examination work
1	Design and Realisation		
2	Graphical Communication		
3	Technology		
	other subject titles please specify:		
4			
5			
6			
7			
8			

Thank you for your co-operation in filling in this questionnaire

E Stephanie Atkinson

page 3

Figure 4.5 cont. A copy of the postal questionnaire sent to the heads of technology in the fifty schools selected from a possible one hundred and fifty schools in seven LEA's in the North East of England

Sample	Source	Question Type	Analysis Technique	What data was collected
HOD (45)	Questionnaire			
	1	classification	nominal scale	Background data - school organisation into faculties/departments
	2a	classification	nominal scale	Background data - name of faculty or department
	2b	classification	nominal scale	Background data - numbers of staff in faculty or department
	3	classification	nominal scale	Background data - title of person filling questionnaire
	4	classification	nominal scale	Background data - which subject areas work together to deliver NC Technology
	5	classification	nominal scale	Background data - which subject areas is the respondent responsible for
	6a	classification	ratio scale	number of pupils taking each subject
	6b	classification	ratio scale	number of pupils taking each examination at GSCE level.
	7	classification	nominal scale	percentage balance of coursework to end of year examination.

Figure 4.6 Illustrates the source, question type, analysis technique and what data was collected from the heads' of technology in forty-five of the fifty schools

The responses to the questionnaire revealed how each department/ faculty was organised, how many staff were in each faculty, how many subjects areas were included under the umbrella of the technology department, the number of year 11 pupils who were studying within the area, which subjects they were studying and how many pupils were entered for each examination.

This data was entered into the existing database (Figure 4.4). Analysis of that data was then used in order to aid selection of the eight schools that would be used in Phase One of the project (Information regarding computer software used during the analysis of the data [Microsoft Works, FileMaker Pro and StatView] can be found in Appendix 8.1). The criteria for the initial selection was specified as only those schools who offered the three Design and Technology examinations, Design and Realisation (D&R), Design and Communication (D&C) and Technology. It was felt that this would allow pupil groupings in each of the specified examination subjects to be comparable across each of the schools. The final selection was then completed by using the criteria of the size of the year 11 cohort, (under 225 and over 225) related to the location of the school (city/large town and suburban/small town). This is illustrated in a diagrammatic form in Figure 4.7 below.

	Under 125 pupils in Year 11	Over 125 pupils in Year 11
Inner City / Large Town	* *	* *
Small Town / Suburban	* *	* *

Figure 4.7 Illustrates the final selection criteria used to identify the schools who would be included in the next Phase of the research study

Summary of Samples

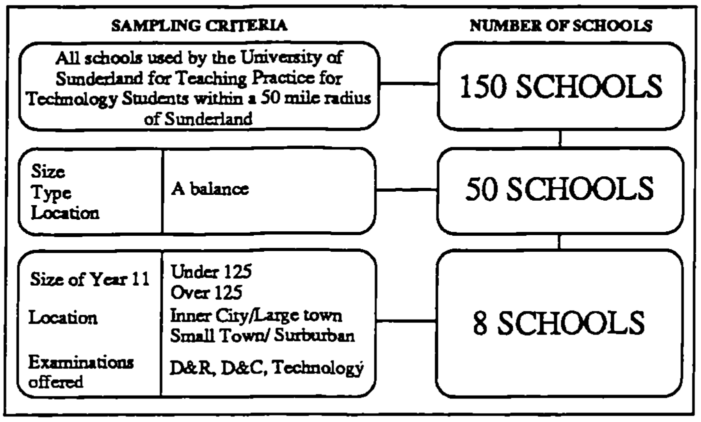


Figure 4.8 Illustrates the sampling criteria used to select eight representative schools from the original sample of one hundred and fifty

Results and their Discussion

This section illustrates, summarises and discusses the data collected during the Initial Survey. The results and discussion have been supported by the use of diagrams and tables where appropriate. A combination of the analysed data from Headteachers and Heads of Technology allowed the researcher to make an informed judgement with regard to the selection of eight suitable schools for Phase One and Phase Two of the study. In addition the collected data enabled the researcher to build up a picture of the combination of design and technology examinations offered in each of the schools in the sample. It also provided evidence of the difference between the number of pupils who took a design and technology subject and the number who were then entered for a GCSE examination in that subject.

Results from the initial survey of the schools selected from seven L.E.A.'s gave the researcher necessary background information regarding the size of each school, number of pupils in year 11, age range of school, location of school and pupil gender.

As already stated each school also sent its GCSE entry lists. Using syllabuses from the relevant examination boards the course work loading on individual pupils was established. This data was collected as it was anticipated that pupils would have differing amounts of coursework depending upon which subjects they had chosen to study. However, initial analysis of the portfolio of subjects selected by individual pupils showed that this was not the case. The data indicated that the majority of pupils each had a similarly high number of coursework projects to complete during years 10/11. This is in sharp contrast to the 1970's and 80's when very few subjects, other than C.D.T. used coursework as a means of assessment for examination purposes at the end of compulsory education (Design Council, 1980).

Results of the questionnaire sent to each Head of Technology in the selected schools showed that many GCSE syllabuses were included under the umbrella of design and technology. However, it was particularly those syllabuses that included design and make tasks leading to three-dimensional outcomes that the researcher wished to target. These long term pieces of coursework had been identified during the review of the literature as the best starting point for research into de-motivation.

As explained in the method section of this chapter, only schools offering Design and Realisation (D&R), Design and Communication (D&C) and Technology courses were considered for the next stage of the study. The year that the initial survey was carried out was the last year that pupils were given the freedom to choose whether or not they took a design and technology subject as one of their GCSE courses. (During Phase One of the research project, the following year, it was compulsory for all pupils to take technology at

Key Stage 4 (DES, 1990) as part of the National Curriculum orders.) Each school had its own policy regarding these choices and this accounted for the variation in the proportion of pupils taking each subject in the different schools. Analysis of the information received from the Heads of Technology revealed the combination of D&R, D&C and Technology subjects to be found in Table 1 and Appendix 3.1. Forty-three percent of schools offered all three subjects. 'D&R & Technology' and 'D&R & D&C' were the next most popular combinations. A few schools offered D&R on its own, but no school offered only Technology or only D&C.

	Number	Percentage
D&R, D&C and Technology	13	43%
D&R andTechnology	6	20%
D&R and D&C	5	17%
D&R	4	13%
D&C and Technology	2	07%

Table 4.1 Provides the combination of subjects offered under the umbrella of Technology by the schools in the sample *(n = 30)*

Of the total Year 11 sample from the thirty schools (5328 pupils) 15% studied D&R as a GCSE course, 11% studied D&C and 10% studied Technology (the number taking each subject can be found in Table 4.2). Each of the schools had a different policy regarding pupils who wished to take more then one design and technology subject. The number of pupils doing so was found to be small.

The examination entry pattern provided an interesting insight into the success which pupils were experiencing in these subjects. The numbers of pupils who were entered for the examinations showed a varying drop out rate. Technology entered 97% of all the pupils taking the subject, D&C entered 94% and D&R entered 85% (Table 4.2).

Subject	Number Taking the subject	Number entered for the examination	Percentage
D&R	784	664	85%
D&C	559	526	94%
Technology	534	517	97%

Table 4.2 Provides the number of pupils taking the subjects and the number entered for the examination *(n = 30)*

Analysis of the relevant data also pointed to the fact that there was a significant difference between the number of schools who entered all their pupils for Technology examinations in comparison to the number of schools who entered all their pupils for D&R examinations (Table 4.3).

	Entering 100% of class	Entering less than 100% of class	Total number of classes entered
D&R	7	20	27
Technology	15	6	21

A *chi* -square test was carried out on the data obtained. The value of x was found to be significant at the 0.1% level for a two tailed test ($x = 9.851$, df = 1), i.e. $p = 0.0017$, Fishers Exact p - value = 0.0031. So it was concluded that there was a highly significant difference between the number of schools who entered all the pupils taking Technology for the examination in comparison to the number of schools who entered all.the pupils taking D&R for the examination.

Table 4.3 Illustrates the significant difference between the number of schools who entered all the pupils taking Technology for the examination in comparison to the number of schools who entered all pupils taking D&R for the examination

Table 4.4 presents the finer detail concerning entry patterns. In Technology 71% of the schools entered all of their pupils for the examination with the lowest entry being twenty-nine pupils out of a cohort of thirty-six. In D&C only 30% of the schools entered all of their pupils for the examination, although 75% of the schools entered over 90% of their pupils. The examination entry for D&R was also low, only 26% of the schools having entered all their pupils for the examination, one school entered only seven of their twenty five pupils, whilst another entered only sixteen of their thirty-two pupils (see raw data figure 4.4).

Subject	100% entered	90 - 99% entered	89 - 80% entered	70 - 79% entered	60 - 69% entered	50 - 59% entered	40 - 49% entered	30 - 39% entered	20 - 29% entered	Total No. of Schools
D&R	7	11	3	3	2	1	0	0	1	27
D&C	6	9	5	0	0	0	0	0	0	20
Technology	15	4	2	0	0	0	0	0	0	21

Table 4.4 Presents the number of schools *(n = 30)* entering their pupils for technology examinations, grouped by percentage

The reasons for these differences were found to be complex. Although as the teachers explained (Appendix 4.1 for sample of transcripts), in the majority of schools only the more intelligent pupils were encouraged to take Technology as the content was thought to be too difficult for less able pupils. As one teacher explained:*"Basically when you say that for technology you have to be able to understand technological activity, and carry out calculations, that immediately eliminates quite a number of pupils"*.

In schools that offered all three syllabuses it was also seen to be the case that many of the pupils taking D&R were expected to achieve low average scores across the full portfolio of GCSE examinations they were attempting. These disappointing levels of non-achievement were seen by the teachers in the schools to be linked to pupil de-motivation. When teachers were asked why they thought that projects were not finished one replied *"Lack of time, lack of realistic choice, but mainly lack of motivation"*. Another teacher referred to pupils who *"...lose the momentum and then need motivating."* Whilst two teachers believed that the examination project work *"...demotivated the majority of pupils."* These comments were considered to be useful additional support for the next phase of the study

Initial Survey Conclusion

The Initial Survey achieved what it set out to achieve. The aim of this phase of the study was to select eight representative schools from which data could be collected in order to identify some of the causes of pupil demotivation amongst Key Stage 4 pupils in studying design and technology. The research tools used during this phase provided the data necessary to accomplish this aim. The exploratory and explanatory information was provided in a form that was often suitable for statistical analysis. The data obtained from the head teacher at each school enabled the researcher to construct an informed picture of relevant information regarding fifty schools from the original sample of one hundred and fifty schools in seven Local Education Authorities in the North East of England. The information gleaned from the questionnaire to the head of technology in each of the fifty schools provided the researcher with the relevant data that enabled her to choose an appropriate sample of eight schools that would be used in the research project throughout Phases One and Two.

Chapter Five

Phase One

Introduction

Design and technology in schools involves a complex integration of processes, concepts, knowledge and skills (D.E.S., 1992). As the subject area has developed so has the use of the design process as a method of delivering and examining subject content (for example: Design Council, 1980; D.E.S., 1987; A.P.U. / E.M.U., 1991). The latest revision of National Curriculum (NC) Design and Technology has retained support for the activity of designing and making even though there has been changes in emphasis regarding content throughout the revision procedure (D.F.E,1995).

Design processes used in schools have developed out of the linear design models used in the early 1960's (A.P.U. / E.M.U., 1991). As teachers have become more experienced in working with them and as the subtlety of the process has become more apparent, so the models have become increasingly complex. By the end of the 1980's many models of the process had been developed (Layton, 1991). It was acknowledged that some models became so complex that they were confusing to those who used them (A.P.U. / E.M.U., 1991). In 1986 the Department for Education and Science (DES) suggested that what was needed was a loose framework to guide designing rather than a well defined process model which they saw as a *"straitjacket"*. This approach supported by Lawson (1990) stressed that designing required flexible procedures. He pointed out that when designing for different situations similarities did exist although it was most important to be aware of the essential differences too.

The design processes used in schools have tended to be taught through the use of long term pieces of course work in the form of design and realisation projects (Chidgey,1994). However over the past few years the researcher and others, including practising teachers (e.g. Grieve, 1993, Barlex, 1994), have observed a lack of enthusiasm amongst a growing number of Key Stage 4 pupils for this form of activity. This has been in opposition to the commonly held belief (e.g. Design Council, 1980; HMI, 1983; Black & Harrison, 1985; Downs, 1986, Cross & McCormick, 1986) that project based course work was, for pupils, an exciting, motivating method of learning the complex integration of processes, concepts knowledge and skills needed to develop capability in design and technology.

The literature review had revealed and confirmed several key factors which related to the possible causes of de-motivation amongst Key Stage 4 pupils studying design and technology. Some of these factors were seen to be pupil dependent whilst others were identified as teacher or externally dependent. The Initial Survey involving fifty schools in the North East of England had been carried out in order to establish eight representative schools for the prime focus of the research project during both Phases One and Two.

Based on personal professional experience and from initial field work it had been identified that there was a need for an in-depth analysis of the processes involved in these long term pieces of course work completed during Key Stage 4. The researcher believed that such an analysis would provide the tangible indicators needed to identify some of the causes of pupil dissatisfaction with this area of the curriculum (Down, 1986). It was with this objective in mind that the various research tools for this phase of the study were designed and developed. Reference being made throughout that process to the review of relevant literature on research methodology that had been carried out at the beginning of the research project (e.g. Cohen & Manion, 1985; Bell, 1987; Coolican, 1990; Robson, 1993; Atman, 1993).

Aims of Phase One

* To develop a greater understanding of pupil perception regarding:
  * their enjoyment of their studies in design and technology;
  * which aspects of the design process they enjoy and why;
  * which aspects of the design process they find difficult and why;
  * which aspects of the design process they find boring and why;
  * which aspects they feel they need most help with and why.

* To develop a greater understanding of teacher perceptions regarding:
  * pupils level of enjoyment within their studies in design and technology;
  * the difficulties pupils have within their studies in design and technology;
  * which aspects of the design process pupils enjoy and why;
  * which aspects of the design process pupils find difficult and why;
  * which aspects of the design process pupils find boring and why;
  * which aspects they feel they need to help pupils with and why.

Method

Methods of Examining the Issues

Phase One sought to examine the issues raised in the introduction, the review of the literature and the initial survey through the following means:

* the use of documentary sources, such as school prospectuses, examination syllabuses;
* questionnaires;
* goal orientation test;
* semi-structured interviews.

The various data collection methods, the size of the sample and sampling criteria used throughout Phase One of the research project can be found in Figure 5.1.

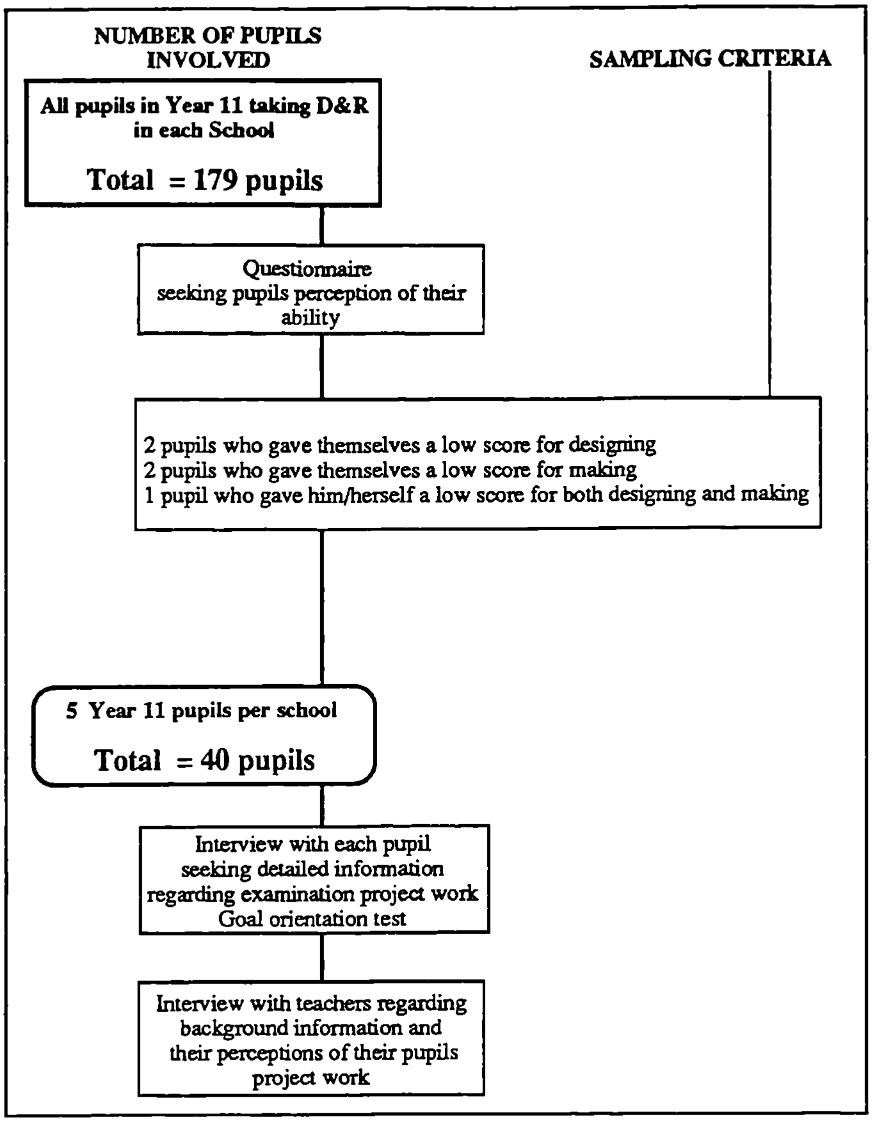


Figure 5.1 Illustrates the research activity in the eight chosen schools during Phase One

Data Collection Methods

Data was collected in the following manner:

In the first instance all year 11 D&R pupils from each of the eight schools identified during the Initial Survey were targeted as the sample from whom data would be collected. A total of one hundred and seventy-nine D&R pupils, one hundred and fifty-three boys and twenty-six girls completed a questionnaire. (Figure 5.2) It should be noted that the proportion of girls to boys in the sample made it unhelpful for statistical purposes. However, as observed in Examination Board statistics the imbalance of boys to girls in design and technology classes at GCSE level reflected the picture found nationally with only a small number of girls taking design and technology at GCSE level in the UK at the time of the Initial Survey.

Figure 5.2 Example of the questionnaire presented to a hundred and seventy-nine pupils from the eight schools in Phase One

Please could you fill in this questionnaire to help me in my research. The information that you provide will be strictly confidential and will only be used for statistical analysis in my research.

1 Which class/form are you in?

2 What is your date of birth? (day / month / year)

3 Are you male or female? Please tick in the appropriate box. (male / female)

4 a) Please fill in the chart below stating all the subjects you are studying this year.

Subject	Entered for Exam

b) on the chart above please tick the subjects in which you are entered for a GCSE Examination

5 Why did you choose to take a design and technology subject during year 10 and 11 (4th and 5th year)?

....

....

....

6 In year 9 (third year) did you enjoy the work you did in design and technology more or less than you do now in year 11 (5th year)? Please tick one of the boxes below.

a)

a lot more	a little more	about the same	a little less	a lot less	don't know

b) Why do you think you enjoyed the work you did in design and technology during year 9 more or less than you do now?

....

....

....

page 1

7 Indicate with a tick on the chart below, how much you areenjoying each of the following aspects of design and technology work during years 10 and 11 (4th and 5th year)

	enjoy a lot	enjoy a little	do not enjoy very much	do not enjoy at all	haven't done this
selecting your project					
researching for your project					
thinking of a number of different solutions					
working out the details of your chosen idea					
making your final chosen solution					
making your chosen solution work					
evaluating your project					
using tools and equipment in the workshops					
putting together your folio of design work					
writing up your report					

8 a) Do you come into the design and technology department to do extra work outside timetabled lesson times?

yes	
no	

If you have answered yes to 9 a) please answer part b) and c)

b) How often do you come into the design and technology department to do the extra work?

	✓
twice a week	
once a week	
twice a month	
once a month	
only when projects need finishing	
other amounts of time please specify	

c) When do you come into the design and technology department to do the extra work?

	✓
during lunch time	
after school	
during private study time	
during time when you are timetabled for other lessons	
other times please specify	

9 a) How many separate design and technology projects have you done during years 10 and 11 (4th and 5th year)?

year 10	year 11

page 2

Cont.

b) Please tick on the chart below which aspects of each project you have completed during years 10 and 11.

	designing	making	evaluating	all complete
project 1				
project 2				
project 3				
project 4				
project 5				

10 Whilst you have been working on your design projects during years10 and 11 (4th and 5th year) have you needed help from your teachers with some aspects of your work? Please tick the appropriate answer boxes.

	a lot of help always	a little help always	a lot of help sometimes	a little help sometimes	very little help at all
selecting your project					
researching for your project					
thinking of a number of different solutions					
working out the details of your chosen idea					
making your final chosen solution					
making your chosen solution work					
evaluating your project					
using tools and equipment in the workshops					
putting together your folio of design work					
writing up your report					

11 Below is a list of four different aspects of design and technology project work. Using the numbers1,2,3, and 4, put the list into rank order where:

1 = the aspect you enjoy the most, 2 = the aspect you enjoy second best,
3 = the aspect you enjoy third best, 4 = the aspect you enjoy least.

	Rank Order
Research	
Design	
Make	
Evaluate	

page 3

12 If you come up against a difficulty in your design and technology project work do you enjoy trying to solve it yourself? Please tick the appropriate answer box.

	always	sometimes	never
a) In the classroom			
b) at home			

13 a) Do you get bored with your work at the design stage of your design and technology projects? Please tick the appropriate answer box.

very bored	a little bored	not bored at all

b) Which aspects of designing do you get bored with?

....

....

....

14 In which aspects of a design and technology project do you find it difficult to achieve a good result? Please tick the appropriate answer box.

	great difficulty	some difficulty	little difficulty	no difficulty
selecting a project				
researching for a project				
thinking of a number of different solutions				
working out the details of your chosen idea				
making models to help work out details				
making your final chosen solution				
making your chosen solution work				
evaluating your project				
using tools and equipment in the workshops				
putting together your final folio of design work				
writing up your report				

page 4

Cont.

15 a) Do you do any of your design and technology project work at home? Please tick in the chart below which aspects of your design and technology work you do at home.

	often	sometimes	once in a while	never
selecting a project				
research				
designing				
working out technical details				
making your chosen design				
evaluating your project				
writing up your report				
putting together your design folio				
any other aspects please specify				

16 a) Are your parents interested in your design and technology projects? Please tick the appropriate answer

very interested	interested	not very interested	not at all interested

b) Do your parents help you with your Design and Technology projects? Please tick on the chart below which aspects of your design and technology work your parents help you with?

	often	sometimes	once in a while	never
selecting a project				
research				
designing				
working out technical details				
making your chosen design				
evaluating your project				
writing up your report				
putting together your design folio				

any other aspects please specify

Thank you very much for your co-operation in filling in this questionnaire and providing me with statistical information for my research.

E Stephanie Atkinson

page 5

Figure 5.2 Example of the questionnaire presented to a hundred and seventy-nine pupils from the eight schools in Phase One

D&R pupils had been chosen after analysis of the questionnaires from the forty-five Heads of Technology during the Initial Survey. This decision had been made for two reasons. Firstly, D&R pupils tended to have a high drop-out rate in the examinations (see Table 5.4) and drop-out rates were considered by the researcher to be a possible indicator of de-motivation. Secondly, it appeared from the literature review, an earlier field study and from previous professional experiences, that long term pieces of coursework, fundamental to the delivery of design and technology, could prove to be tangible indicators in the identification of some of the causes of pupil de-motivation. Through analysis of the different syllabuses it was established that D&R utilised long term coursework projects. It was also noted that the design projects set in D&R courses tended to address the complete design process in a more thorough manner than in either of the other two syllabuses.

The questionnaire for the targeted D&R pupils was taken to each of the schools by the researcher, completed and returned whilst the researcher was present. This removed the problems associated with non-return of questionnaires (Cohen & Manion, 1985; Coolican, 1990).

The questionnaire was designed to provide the researcher with information relating to the pupils perceptions in connection with a number of aspects of D&R and the content of the courses which they had tackled. The questionnaire was designed in such a way as to encourage pupils to participate fully (Bell, 1987). Easy questions were used at the beginning. Questions in the middle covered the more difficult areas whilst the last questions were once again more interesting to encourage the completion of the whole questionnaire. Attitude questions were interposed throughout to vary the responses required (Cohen & Manion, 1985).

Sample	Source	Question Type	Analysis Technique	What data was collected
Pupils (179)	Questionnaire			
	1	classification	nominal scale	Background data - pupils school class
	2	classification	ratio scale	Background data - pupils date of birth
	3	classification	nominal scale	Background data - male /female
	4	classification	nominal scale	Background data - indication of which subjects were studied by pupils
	5	open ended	Researcher's categories from collected data to produce quantitative data (RCQD) - nominal scale	pupils reasons for choosing to take technology subjects
	6a	rated using evaluative factors (REF)	ordinal scale	pupils perceptions of their levels of enjoyment/dislike of work in yr. 9 as opposed to yr. 11.
	6b	open ended	RCQD - nominal scale	pupils reasons for their enjoyment/dislike of work in yr. 9 as opposed to yr.11.
	7	2-dimensional grid classification (2DGC)	ordinal scale	pupils perception of their enjoyment of each aspect of the design process
	8a	yes/no	nominal scale	how many pupils did extra work outside timetabled lessons.
	8b	structured list	nominal scale	how often this extra work was done
	8c	structured list	nominal scale	when it was done
	9a	quantity	ratio scale	how many projects pupils did in years 10 and 11
	9b	2DGC	ordinal scale	how much of each project was complete
	10	2DGC	ordinal scale	pupils perceptions of how much help they needed from teachers with each aspect of the design process
	11	rank order	ordinal scale	rank order of pupil enjoyment of four areas of the design process
	12a	2DGC	ordinal scale	pupil perception of their capability to deal with solving difficulties with aspects of the design process for themselves - in the classroom
	12b	2DGC	ordinal scale	pupil perception of their capability to deal with solving difficulties with aspects of the design process for themselves - at home
	13a	REF	ordinal scale	pupil perception of whether they became bored with designing
	13b	open	RCQD - nominal scale .	aspects that caused boredom
	14	2DGC	ordinal scale	aspects of the design process in which pupils perceived that they had difficulty in achieve good results
	15	2DGC	ordinal scale	which aspects of the design process pupils do and how often
	16a	REF	ordinal scale	how interested pupils believe their parents are in their project work
	16b	2DGC	ordinal scale	which aspects of the design process do parents help pupils with in their project work and how often do they help.

Figure 5.3 Illustrates the source, question type, analysis technique and what data was collected from the 179 D&R pupils in the sample of fifty schools

The construction of the individual questions used each of the formats identified by Kerlinger (1970) and Cohen & Manion (1985) these being; classification; open ended;

quantity; two dimensional grid classification; and rank order formats (see Figure 5.3). In the fixed alternative questions where pupils could choose between two or more alternative answers, care was taken to overcome the disadvantages of superficiality, and the forcing of inappropriate answers because none of the offered alternatives were applicable (Kerlinger, 1970). Open-ended questions were also used as these were found to be helpful in that they allowed pupils to give unexpected or unanticipated answers, although when data came to be analysed the coding of such answers was found to be a slow process. Scale questions where pupils were able to locate their responses on a scale of fixed alternatives were found to be a useful tool when answers regarding attitudes, ratings or rank orders were required. Care was taken to ask questions which double checked the validity of pupil's answers particularly concerning attitudes (Robson, 1993).

The responses to the questionnaire revealed general information regarding : the pupil's enjoyment of the process used in design and technology project work; their perceived difficulties with that process and the help they received with it from their teachers and parents. The collected information was then collated and the resulting data was entered into a number of data bases to enable analysis to take place (see Appendix 3.2 for examples).

At the same time within the research process a semi-structured interview was carried out with each of the design and technology teachers who taught the pupil sample. The intention of this interview was two fold. Some questions were designed to provide further background information about the school and the design and technology department, others were there to enable the teacher to provide their views regarding their pupil's ability and attitudes whilst involved in design and technology project work. This data was also used wherever possible to triangulate with data collected from the pupils in order to prevent a bias or a distorted view being formed (Coolican, 1990; Cohen & Manion, 1985). The answers to this section of the interview sought to inform the researcher of the teacher's perception of their pupils enjoyment of the process and of their ability to achieve satisfactory results. There were also questions that examined the teacher's understanding of the reasons for the de-motivation of some of their pupils (Appendix 1.1[1] for interview pro-forma, and Figure 5.4 for the structure and analysis mechanism of each question). Each interview was recorded on tape and these were then transcribed verbatim (see Appendix 4.1 for examples of the transcriptions). The data analysed from the transcripts was then used both qualitatively and quantitatively.

[1] *This interview pro-forma and any others to follow which were believed to be too long to be included within the main body of the text have been included in the appendices.*

Figure 5.4 Illustrates the source, question type, analysis technique and what data was collected from interviews carried out with the eight design and technology teachers in the sample of eight schools

Sample	Source	Question Type	Analysis Technique	What data was collected
HOD (8)	Interview			
	1	yes - no	nominal scale	Background data - falling roles
	2	classification	Researchers categories from collected data to produce quantitative data (RCQD) - nominal scale	Background data - School catchment area
	3	open ended	RCQD - nominal scale	Background data - Parental support
	4	open ended	RCQD - nominal scale	Background data - School uniform/discipline
	5	open ended	RCQD - nominal scale	Background data - Supportive management structure?
	6	open ended	RCQD - nominal scale	Background data - How pupil groupings are organised in the school
	7	open ended	RCQD - nominal scale	Background data - How is Setting, streaming, mixed ability organised
	8	open ended	RCQD - nominal scale	Background data - how option choices were organised
	9	open ended	RCQD - nominal scale	Background data - how pupils selected D&T
	10	yes-no	RCQD - nominal scale	Background data - Did all pupils get their first choice
	11	quantity	ratio scale	Background data - percentage of girls in yrs 10/11 D&T
	12	open ended	RCQD - nominal scale	Background data - which areas girls tended to opt for
	13	open ended	RCQD - nominal scale	Background data - How examination syllabuses were chosen
	14	open ended	RCQD - nominal data	Background data - How teaching groups were organised
	15	open ended	RCQD - nominal scale	Background data - Availability of resources
	16	open ended	RCQD - nominal scale	Background data - Homework policy
	17	open ended	RCQD - nominal scale	Background data - Policy regarding extra work
	18	open ended	RCQD - nominal scale	Background data - policy regarding work during other lessons
	19	open ended	RCQD - nominal scale	Background data - Organisation of yrs 7,8,9. 3yrs previously
	20	open ended	RCQD - nominal scale	Background data - yrs 7,8,9. now
	21	quantity	ratio scale	Background data - hrs for 7,8,9
	22	quantity	ratio scale	Background data - hrs for year10/11
	23	open ended	RCQD - nominal scale	Background data - Timing of C/work assignments
	24	open ended	RCQD - nominal scale	Background data - Policy on who would/would not be entered for examination
	25	classification	nominal scale	Background data - when these decisions were made
	26	open ended	RCQD - nominal scale	Background data - did decision regarding non entry cause motivational problems
	27	open ended	ratio scale	Background data - hrs given for major project
	28	yes - no	RCQD - nominal scale	Background data - teacher perceptions regarding pupil capabilities to fulfil GCSE
	29	structured list	nominal scale	Background data - which of the three areas school most successful in
	30	yes - no	nominal scale	Background data - fairness & compatibility across staff
	31	open ended	RCQD nominal scale	Background data - compatibility between markers across school
	32	open ended	RCQD - nominal scale	Background data - parental help given to pupils
	33	open ended	RCQD - nominal scale	Background data - parental help with GCSE project
	34	open ended	RCQD - nominal scale	Background data - which aspect of process gets most help from parents
	35	yes - no	nominal scale	Do long projects demotivate pupils
	36	quantity	ratio scale	How many projects done in yrs 10/11
	37	yes - no	nominal scale	Was there a limit on size of projects

Continued over leaf

Cont.

Sample	Source	Question Type	Analysis Technique	What data was collected
	38	yes - no	nominal scale	Were school able to give choice of project in yr 10
	39	yes - no	nominal scale	Were school able to give choice of project in yr 11
	40	classification	RCQD - nominal scale	Did giving choice help motivation
	41	open ended	RCQD - nominal scale	Was the examination a motivator
	42	yes - no	nominal scale	Was there a willingness to complete projects
	43	open ended	RCQD - ordinal scale	Reasons for unfinished projects
	44	classification	nominal data	Did many pupils or few pupils have unfinished work
	45	rank order	ordinal scale	Rank order of enjoyment of the process
	46	yes - no	nominal data	Was girls rank order different
	47a	open ended	RCQD - nominal scale	Aspects of the design process enjoyed the least
	47b	open ended	RCQD - nominal scale	Aspects of the design process enjoyed least by girls
	48	yes - no	nominal data	Did enjoyment tie in with successful/unsuccessful
	49	open ended	RCQD - nominal scale	Aspects teachers found most difficult to teach
	50	open ended	RCQD - nominal cala	Aspects teachers found most difficult to resource
	51a	open ended	RCQD - nominal scale	In which aspects did pupils need the most help from staff
	51b	open ended	RCQD - nominal scale	Were there differences between boys and girls over amount of help needed
	52	open ended	RCQD - nominal scale	Will the NC at key stages 3 & 4 improve the situation

Figure 5.4 cont. Illustrates the source, question type, analysis technique and what data was collected from interviews carried out with the eight design and technology teachers in the sample of eight schools

After careful consideration of the data collected from both the teachers and the pupils certain aspects concerning the design process and pupils' attitudes towards it were highlighted as in need of further clarification. In order to collect this new data interviews were organised with five pupils from each of the eight schools. A combination of data from the pupil questionnaire and the teacher interviews was used in order to establish selection criteria for choosing which pupils would be seen out of the original sample. After analysis of the data pupils enjoyment of designing combined with their perceived difficulties with that process were the selection criteria chosen. It had been thought that the amount of help pupils had received with their project work would be one of the criteria used. However, analysis of the data showed that pupils who did not seek help fluctuated between those who did not seek help but should have, to those not needing help because they were competent. It was therefore judged to be an unreliable indicator for selection of the interview subjects.

	Number of pupils in each school
Low Score in perceived ability to design	2
Low Score in perceived ability to make	2
Low Score in perceived ability to design and make	1

Figure 5.5 Illustrates the selection criteria used when choosing the forty pupils to be interviewed

The sample of forty pupils was chosen using the criteria illustrated in Figure 5.5. Five pupils were identified in each school. Two pupils who had given themselves a low score in designing, two who had given themselves a low score in making and one pupil who had given him/herself a low score in both designing and making. A twenty minute semi-structured interview was then carried out with these pupils. These informal but guided interviews (Coolican, 1990) were designed to build upon information gained in the earlier questionnaire. During the interviews (see Appendix 1.2 for the structure of the interview prompt sheet) the researcher was able to target an area that had been highlighted as problematic during analysis of the questionnaires - that of communication skills. The forty pupils were encouraged to talk about the various forms of drawing and writing that they had used in their design and technology project work. Answers to these questions provided further insight into the intricate relationship between modelling skills and conceptual skills regarding the processes of designing.

Questions were also asked relating to individual approaches to the design process that had been utilised by the pupils in order to complete their GCSE major projects. These approaches were discussed with the pupils in some depth, starting with the choosing of the brief through to the completion of practical work and evaluation (Tapes can be found in Appendix 9.2 and examples of the transcripts of the interviews can be found in Appendix 4.1).

The interviews were carried out by a single research assistant who was well versed, through their own professional background, in the requirements of the task and was familiar with the content of the research project. They were carried out using an interview guide (see Appendix 1.2) which outlined the topics to be covered and questions to be asked. This technique allowed the interviewer to decide how to work in and phrase questions at the time of the interview with each pupil. The questions related to design project work, the design process, and the skills needed in order to carry out the work. At this stage the analysis technique was decided upon for each question (see Figure 5.6). The interviews were recorded on tape (see Appendix 9.2). Transcripts of the relevant information were made and these were coded in order that the ensuing data could be entered into several data bases (see Appendix 3.2) before analysis.

Figure 5.6 Illustrates the source, question type, analysis technique and what data was collected from interviews carried out with the forty pupils from the sample of eight schools

Sample	Source	Question Type	Analysis Technique	What data was collected
Pupils (40)	Interview			
	1	structured list	nominal scale	Background data - were D&C, Tech studied as well as D&T?
	1a	structured list	ordinal scale	Background data - which of the three subjects were enjoyed the most
	1b	open ended	Researcher's categories from collected data to produce quantative data (RCQD) - nominal scale	Background data - Reasons for enjoyment in 1a
	1c	structured list	ordinal scale	Background data - Which of the three was most difficult
	1d	open ended	RCQD - nominal scale	Background data - Reasons why 1c was most difficult
	1e	structured list	nominal scale	Background data - Which of the three was most time consuming
	1f	open ended	RCQD - nominal scale	Background data - Reasons why 1e was most time consuming
	2	structured list	RCQD - nominal scale	Background data - Which aspects of D&T were studied
	3	open ended	RCQD - nominal scale	Background data - was there any other type of work carried out in D&T
	4A	yes-no	nominal scale	Did pupils like having to sketch early ideas
	4Aa (if yes to 4A)	open ended	RCQD - nominal scale	What did pupils like about sketching early ideas
	4Ab (if yes to 4A)	open ended	RCQD - nominal scale	What did pupils dislike about sketching early ideas
	4Aa (if no to 4A)	open ended	RCQD - nominal scale	What did pupils dislike about sketching early ideas
	4Ab (if no to 4A)	open ended	RCQD - nominal data	What did pupils like about sketching early ideas
	4B	yes-no	nominal scale	Did pupils like having to do careful drawings with sizes on them
	4Ba (if yes to 4B)	open ended	RCQD - nominal scale	What did pupils like about careful sketches
	4Bb (if yes to 4B)	open ended	RCQD - nominal scale	What did pupils dislike about careful sketches
	4Ba (if no to 4B)	open ended	RCQD - nominal scale	What did pupils dislike about doing careful sketches
	4Bb (if no to 4B)	open ended	RCQD - nominal data	What did pupils like about doing careful sketches
	4C	yes-no	nominal scale	Did pupils like having to do working drawings
	4Ca (if yes to 4C)	open ended	RCQD - nominal scale	What did pupils like about doing working drawings
	4Cb (if yes to 4C)	open ended	RCQD - nominal scale	What did pupils dislike about doing working drawings
	4Ca (if no to 4C)	open ended	RCQD - nominal scale	What did pupils dislike about doing working drawigs
	4Cb (if no to 4C)	open ended	RCQD - nominal data	What did pupils like about doing working drawings
	4D	yes-no	nominal scale	Did pupils like having to do a careful perspective drawing
	4Da (if yes to 4D)	open ended	RCQD - nominal scale	What did pupils like about doing a careful perspective drawing
	4Db (if yes to 4D)	open ended	RCQD - nominal scale	What did pupils dislike about doing a careful perspective drawing
	4Da (if no to 4D)	open ended	RCQD - nominal scale	What did pupils dislike about doing a careful perspective drawing
	4Db (if no to 4D)	open ended	RCQD - nominal data	What did pupils like about doing a careful perspective drawing
	4E	yes-no	nominal scale	Did pupils like having to annotate sketches
	4Ea(if yes to 4E)	open ended	RCQD - nominal scale	What did pupils like about having to annotate sketches
	4Eb(if yes to 4E)	open ended	RCQD - nominal scale	What did pupils dislike about having to annotate sketches
	4Ea(if no to 4E)	open ended	RCQD - nominal scale	What did pupils dislike about having to annotate sketches
	4Eb(if no to 4E)	open ended	RCQD - nominal data	What did pupils like about having to annotate sketches
	4F	yes-no	nominal scale	Did pupils like having to do lettering for headings etc.

Continued over leaf

Sample	Source	Question Type	Analysis Technique	What data was collected
	4Fa (if yes to 4F)	open ended	RCQD - nominal scale	What did pupils like about having to do lettering for headings etc.
	4Fb (if yes to 4F)	open ended	RCQD - nominal scale	What did pupils dislike about having to do lettering for headings etc.
	4Fa (if no to 4F)	open ended	RCQD - nominal scale	What did pupils dislike about having to do lettering for headings etc.
	4Fb (if no to 4F)	open ended	RCQD - nominal data	What did pupils like about having to do lettering for headings etc.
	4G	yes-no	nominal scale	Did pupils like having to do a summative evaluation
	4Ga (if yes to 4G)	open ended	RCQD - nominal scale	What did pupils like about having to do a summative evaluation
	4Gb (if yes to 4G)	open ended	RCQD - nominal scale	What did pupils dislike about having to do a summative evaluation
	4Ga (if no to 4G)	open ended	RCQD - nominal scale	What did pupils dislike about having to do a summative evaluation
	4Gb (if no to 4G)	open ended	RCQD - nominal data	What did pupils like about having to do a summative evaluation
	5	structured	nominal scale	What project did pupils tackle for GCSE
	6a	yes - no	nominal scale	Did pupils choose their own project
	6b	yes - no	nominal scale	Did pupils find it easy to think of a project
	6c	yes - no	nominal scale	How did pupils choose the project
	7a	yes - no	nominal scale	Did pupils tackle research
	7b	yes - no	nominal scale	Were pupils aware of the importance of research
	8	yes - no	nominal scale	Did pupils enjoy the research process
	8a (if yes to 8)	open ended	RCQD - nominal scale	What caused pupils enjoyment when doing research?
	8b (if yes to 8)	open ended	RCQD - nominal scale	What did pupils dislike when doing research
	8a (if no to 8)	open ended	RCQD - nominal scale	What did pupils dislike when doing research
	8b (if no to 8)	open ended	RCQD - nominal scale	What caused pupils enjoyment when doing research?
	9	open ended	RCQD - nominal scale	What types of research were done
	10	open ended	RCQD - nominal scale	Where did pupils do research
	11A	yes - no	nominal scale	Did pupils tackle the written aspects of research
	11B	yes - no	nominal scale	Did pupils enjoy having to write about research
	11Ba(if yes to 11B)	open ended	nominal scale	what did pupils find enjoyable when writing about the research
	11Bb(if yes to 11B)	yes - no	nominal scale	what wasn't enjoyable about writing up the research
	11Ba (if no to 11B)	open ended	nominal scale	what wasn't enjoyable about writing up the research
	11Bb(if no to 11B)	yes - no	nominal scale	what did pupils find enjoyable when writing about the research
	12	yes - no	nominal scale	Did pupils tackle design work during major project
	13	yes - no	nominal scale	Did pupils enjoy designing more or less than making
	14	yes - no	nominal scale	Were pupils pleased with their design work
	14a (if yes to 14)	open ended	RCQD - nominal scale	What were pupils pleased with in their designing
	14b(if yes to 14)	open ended	RCQD - nominal scale	What were pupils not pleased with in their designing
	14a (if no to 14)	open ended	RCQD - nominal scale	What were pupils not pleased with in their designing
	14b (if no to 14)	open ended	RCQD - nominal scale	What were pupils pleased with in their designing
	15	structured list	nominal scale	Did pupil draw a number of different ideas?
	15a (if yes to 15)	yes - no	nominal data	Did pupils enjoy drawing different ideas
	15b (if yes to 15)	open ended	RCQD - nominal scale	If pupils did not enjoy drawing different ideas - why not?
	15c (if yes to 15)	open ended	RCQD - nominal scale	What help did pupils need with this type of designing

Continued over leaf

Sample	Source	Question Type	Analysis Technique	What data was collected
	15d (if yes to 15)	open ended	RCQD - nominal scale	From whom did pupils seek help
	16	structured list	nominal scale	Did pupils do drawings to develop chosen ideas
	16a (if yes to 16)	open ended	RCQD - nominal scale	Did pupils enjoy developing their chosen ideas
	16b (if yes to 16)	open ended	RCQD - nominal scale	If pupils did not enjoy developing their chosen ideas - why not?
	16c (if yes to 16)	open ended	RCQD - nominal scale	what help did pupils need with this aspect
	16d (if yes to 16)	open ended	RCQD - nominal scale	From whom did pupils seek help
	17	structured list	nominal scale	Did pupils do working drawings
	17a (if yes to 17)	open ended	RCQD - nominal scale	Did pupils enjoy doing working drawings
	17b (if yes to 17)	open ended	RCQD - nominal scale	If pupils did not enjoy doing working drawings - why not?
	17c (if yes to 17)	open ended	RCQD - nominal scale	What help did pupils need with working drawings
	17d (if yes to 17)	open ended	RCQD - nominal scale	From whom did pupils seek help?
	17a (if no to 17)	open ended	RCGQ - nominal scale	How did pupils work out sizes of materials
	17b (if no to 17)	open ended	RCGQ - nominal scale	How did pupils work out the constructional details?
	18a	yes - no	nominal scale	Did pupils make their final project
	18b	yes - no	nominal scale	Did pupils finish making their projects
	19	yes - no	nominal scale	Did pupils enjoy making their projects
	19a (if yes to 19)	open ended	RCQD - nominal scale	What was it that pupils enjoyed about making their projects
	19b (if yes to 19)	open ended	RCQD - nominal scale	Was there anything that pupils did not enjoy
	19a (if no to 19)	open ended	RCQD - nominal scale	what was it that pupils did not like about making their project
	19b (if no to 19)	open ended	RCQD - nominal scale	What points did pupils enjoy about making their projects
	20	yes - no	nominal scale	Where pupils pleased with their final project
	20a (if yes to 20)	open ended	RCQD - nominal scale	What were pupils pleased with
	20b (if yes to 20)	open ended	RCQD - nominal scale	Was there anything pupils were not pleased with
	20a (if no to 20)	open ended	RCQD - nominal scale	What were pupils not pleased with in their final projects
	20b (if no to 20)	open ended	RCQD - nominal scale	Was there anything that pupils were pleased with
	21	yes - no	nominal scale	Did pupils make any 3D models during the design process
	21a (if yes to 21)	open ended	RCQD - nominal scale	Did pupils find these models helpful
	21b (if yes to 21)	open ended	RCQD - nominal scale	Did pupils enjoy making these models
	21a (if no to 21)	open ended	RCQD - nominal scale	Would pupils have enjoyed this type of modeling if it had been appropriate
	22	yes - no	nominal scale	Whether pupils wrote an evaluation for their project
	23	yes - no	nominal scale	Whether pupils felt writing an evaluation was a good way of finishing a project
	23b	open ended	RCQD - nominal scale	Expansion on pupils reasons for yes or no
	24	structured list	nominal scale	How well pupils felt they had done in their project
	25	open ended	RCQD - nominal scale	Expansion on pupils reasons for how they felt they had done
	26	yes - no	nominal scale	Whether pupils would be using their skills in the following year
	27	open ended	nominal scale	Expanding upon answer to 26
	28	yes - no	nominal scale	Whether pupils would choose D&R if they were asked to choose their option choices again.
	29a (if yes to 28)	open ended	RCQD - nominal scale	Why pupils would choose to do D&R
	29b (if yes to 28)	open ended	RCQD - nominal scale	Why pupils would not choose to do D&R

Figure 5.6 cont. Illustrates the source, question type, analysis technique and what data was collected from interviews carried out with the forty pupils from the sample of eight schools

During the same visit, the five pupils were each asked to complete an attitude scale regarding important behavioural characteristics associated with accomplishing goals (see Appendix 1.3 for questionnaire). This questionnaire was based on an index designed by Atman (1986) as a culmination of her research into conation. Atman's research was concerned with the development of new strategies to overcome what she perceived as a lack of *"sustained motivation capacity"* in adolescents and young adults (Atman, 1993). She believed that the motivation strategies adopted by teachers could be contributing to the motivation crisis she, and others have noticed in American schools (Atman, 1993). Atman developed an index which when completed provided a profile of a pupil's goal accomplishment style. It gave an individual score for each of the interwoven stages of reflecting, planning and acting which she, and others, believed were important behavioural characteristics needed in order to accomplish goals. In 1993 she also suggested that these characteristics were essential ingredients for those tackling design and technology project work (Atman, 1993). It was therefore considered pertinent to utilise the index in order to ascertain the goal accomplishment style of the final sample involved in this research study. Once complete the data were entered into a new database (see Appendix 3.3). This was analysed in conjunction with the data already collected in order that informed judgements could be made regarding the forty pupils targeted during this phase of the research study.

Sample	Source	Question Type	Analysis Technique	What data was collected
Year 11 (40)	Questionnaire			
	1-84	2D grid classification	nominal scale	general motivational attributes - conation

Figure 5.7 Illustrates the source, question type, analysis technique and what data was collected from an attitude questionnaire carried out with the forty pupils from the sample of eight schools

Phase One Results and their Discussion

This section illustrates, summarises and discusses the data collected during Phase One of the Research Project. The results and discussion have been supported by the use of diagrams, tables and graphs where appropriate. A combination of the analysed data collected from the questionnaire given to all D&R pupils in the eight chosen schools, and the semi-structured interviews with their teachers and a selected sample of forty pupils taken from the original 179 pupils, allowed the researcher to reach certain conclusions related to the topic under discussion. It fulfilled the aims of Phase One of the study in that it enabled the researcher to develop a greater understanding of pupil and teacher perceptions regarding various aspects that concern the design process used during GCSE examination project work in design and technology. The analysis and ensuing discussion also helped to clarify the complex picture concerning some of the suggested motivational factors that had been identified during the analysis of the literature review.

Pupil Perceptions of Aspects Considered to be Important to this Research Project

During Phase One the analysis of the questionnaire given to the 179 pupils (raw data can be found in Appendix 2.1) had provided specific data regarding a number of issues relevant to the research topic: pupils reasons for opting for D&R; a comparison of the enjoyment of design and technology in Years 7-9 and Years 10-11; the effect of boredom on project work; the amount of extra time used for project work and the parental support given; the completion rate and the number of projects tackled; the pupils' thoughts regarding the aspects of the design process involved in project work.

Each of these issues will be dealt with separately and an analysis of the correlation between relevant issues will then follow.

Pupil's Reasons for Opting for D&R

Analysis of an open ended question (refer to Table 5.1) regarding a pupil's reason for opting to take D&R as one of their GCSE subjects indicated that past experience in design and technology during years 7 - 9 had a highly significant influence (x^2 = 222.18, df = 3 , i.e. p <0.001) upon a pupil's choice of options at GCSE level. The coding of the responses to the open ended question had involved combining the detailed information, from a representative sample of answers, into a limited number of categories that allowed for statistical analysis. The process had the effect of turning the answers to the open ended questions into a defined set of standard responses. The researcher was aware from the literature that this process would inevitably involve some loss of information although careful coding could ensure a minimum of relevant information being lost (Robson,1993).

	Observed	Expected	Totals
Past Experience in yrs 7-9	131	44.75	175.75
Anticipated qualities	18	44.75	62.75
Of use in the future	18	44.75	62.75
Option choices	12	44.75	56.75
Totals	179	179.00	358.00

The expected frequencies were calculated on the basis of equal probability for each possibility. A one sample *chi-square* test was carried out on the data obtained. The value of x^2 was found to be significant at the 0.1% level for a two tailed test ($x^2 = 222.18$, df = 3), i.e. $p < 0.001$, and so it was concluded that past experience during years 7 - 9 had a highly significant influence upon pupils who chose to study design and technology at key stage 4.

Table 5.1 Lists the reasons given by pupils (*n = 179*) for having chosen to take D&R at Key Stage 4

Of those pupils who had chosen D&R because of past experiences (see database in Appendix 3.1 for raw data), a quarter of them generalised, stating that they had enjoyed the lessons or that they had enjoyed the activity of designing and making. Just over half of the pupils expressed pleasure at having made things. As one pupil explained *"I dicided (sic) to take D&R bicause (sic) I enjoyed disign (sic) at my old school and I like making things"*. Many specifically mentioned that they had enjoyed working with their hands, with tools and with materials. *"I enjoy using my hands and wanted to develop my practical skills"*. Wood was the material mentioned in the majority of cases. In comparison, only a small sample specifically referred to having enjoyed designing. *"I was interested in designing and I am quite good at art and drawing"*. A few pupils had chosen D&R because they believed that they were good at it, whilst another small group had chosen it because they liked having a tangible outcome, as one pupil stated *"because I have something to show for my work"*.

In the group of pupils who had chosen D&R because of qualities they anticipated would be evident (see database in Appendix 3.1 for raw data), the vast majority had believed that the subject would be interesting. One pupil felt it would be creative, another challenging and four pupils had chosen D&R because they thought that it would be easy. For these four pupils the evidence from the remainder of their questionnaires indicated that this had not been the case.

Those who had believed that studying D&R would help them in the future had decided that the practical skills gained would be of use in their future careers or in their lives in general. As two pupils explained their reasons were:*"Because I was originally hopeing (sic) to be a joiner when I left school"; "If my career as a musician does not work I would be interested in joinery"*. Gaining good GCSE results and even wishing to take the subject at A level, then at degree level had been the reasoning behind several pupils choice.

Of the remaining pupils, six percent had chosen D&R because they had had to choose a practical subject within the option scheme and D&R had seemed to be the best choice. Finally, only one percent of the pupils had ended up taking D&R because they did not get their first choice in their school's option scheme.

It had been expected that peer or parental pressure would influence some pupils however this was not found to be the case which could have been because pupils did not wish to admit it or the data could be said to add support to the findings of McCarthy & Moss in 1990.

Comparison of Enjoyment of Design and Technology in Years 7 - 9 and 10 - 11

Having established that the activities during years 7 - 9 had influenced the pupils' choice it is interesting to note that a significant number of pupils (x^2 = 1204.667, df = 2, i.e. p <0.001) stated that they enjoyed the design and technology work carried out during their GCSE course more than in earlier years (see Table 5.2).

	Observed	Expected
Enjoyed Technology in yrs 7-9	45	59.666
Enjoyed both equally	46	59.666
Enjoyed Technology in yrs 10-11	88	59.666

The expected frequencies were calculated on the basis of equal probability for each possibility. A one sample *chi*- square test was carried out on the data obtained. The value of x^2 was found to be significant at the 0.1% level for a two tailed test (x^2 = 1204.667, df = 2), i.e. p <0.001, and so it was concluded that a highly significant number of pupils stated that they enjoyed the design and technology during years 10/11 more than in earlier years.

Table 5.2 Lists the number of pupils who specified whether they had enjoyed design and technology during years 7 - 9, as opposed to during years 10 - 11 or whether they had enjoyed them both equally

Only twenty-five percent of the sample had preferred their design and technology classes in years 7 - 9. No statistical analysis of this data could be carried out as the pupils' responses were not independent (i.e. some pupils gave more than one response) the data was therefore presented in Figure 5.8. Analysis of this small group of pupils showed that the main reason given for that preference was the nature of the projects set in years 7 - 9. Pupils mentioned such aspects as, less pressure, more time, easier tasks, and more practical activities. They explained that there was less paperwork involved in the projects. A small number mentioned the fact that they had liked their teachers more during those earlier years. They suggested that they had had more help from them. They also referred to the fact that in years 7 - 9 they had been able to be with more of their friends.

Enjoyed Project Work	37	Nature of the projects	29
		Differences in paperwork	7
		Differences in practical	1
Enjoyed Yr 7-9 Classes	2	Quiet class	1
		With more of ones friends	1
Enjoyed Teachers	6	More help from teacher	2
		Different teacher	4

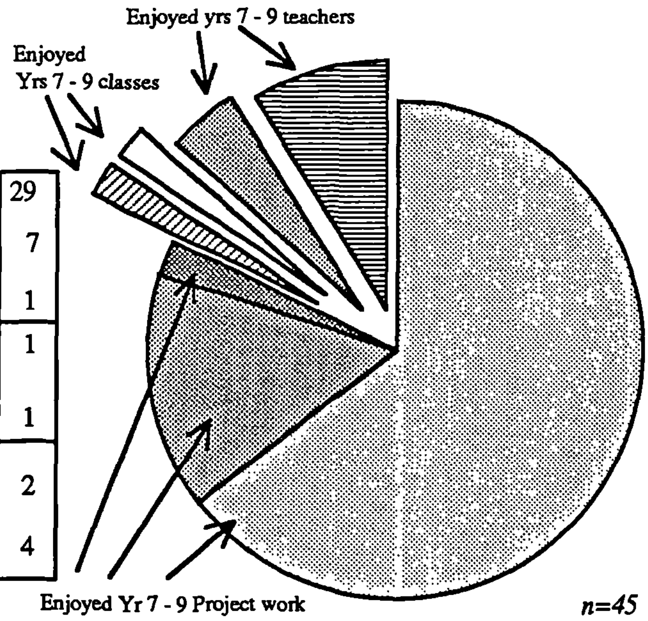


Figure 5.8 Illustrates the reasons why pupils liked years 7-9 the most. The included table indicates the numbers of pupils in each category

When the work tackled in years 7 - 9 was discussed with the teachers it became evident that projects used during those years were more teacher led, more structured, and more concerned with the acquisition of specific skills (see transcripts of teacher interviews Appendix 4.1). It was also explained by the teachers that each task was completed in a relatively short space of time and certainly involved the pupils in less paper orientated design activity than could be found in work carried out during GCSE courses. The other factor mentioned by pupils, that of not being with their friends during years 10/11 was mainly due to the option systems. Teachers explained that the options caused classes, and therefore friendship patterns established during years 7-9, to be split up. In the case of girls this was seen to cause a sense of isolation as so few girls opted to take design and technology subjects at GCSE.

More choice	34
Allowed to use more equipment and machinery	10
Treatment as a pupil	4
The nature of project work in yrs 10-11	40

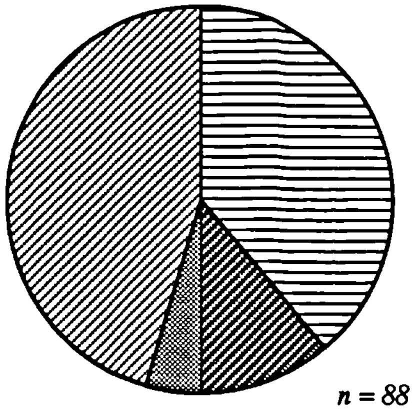


Figure 5.9 Illustrates the reasons that pupils gave for liking Years 10 - 11 the most. The included table indicates the numbers of pupils in each category

In comparison to the small group who had enjoyed years 7-9 the most, a much larger group, fifty percent of the sample, enjoyed their GCSE D&R course more. However once again no statistical analysis could be carried out on the reasons given by the pupils as their responses were not independent. The data was presented in the Figure 5.9. Analysis showed that thirty-eight percent of this group stated that the reason for their enjoyment of their GCSE D&R course was because they were able to choose their own projects. Fifteen percent mentioned that they enjoyed feeling more independent as they had learnt more and were therefore capable of doing more for themselves. Thirty-one percent referred to the challenging nature of the projects tackled. Twenty-two percent referred in a negative way to the work they had done in years 7 - 9. They suggested that the work had been boring, too easy, that they had made too many small projects and that they had disliked moving around from one design and technology area to another so often (Figure 5.10). This use of a rotational system was highlighted as problematic by HMI in a report in 1992 (DFE, 1992).

Work too easy	7
Briefs set inapplicable	4
Content of projects	3
Lack of choice	4
Disliked "circus"	2

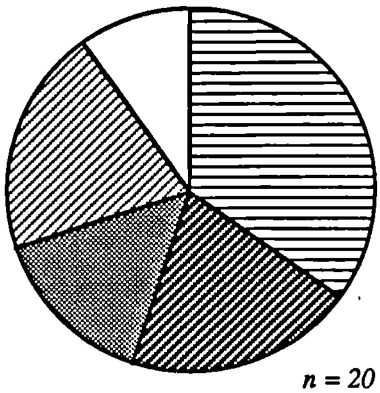


Figure 5.10 Illustrates the reasons that pupils gave for disliking Years 7 - 9. The included table indicates the number of pupils in each category

Effect of Boredom with Design and Technology Project Work

From an early stage of the research project it was anticipated that a pupil's perceived boredom could have an influence on de-motivation. It was well understood by the researcher that to pupils the term boredom could imply a variety of feelings, including frustration, inadequacy, and disinterest. The researcher was also aware that to ask fifteen year olds if they were bored would almost certainly receive a reply in the affirmative. The response was therefore asked for in fixed scale format (Cohen & Manion, 1985) using a series of gradations, not bored, a little bored and very bored. Results did show that only a small number of pupils, twenty-one percent, stated that they were not bored, whereas sixty-four percent stated that they were a little bored and fifteen percent stated that they were very bored with certain aspects of their project work (see Figure 5.11). The collected data also indicated that there was no significant gender difference between pupils in the three identified boredom categories (see Table 5.3)

	Boys	Girls	Totals
Not bored	33 (22%)	5 (19%)	38 (21%)
A little bored	98 (64%)	16 (62%)	114 (64%)
Very bored	22 (14%)	5 (19%)	27 (15%)
Totals	153	26	179

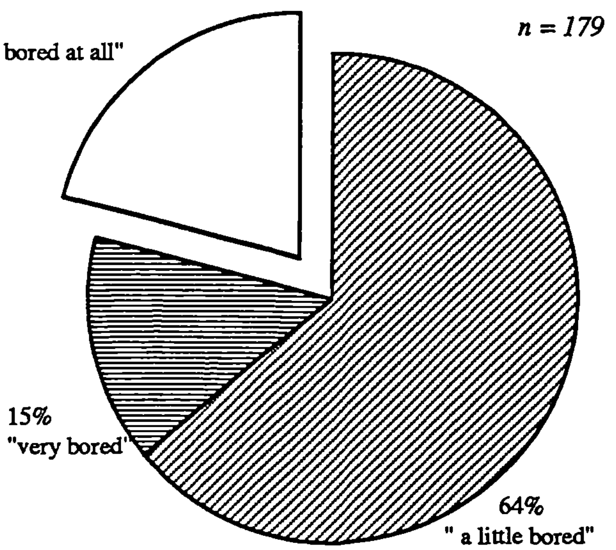


Figure 5.11 Illustrates how bored the pupils believed they were with their project work. The included table indicates how many pupils there were in each category, these are also grouped by gender

COMPARISON BETWEEN THE BOREDOM OF BOYS AND GIRLS WITH THEIR PROJECT WORK			
	Not Bored	A Little Bored	Very Bored
Boys	33	98	22
Girls	5	16	5
			n = 179

A 2 x 3 x^2 table analysis was carried out on the data obtained. The value of *chi-square* showed no significant difference between boys and girls in the three identified boredom categories ($x^2 = 0.426$, df = 2), i.e. $p = 0.8081$.

Table 5.3 Compares the perceived boredom between boys and girls with their project work and illustrates that there is no significant difference between the genders regarding boredom

When looking at the reasons the pupils gave for their boredom it was found that twenty seven percent were bored with it all, thirty-seven percent cited various aspects of the design process as causing the problem whilst thirty-six percent specified the mechanics of carrying out the process as reasons for their boredom (Table 5.4).

	Sub-divisions	Very bored	A little bored	Totals
Bored with it all		16 (59%)	22 (19%)	38 (27%)
Bored with aspects of the process	Research	3 (11%)	15 (13%)	18 (13%)
	Designing	1 (04%)	22 (19%)	23 (16%)
	Making	2 (07%)	5 (04%)	7 (05%)
	Evaluating		4 (04%)	4 (03%)
Bored with the mechanics of the process	All paperwork		8 (07%)	8 (06%)
	Writing	3(11%)	23 (20%)	26 (18%)
	Drawing		9 (08%)	9 (06%)
	Orth drgs.	1(04%)	3 (03%)	4 (04%)
	Dimensioning		3 (03%)	3 (02%)
	Slowness of the process	1(04%)		1 (01%)
	Totals	27	114	141

Table 5.4 Illustrates the reasons that bored pupils *(n = 141)* gave for their boredom and indicates the number of pupils in each category

Although not surprising, it was interesting to note the high percentage of pupils who referred to 'writing' rather than drawing as causing boredom. Evidence from the literature (e.g. D.F.E., 1992) and observation by the researcher would suggest that this was because pupils were being encouraged by their teachers to provide information in a written form at every stage of the process in order to meet each of the assessment criteria for examination purposes. That strategy added greatly to the amount of written work needed in each project. Which in turn seemed to lead to considerable pupil frustration when progress to the next stage of the process was hindered.

One might also have expected to find 'evaluation' high on the list of causes of boredom due to its written format. However, that was not the case (see Table 5.4). The reason for its non-appearance was understood when teachers were questioned. They explained that pupils had not reached the evaluation stage in their major projects at the time of completing the questionnaire and, in earlier projects less emphasis had been placed on that aspect of the process.

Amount of Extra Time Used for Project Work and Parental Support

The ability to complete design and technology projects in time for assessment was recognised by the researcher as a possible motivating factor for the pupils. Design processes used in schools today have developed out of the early, simple linear models (APU, 1991). A combination of the complexity of the process used and the need to have evidence for assessment, has produced an increased workload for pupils engaged in design and technology project work. In recent years it has become an established practice in all schools for pupils to carry out some of their project work in their own time in order to meet deadlines. It therefore seemed important to establish whether some pupils or all pupils produced work outside of timetabled lessons.

	Number	%
Only when projects needed finishing	52	59%
Regularly twice a week	17	19%
As often as possible	6	7%
Once a week	4	5%
Once a fortnight	4	5%
Three or more times per week	3	3%
Whenever needed	2	2%

Table 5.5 Illustrates how many *(n = 88)* and how often pupils, who carried out extra work in school, did so

During interviews with the teachers it was established that each school did provide opportunities for pupils to use the design and technology department beyond their timetable commitment. When the pupils were asked fifty-one percent of boys and thirty-five percent of girls stated that they did do extra work for their projects in school. When this extra work was done varied considerably (Table 5.5). The majority only came in when it was needed, normally when project deadlines were looming, others came in regularly and one or two came in as often as possible. Three quarters of those who came in to do extra work did so at lunch time or after school (Table 5.6). The other quarter came in when they were timetabled for other lessons although in the majority of schools, as teachers explained, this was against school policy.

	Number	%
After school	36	41%
During lunch times	29	33%
During other lesson times	22	25%
Before school	1	1%

Table 5.6 Illustrates the times when those pupils *(n = 88)* who did extra work carried it out

Each school had its own procedure regarding homework, however all schools expected all pupils to do homework during years 10 and 11. In some it was given regularly each week whilst others expected it to be carried out when the project dictated that it was appropriate. When pupils were questioned regarding extra work at home, ninety-six percent of girls and eighty-six percent of boys stated that they did do work at home on their projects. It was interesting to compare the fact that whilst fewer girls than boys carried out extra work in school, more girls than boys did their project work at home (Table 5.7). This the teachers believed followed a growing trend that they had observed. They suggested that the outside interests of many boys seemed to take priority over school work even during years 10 and 11 when examination pressures were upon them.

	Boys	Girls	Totals
Extra work on projects in schoool	78 (51%)	9 (35%)	87 (49%)
Extra work on projects at home	133 (86%)	25 (96%)	158 (88%)
Parental interest	122 (80%)	22 (85%)	144 (81%)
Help from parents with projects	85 (56%)	14 (54%)	99 (55%)

Table 5.7 Compares the gender differences between pupils *(n = 179)* who carried out extra work in school and those who carried the extra work out at home. It also compares the difference between parental interest and help given by parents with the project work in terms of the gender of the pupil

With regard to the work carried out at home, all aspects of the design process were tackled. The most popular was research and the least often tackled was the making of the artifact itself. On a question of parental interest, a similar percentage of girls and boys stated that their parents were interested in their project work. Just over half said that they had had help from their parents with some aspects of their project work although this was seldom more than 'once in a while'. Pupils suggested that most of the help given was in the areas of selecting problems to solve and in collecting research. I would suggest that that may have been due to the fact that both of these aspects of the process are gender neutral and therefore either or both parents were able to help. It is also the case that unlike other stages of the process neither of these aspects required particular design or practical skills, which the parents may not have possessed. Gender differences on help received from parents only became apparent with regard to making the prototype, where girls admitted to receiving a little more parental help than the boys (Table 5.7).

Completion Rate and Number of Projects Tackled

It is human nature to have pride in one's creations (Weiner, 1992). Pupils wish to be able to take their projects home, to show them to parents, give them to others or keep them for themselves. In order to establish how many projects each pupil had attempted, how many they had completed, and which aspects of each project they had finished, pupils were asked to answer a question regarding their project work throughout years 10 and 11.

No of projects	All complete			All complete bar one			All complete bar two			All complete bar three			All complete bar four			All complete bar five		
	T	b	g	T	b	g	T	b	g	T	b	g	T	b	g	T	b	g
6	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	20	18	2	11	11	-	7	6	1	3	3	-	7	7	-	12	12	-
4	1	1	-	2	1	1	2	2	-	3	2	1	3	3	-	-	-	-
3	18	9	9	7	7	-	6	6	-	5	5	-	-	-	-	-	-	-
2	31	23	8	28	25	3	11	10	1	-	-	-	-	-	-	-	-	-
1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Totals	72	53	19	48	44	4	26	24	2	11	10	1	10	10	0	12	12	0

Table 5.8 Illustrates the number of projects attempted by pupils *(n = 179)* during years 10 - 11. It also indicates the number of projects that they completed. This data is shown as a total and is also grouped by gender

From an analysis of the collected data it was disappointing to find how few projects were finished (see Table 5.8). It was also apparent when the data was separated into boys and girls that there was a significant difference (x^2 = 13.655, df = 1, i.e. p <0.002) in completion rates (Table 5.9). Seventy-three percent of girls finished their projects whilst only thirty-five percent of boys finished theirs. It was recognised at this stage of the study that failure to complete projects, and in particular the gender differences in this respect, could be an important factor which would need further investigation as the research study progressed.

	Boys	Girls	Totals
Finished	53	19	72
Unfinished	100	7	107
Totals	153	26	179
Chi - square	1104.500	72.000	612.500
p - Value	<.0001	<.0001	<.0001

	Finished	Unfinished	Totals
Boys	53	100	153
Girls	19	7	26
Totals	72	107	179
(x^2 = 13.655, df = 1), i.e. p = <.0002 Fisher's exact P- Value = .0004			

Table 5.9 Indicates the number of project finished by the pupils. The results are grouped by gender. The significant difference between the completion rate of boys and girls is also indicated.

Aspects of the Design Process Involved in Project Work

The other major area of research addressed by the questionnaire concerned the various aspects of the design process that pupils needed to tackle in order to complete each of their projects.

Analysis of the data regarding the rank order in which pupils placed their enjoyment of research, designing, making and evaluating produced no surprises. Results supported both the evidence found during the literature review (e.g. A.P.U.,1991; Grieve, 1993) and the past professional experience of the researcher. A significantly large number of pupils believed making to be the most enjoyable aspect of the process, designing the next most enjoyable, research the third most enjoyable and evaluating the least enjoyable (Tables 5.10 & 5.11). In the questionnaire the term 'dislike' was not used. However, the very small number of pupils who said that they enjoyed research and the even smaller number who stated that they enjoyed the evaluation stage of the process supported the researcher's and others belief that the majority of pupils, particularly boys (A.P.U. 1991) disliked both activities. This has been found to be particularly the case in the evaluation of the project which should take place at the end of the process.

Aspects of the process	Pupil selection of Rank Order				Ranked Data			
	1st	2nd	3rd	4th	1st	2nd	3rd	4th
Research	8	37	98	36	4	2	1	3
Design	25	126	21	7	2	1	3	4
Make	157	8	10	4	1	3	2	4
Evaluate	4	16	37	122	4	3	2	1

Table 5.10 Indicates the popularity of each identified aspect of the design process by the pupils *(n = 179)* in 1993

	Variance	*df*	*Chi- Sqaure*	*P-Value*
Research	1440.917	3	4322.750	<.0001
Design	2993.583	3	8980.750	<.0001
Make	5606.250	3	16818.750	<.0001
Evaluate	2838.250	3	8514.750	<.0001

Table 5.11 Illustrates the results of a one sample *chi*- square test that was carried out separately on the data for each aspect of the process as found in Table 5.10. The hypothesized variance between the popularity of each aspect of the process was calculated as 1

Part of the questionnaire divided the design process into ten separate units based on the linear process model used by the majority of teachers. Pupils were asked to indicate how much they had enjoyed each aspect of the process, how much teacher help they had needed and how much difficulty they had had in achieving good results between each of the separate aspects of the process. There was found to be a significant difference in the average scores given by pupils for each aspect of the process under each of the three headings, enjoyment ($p = 0.03$ level (two tailed t-test; $t = 2.53$, $df = 9$)) , achievability ($p = <0.0001$ level (two tailed t-test; $t = 11.97$, $df = 9$)) and independence ($p = 0.0001$ level (two tailed t-test; $t = 6.320$, $df = 9$)) (see Table 5.12). As far as pupil's perceptions regarding their enjoyment of each stage of the process was concerned, there was once again evidence to support the earlier findings indicating that written aspects of project work were unpopular. Evaluating, research, and report writing were all given lower than average scores. Whilst as before the aspects enjoyed the most were those concerned with the manufacturing process; using tools and equipment ; making the chosen solution, and making the solution work.

When it came to pupils perceptions concerning their ability to achieve satisfactory results at each stage of the process, pupils were fairly sure of their performance across each identified section of the process. All the mean scores were well above average. The high mean score for 'selecting a project' indicated that pupils felt they had little difficulty in identifying a need or opportunity to address. This was not found to be the case for pupils who's questionnaires had indicated low scores in achievement and high scores in levels of boredom. In their case, low scores on 'selecting a project', supported by observations at a later stage of the study, indicated that they did have difficulty in choosing suitable projects. However, this was the last time that the majority of pupils were given complete freedom to choose their own projects. Since then most GCSE Examination Boards involved in this research project have specified targeted areas for the GCSE examination projects.

	The Process	Enjoyment	*RO*	Achievement	*RO*	Independence	*RO*
1	Selecting a project	2.93	*4*	3.44	*1*	3.16	2
2	Researching a project	2.59	7	3.27	2	2.92	*6.5*
3	Thinking of a number of ideas	2.63	*8*	3.15	*3*	2.82	*8*
4	Working out the chosen solution	2.92	*5*	2.94	*10*	2.92	*6.5*
5	Making the chosen solution	3.27	*3*	3.09	*5*	3.08	*3*
6	Making the chosen solution work	3.28	2	2.95	*9*	2.93	*5*
7	Using tools and equipment	3.54	*1*	3.00	*7*	3.37	*1*
8	Evaluating the project	2.47	*9*	2.99	*8*	2.56	*10*
9	Putting together a folio	2.73	*6*	3.02	*6*	2.99	*4*
10	Writing the report	2.10	*10*	3.12	*4*	2.74	*9*
	Mean	2.846		3.097		2.949	
	df	9		9		9	
	t - Value	2.528		11.966		6.320	
	p - Value	.0323		<.0001		.0001	
						RO = Rank Order	

Table 5.12 Illustrates the significant difference in the average scores given by the pupils *(n = 179)* under the three headings, enjoyment, achievability and independence regarding aspects of the process. The table also indicates the rank order of each aspect of the process under the three selected headings

A Spearman Rank Order Correlation test was carried out on the two variables, pupil's levels of enjoyment and pupil's perceived ability to achieve good results for each aspect of the design process. It was found that there did not appear to be a significant association between the two variables (rho = -.273, n = 10). However, the association was negative, suggesting a slight correlation between high rankings on one variable with low rankings on the other.

On the other hand the same correlation test carried out on pupil's levels of enjoyment and independence from teachers help with each aspect of the process showed that in this case there was a significant correlation (rho = 0.870, n = 10) indicating that the high ranks for enjoyment tend to be associated with the high ranks for independence.

Finally a correlation test was carried out on pupil's levels of independence and pupils' perceived ability to achieve good results for each aspect of the process. In this case it was found that there did not appear to be a significant association between the two targeted variables (rho = 0.106, n = 10).

The high mean score for researching was surprising. It indicated that pupils believed they had little difficulty in achieving good results even though the scores for 'enjoyment' suggested that they did not enjoy the activity (Figure 5.12). The high mean score achieved for 'writing a report' should, once again, not be taken as indicating ability in the examination project report. As explained earlier, feedback from teachers suggested that the individual pupil score could only be based on the relatively simple reports pupils had written for earlier projects as the questionnaire had been completed before the more complex and time consuming report involved in the examination project had been attempted.

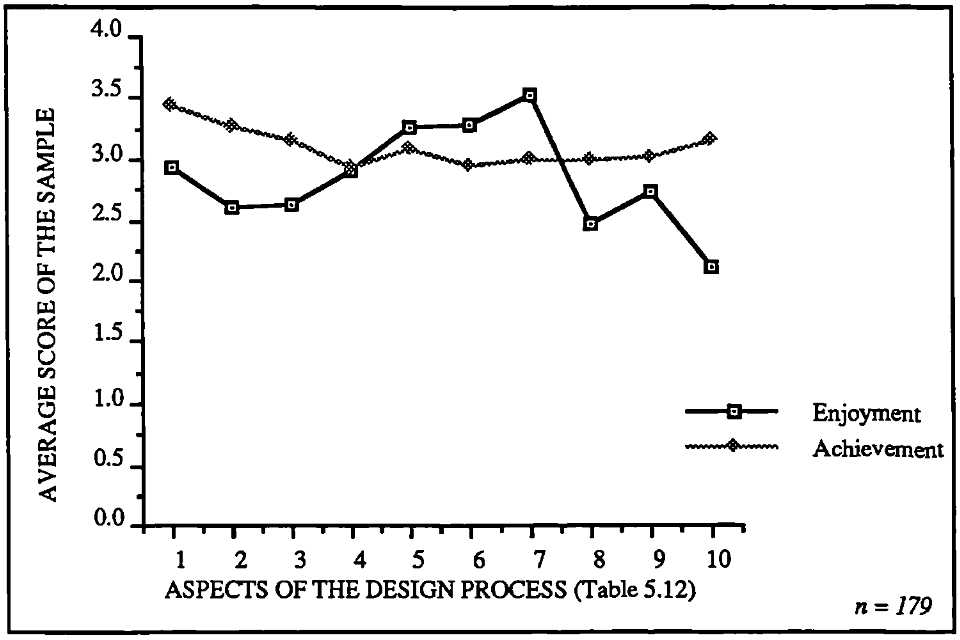


Figure 5.12 Illustrates the comparison between pupils average scores for each aspect of the design process grouped by achievement and enjoyment

It is interesting to note that the areas of the process concerned with '...making sure the idea worked before manufacturing began' and the section concerned with '...trying to make the solution work during the manufacturing stage' both scored poorly even though, particularly the later, had scored highly when enjoyment of the process was considered. This would suggest to the researcher that pupils enjoyed making the solution work even though they found satisfactory results difficult to achieve.

In the questionnaire, pupils were asked to indicate how much help they had needed with the process. Their responses used a fixed scale of five graduated alternatives. Analysis of the results for the areas needing most help were as expected, evaluating, report writing, and thinking of a number of ideas at the early design stage (Table 5.12). However, when it came to the aspects where pupils indicated a need for less teacher support, some of the results were confusing. They implied that pupils needed little help with using tools and equipment and making the solution. As the professional experience of the researcher indicated that this was not usually the case the results were scrutinised more carefully. They were looked at in conjunction with the data collected from two other questions, pupil's ability to achieve good results and pupil's ability to work through problems on their own. This combined analysis suggested that the data collected regarding the pupils' need for help, could be interpreted in one of two ways. For instance, it could indicate that pupils did not seek help because they believed that they did not need to due to their level of competency. On the other hand analysis of the data suggested that, for whatever reason, some pupils did not seek help even though they did need to because of their lack of the required skills and expertise to complete the task. This confused picture suggested that interpretation of the data regarding independence from teachers help could not be relied upon and should therefore not be used in any further analysis.

Analysis of the Correlation Between the Issues Identified

Once all the responses to the questionnaire had been analysed in isolation the relationship between certain sets of data were correlated in order to clarify further the various factors of interest to this research project.

	Enjoyed	Did not enjoy	Expected Result		Not bored	Bored
Complete	54	18	high total	low total	23	49
Incomplete	72	35	low total	high total	15	92
Totals	126	53	average	average	38	141

A one sample *chi* - square test was carried out on the data for completion/in-completion and enjoyment. The value of x^2 was found to be significant at the 0.01% level for a two tailed test (x^2 = 162.000, df = 1), i.e. p = <0.0001, and so it was concluded that a highly significant number of pupils who said that they enjoyed the process failed to finish their project work.

Table 5.13 Indicates a comparison of the effect of enjoyment of the process in general and boredom on the completion rate of project work. It illustrates the significant number of pupils (n = *179*) who said that they enjoyed the process and yet failed to finish their project work

As has already been discussed the completion of project work was considered to be an important factor in motivating or de-motivating pupils. It was therefore decided to establish whether there was any correlation between completion rates and boredom and completion rates and perceived enjoyment of the process (Table 5.13). The results of the completion/enjoyment data did not fit the 'expected result' pattern in each cell of the table (central block of Table 5.13). One would have expected the proportion of pupils who enjoyed the process to be weighted towards complete rather than incomplete projects. However, analysis of the data suggested that this was not the case. A significant number of pupils who enjoyed the process failed to complete their projects (Table 5.13). This evidence added support to the need for further research into this aspect during the next phase of the study.

The results of the completion/boredom data when viewed as a total sample were as anticipated. A significant number of those who were bored did not complete their projects whilst a significant number of those who were not bored did manage to finish theirs (Table 5.14).

	Complete	Incomplete
Not Bored	23	15
Bored	49	92
Varience	338.000	2964.500
df	1	1
chi - square	338.000	2964.500
p value	< .0001	<.0001

n = 179

Table 5.14 Illustrates the significant effect that boredom had upon completion rate of project work

However, when the data was split by gender, it could be seen that there were some marked differences between boys and girls (Table 5.15). With regard to the boys, the proportion of them who were not bored and yet failed to complete their projects was noticeably high. The opposite was found to be the case for the girls. All girls who were not bored completed their projects on time, although, the small size of the girl sample prevented statistical comparisons being made. It is worth noting that of the five girls who were not bored, all completed their projects. In the gender groups where pupils believed that they did not enjoy designing it was also found that a significantly large proportion of girls still managed to finish their projects on time whilst a significant number of boys did not (Table 5.16).

	Not Bored			Bored		
	T	b	g	T	b	g
Complete	23	18	5	49	35	14
Incomplete	15	15	0	92	85	7
Totals	38	33	5	141	120	21
Variance	32.000	4.500	12.500	924.500	1250.000	24.500
df	1	1	1	1	1	1
Chi - Square	32.000	4.500	12.500	924.500	1225.000	24.500
p = Value	<.0001	.0678	.0008 *	<.0001	<.0001	<.0001

* *Number in one of these cells is too small for the p = value to be considered reliable* *n=179*

Table 5.15 Indicates the gender difference in the effect that boredom had upon completion rate of project work

	Enjoyed the process			Did not enjoy the process		
	T	b	g	T	b	g
	54	40	14	18	13	5
Complete	72	66	6	35	34	1
Incomplete	126	106	20	53	47	6
Totals	162.000	383.000	32.000	144.500	220.500	8.000
Variance	1	1	1	1	1	1
df	162.000	383.000	32.000	144.500	220.500	8.000
Chi - Square	<.0001	<.0001	<.0001	<.0001	<.0001	.0094 *

* *Number in one of these cells is too small for the p = value to be considered reliable* *n=179*

Table 5.16 Indicates the effect that enjoyment of the process in general had upon completion rates. It also illustrates the significant gender difference in completion rate by those pupils who did not enjoy the process

The addition of further factors to the analysis matrix made sub-groups smaller and smaller, and therefore not viable for statistical hypothesis testing. However, it was considered worthwhile to carry out these analyses in order to see if finer details might help to disentangle the complex picture further. One such analysis looked to establish a co-variation between three separate factors: completion rates; boredom; and enjoyment of the whole process in general. As earlier analysis of the data on boredom had shown the majority of pupils (seventy-nine percent) were bored by certain aspects of the process. It was therefore not surprising to find a significantly high proportion of bored pupils in each of the sub-groups in this analysis (Tables 5.17). Within the very small sample of twenty-three pupils who were not bored and completed their projects it was disappointing to find that only half of them suggested that they had enjoyed the process. Whilst at the opposite end of the boredom scale, it was pleasing to find that although a quarter of the forty-nine pupils stated that they were bored with their project work they still completed them and even suggested that they had enjoyed the process.

		Not Bored		Bored		*df*	*Chi* - square	*p* - value
Complete	Enjoy	19	50%	35	25%	1	128.000	<.0001
	Dislike	4	10%	14	10%	1	50.000	<.0001
Incomplete	Enjoy	14	37%	58	41%	1	968.000	<.0001
	Dislike	1	3%	34	24%	1	544.500	<.0001
Totals		38		141				*n=179*

Table 5.17 Illustrates the percentage and significance of bored and not bored pupils in relationship to enjoyment and completion rates

An analysis of the apparent contradiction between boredom with the project and enjoyment of the process suggested to the researcher that there was a possible mismatch between a pupil's perception of what the process involved and the reality of what project work actually entailed. It was realised that further research in this area would be advantageous during the next phase of the study.

When looking at those who completed their projects in comparison to those who had failed to finish on time, there was a similar percentage of each sample who enjoyed the work whether they were bored or not. However, when it came to comparing the two sub-groups who disliked the process then there was a marked difference. Twenty-four percent of those who disliked project work and were bored did not complete their projects in comparison to only three percent of those who disliked project work but believed they were not bored (Table 5.18).

	Complete Projects						In-complete Projects					
	Enjoyed Project work			Disliked Project work			Enjoyed Project work			Disliked Project work		
	T	b	g	T *	b *	g *	T	b	g *	T *	b*	g *
Not Bored	19	14	5	4	4	0	14	14	0	1	1	0
Bored	35	26	9	14	9	5	58	52	6	34	33	1
Totals	54	40	14	18	13	5	72	66	6	35	34	1
Variance	128.000	72.000	8.000	50.000	12.500	60.500	968.000	722.000	18.000	544.500	512.000	.500
df	1	1	1	1	1	1	1	1	1	1	1	1
Chi - Square	128.000	72.000	8.000	50.000	12.500	60.500	968.000	722.000	18.000	544.500	512.000	.500
p = Value	<.0001	<.0001	.0094	<.0001	.0008	.0008	<.0001	<.0001	<.0001	<.0001	<.0001	.9590

Table 5.18 Illustrates the completion rate of projects using the combined factors of enjoyment and boredom
* indicates the cells in which numbers are too small for the *p value* to be considered reliable.

Interviews

Having established a picture regarding pupil's perceptions of general issues concerning project work the interviews with forty pupils selected from the sample in each of the eight chosen schools helped to 'un-peel' further the factors which may be causing the de-motivation witnessed amongst the pupils.

The researcher was able to target an area that had been highlighted as problematic in the questionnaires - that of communication skills. The forty pupils were encouraged to talk about the various forms of drawing and writing that they had used in their design and technology project work. Answers to these questions provided further insight into the intricate relationship between modelling skills and conceptual skills regarding the processes of designing.

Questions had also been asked relating to individual approaches to the design process that had been utilised by the pupils in order to complete their GCSE major projects. These approaches had been discussed with the pupils in some depth, starting with the choosing of the brief through to the completion of practical work and evaluation (Tapes of all the interviews can be found in Appendix 9.2 and samples of the transcripts of the interviews can be found in Appendix 4.2).

The Relationship Between Drawing Skills and Conceptual Design Skills

It was seen as applicable to divide questions regarding drawing skills into the four types most commonly used in design activities: sketching early ideas; careful sketch drawings carried out during the development or detailing of the chosen idea; orthographic drawings; presentation perspective drawings of the final solution. As earlier stated the relevant conceptual skills involved were also discussed. Analysis of the data regarding these skills indicated that pupils were generally more negative about their skills than they were positive (see Table 5.19).

Drawing technique	Positive comments	%	Negative comments	%
Drawing in general		0	find all drawing difficult	20
Early sketching	enjoy thinking of ideas	28	find it difficult to think of ideas	15
	find this type of drg easy	33	find it difficult to do	15
Detailing	enjoy doing careful drg	15	drawing technique difficult	30
			difficult to work out details	25
Orthographic drg	proud of outcome	15	complex drg technique	30
			avoid doing them	20
Final 3D perspective	proud of outcome	15	find it difficult to do	25
	enjoy doing them	28	avoid doing them	25

Table 5.19 Illustrates pupil *(n = 40)* perceptions regarding the drawing process. Only points which were mentioned by 15% or more of the pupils are referred to in this table

It is interesting to note how the balance of positive to negative comments varied throughout the process. At the initial stage when 'early sketches' were being produced the balance was towards positive comments. Sixty-one percent of the comments made were positive whilst only thirty percent were negative. Pupils referred to having: enjoyed thinking of ideas; found it easy; believed it was necessary; enjoyed the drawing technique involved. As one pupil stated when asked about early sketching: *"It's alright. I like thinking up my own ideas and putting them down on paper."* On the other hand negative comments which triangulate with earlier findings, pointed towards certain pupils: having difficulty in thinking of ideas; possessing poor freehand drawing skills; finding the task tedious; being unable to see the point of putting ideas down when they already knew what they wanted to make. Such comments as:*"I don't really like the amount of drawing you have to do. I knew what I wanted to do and it was a waste of time and you couldn't be bothered so your sketches got worse."* and *"It's O.K. but it gets tedious after a while. Got a picture of what I want to do but then told I must do lots of ideas"* were all too familiar.

The balance of positive and negative comments altered in favour of negative comments at both the detailing stage using 'Careful sketches' and the stage when 'Orthographic drawings' were produced. Only fifteen percent of the comments were positive at both these stages of the process whilst forty-five percent of the comments regarding detailing and fifty percent of the comments regarding the carrying out of orthographic drawings were negative. Pupils referred in both these sections to difficulties associated with: working out the details; *"...I find it difficult to work out the sizes"* others spoke of the accuracy needed in the drawing techniques; with one pupil suggesting: *"I don't enjoy doing working drawings. They are worse than sketching. I have been taught to do technical drawing but I haven't sorted out how to do it."* Whilst another explained *"I don't like doing them. They always look a mess. I keep changing my mind and the paper gets messy from rubbing out."* The time-consuming nature of the task was seen by a number of pupils as a problem. Many considered that*"...it is very monotonous."* The majority of the pupils referred to wanting to get on with making their product. The few positive comments related to instances where pupils had: enjoyed working out the details; enjoyed the challenge of this type of drawing; been proud of the outcome *"...it's good to see the finished drawing. It shows others how things will work."*

The careful 'Presentation perspective' drawing produced a more even spread of positive and negative comments. Forty-three percent were positive and fifty percent were negative. There were those who enjoyed the drawing techniques involved, were proud of the outcome, and felt that it was a satisfactory way of completing their design portfolio. On the other hand there were those who spoke of finding the drawing technique difficult or time consuming, *"I don't like doing it. When you know it is your final one, and it has to be right, and if you make mistakes you have to start again"*. There was even one who admitted that her older brother had done her drawing because she knew that she could not achieve a worthwhile result.

The Relationship Between Writing Skills and Conceptual Design Skills
Questions referring to writing skills were divided into the three types most commonly used in designing activities, those relating to: annotation of early sketches in order to explain ideas and thoughts; careful lettering for headings, title sheets, orthographic drawings etc.; the written evaluation at the end of the project. Analysis of that data is shown in Table 5.20.

The overall balance between positive and negative replies regarding the 'Annotation' of early sketches was fairly even, thirty two percent of the comments were positive and thirty percent were negative although, marked differences could be found within those figures. With regard to the writing skills needed in annotation, all the comments made were negative. The majority questioned referred to the un-tidiness that resulted from writing notes alongside their drawings. One pupil wrote *"I don't like putting a lot of writing onto my drawings. It makes them look untidy."* However, when it came to the thought processes involved during the production of annotations, the majority of the comments were positive. Pupils suggested that: they had found it easy to think what to write; they felt it was important to be able to communicate thoughts to others, for example:*"I don't mind writing to explain ideas. It's helpful to explain to others what I am thinking."* Pupils also believed it was a good way of explaining how things worked. *"I like it because it shows how it works. It's a good way to communicate to other people."* They explained that it could help them to clarify details of their chosen idea. The few negative comments concerned not enjoying having to think what to write and more explicitly, not understanding how things worked. It was these pupils who tended to write very little on their design sheets. Very few of the sample mentioned the time taken to annotate their drawings as being an important consideration. Only two pupils suggested that annotation was quick and easy, whilst another two did state that it was tedious if it was done just for the sake of writing something down.

Writing technique	Positive comments	%	Negative comments	%
Annotations	easy to think what to write	15	writing untidy -spoils work	15
	good way of communicating thoughts	17	didn't do it	15
Careful lettering	proud of outcome	18	find it difficult to be neat	20
			tedious	16
Evaluation	good way of finishing project	25	tedious	23
			only do it for assessment	23

Table 5.20 Illustrates pupil *(n = 40)* perceptions regarding the writing process. Only points which were mentioned by 15% or more of the pupils are referred to in this table

Completing the careful lettering (e.g. 'Titles' needed in their design work) was once again reasonably balanced between those who gave positive feedback and those who saw the task in a negative light. Only eight pupils actually referred to having enjoyed the technique involved, although thirteen others suggested that they were either proud of the outcome when they had finished or suggested that it was worth the effort as it enhanced the presentation of their project. *"I enjoy doing careful lettering. I can do it quite well and it looks good."* Negative comments referred to difficulties concerned with the accuracy needed and the time consuming nature of the task. Others admitted that they avoided doing it. The methods used to achieve this form of lettering varied. There were those who used computers because it was quick and easy to achieve satisfactory results As one pupil referring to careful lettering stated *"It takes a long time but I find it easier to do on the computer. Its different, quicker and tidier."* Other pupils explained that they used stencils in order to help them achieve a more accurate outcome. Whilst, finally there were those who preferred to do the lettering freehand, either because they got satisfaction from their endeavours, or because they wished to display an individual 'flavour' to their work. This they suggested could not be achieved by using either a computer or a stencil.

By the time of the interviews all the pupils had handed in their project work for the examination. Design portfolios, practical outcomes and evaluations for some of the pupils were complete although, as earlier research had suggested, evaluation of their work had proved to be a stumbling block for many pupils. Twenty-five percent of the replies regarding the process and the skills needed to complete evaluations were positive whilst forty-six percent were negative. The majority of the pupils who made positive comments mentioned that it was a good way of finishing a project. However, it was felt by the interviewer that this was only a repeat of the teacher's encouragement to the pupils and not necessarily the genuine belief of the pupils concerned. Only one pupil out of the total sample suggested that they did not mind writing an evaluation whilst another said that although they did not enjoy carrying out an evaluation it made up for their lack of drawing skills and therefore gained them valuable marks. The vast majority of the negative comments were concerned with the thought processes involved in producing the evaluation. For example as one pupil stated *"No, I don't enjoy it* (evaluating). *I don't know what to say. The more you put the better marks you get and I cannot think what to write."* Although nine pupils did refer specifically to the time consuming nature of the task. The major difficulties which pupils cited were to do with their lack of understanding regarding what should be written and the fact that they did not appreciate the relevance of the activity. Aspects which proved problematic were: explaining their thoughts; thinking of positive and negative things to say; being able to criticise their outcome when they thought their outcome was suitable. A number of pupils disliked having to reflect upon failure whilst others did not enjoy having to find out what others thought of their solutions. The majority of these pupils quite openly stated that the only reason they did an evaluation was to gain marks for their GCSE project. *"I did it because the exam says I must. I hate writing evaluations. I can never pick out good points and weak points."*

The Relationship Between Manufacturing Skills and Pupils Ability to Produce a Finished Project

	Yes Percentage	No Percentages	Did not make project
Enjoyed making their project	65% (26)	22.5% (9)	12.5% (5)
Pleased with the outcome	58% (23)	32.5% (13)	12.5% (5)

Table 5.21 Illustrates pupil *(n = 40)* perceptions regarding the manufacturing stage of their project work

Pupils' beliefs regarding their manufacturing capability had already been targeted in the earlier questionnaire although clarification concerning, how much they had enjoyed making their artifact, whether they had finished it or not, and whether they were pleased with the outcome were all discussed during the interviews. It was found that sixty-five percent of the pupils had enjoyed the making aspect of their project and fifty-eight percent were pleased with their outcome (Table 5.21). Pupils believed it was their lack of accuracy and poor manufacturing skill level which were the main causes of concern during the making of their products (Table 5.22).

Poor manufacturing skills & inaccuracy	45% (18)
Idea not worked out before hand	7.5% (3)
Too big a project	5% (2)
Time management	12.5% (5)
None	30% (12)

Table 5.22 Indicates the aspects of the manufacturing process which caused pupils problems. The table also indicates the number and percentages of pupils *(n = 40)* to be found in each category

Unfortunately, of the total sample only just over half of them had finished their practical work on time, whilst five others had almost finished. Six explained that they were *"no where near finished"* and five admitted that they had not even started. However, only nine pupils referred to the fact that they had disliked the manufacturing stage of the process. Reasons given for not enjoying this aspect of the work were mainly associated with the pressure of all their examinations and poor time management. On the positive side, the comments could be grouped into those who had enjoyed: the construction processes involved; those who had enjoyed using their hands and working with materials, and those who were proud of the outcome. With one pupil saying, *"I enjoyed making it. I enjoyed putting it together, sanding it to the right sizes. ...really pleased with it. I like the shape and everything. It works. There's nothing I'd like to alter."* What was quite interesting about this group was the fact that a number of them suggested that it was not necessarily the making of it that had caused them pleasure, rather the possession of the finished outcome. As two pupils explained: *"I am finished. It just needs polishing. ... I like to see it finished. It's not that I like making it. It's that I like having it finished. I am pleased with it because I have done it. I wish it was perfect."* and *"I enjoyed making it. I enjoy getting an end result. It worked out as I planned it. I enjoyed making it but I liked even more having the end result."* It could be seen that some of these pupils were able to motivate themselves to tackle something they did not find particularly easy, interesting or enjoyable by looking forward to possessing something they could be proud of.

Those who had had difficulties or were disappointed with the making aspects of their projects cited inaccuracy as the most common cause of their dissatisfaction. Pupils suggested that the cause for the inaccuracy was: a lack of process skills; inaccurate marking out ; things not having been worked out carefully enough in the first place; and a lack of time management, particularly at the design stage, leaving them with too little time to finish the practical work to a satisfactory standard.

The Effects of Giving Pupils a Context to Work in as Opposed to Freedom of Choice

Two different approaches were adopted by the schools when it came to chosing a major project. Of the total sample of forty pupils, thirty were given the freedom to choose their own projects whilst ten were given a context within which to work. In one school this context was set by the Examination Board and in the other instance the school set its own. One of the benefits to the school, of limiting pupil choice, was observed to be in the management of resources. This in turn avoided the possibility of pupils becoming de-motivated as the resources they required were on hand. This benefit was found to be particularly noticeable at the research and manufacturing stages of the project when access to materials from external agencies were of paramount importance. When these were not provided by the school, pupils were seen to become despondent as they waited for specific materials to arrive or failed to remember to acquire them for themselves. In schools where the pupils had to provide the majority of their own research materials the de-motivation observed amongst some of the pupils at such an early stage in the project work was believed by both the researcher and the teacher to have had an effect upon the pupil's subsequent activities. Observation showed that the majority of these pupils continued to be de-motivated for the rest of the project. At the manufacturing stage pupils who had to wait for materials when they were only too aware of the impending deadlines were left de-motivated and rightly or wrongly tended to blame their teachers for their inability to proceed.

	Given a Context	Free Choice
Found it easy to choose	7	14
Thought research was important	4	21
Enjoyed doing research	2	18
Were pleased with design work	5	14
Enjoyed Making	6	20
Finished project	8	16
Were pleased with outcome	6	17
Would choose to do D&R again	7	18

Table 5.23 Indicates the positive comments made by pupils regarding the process. These are grouped into those who were given a context *(n = 10)* and those who were given freedom to choose *(n = 30)* their own design problems to solve

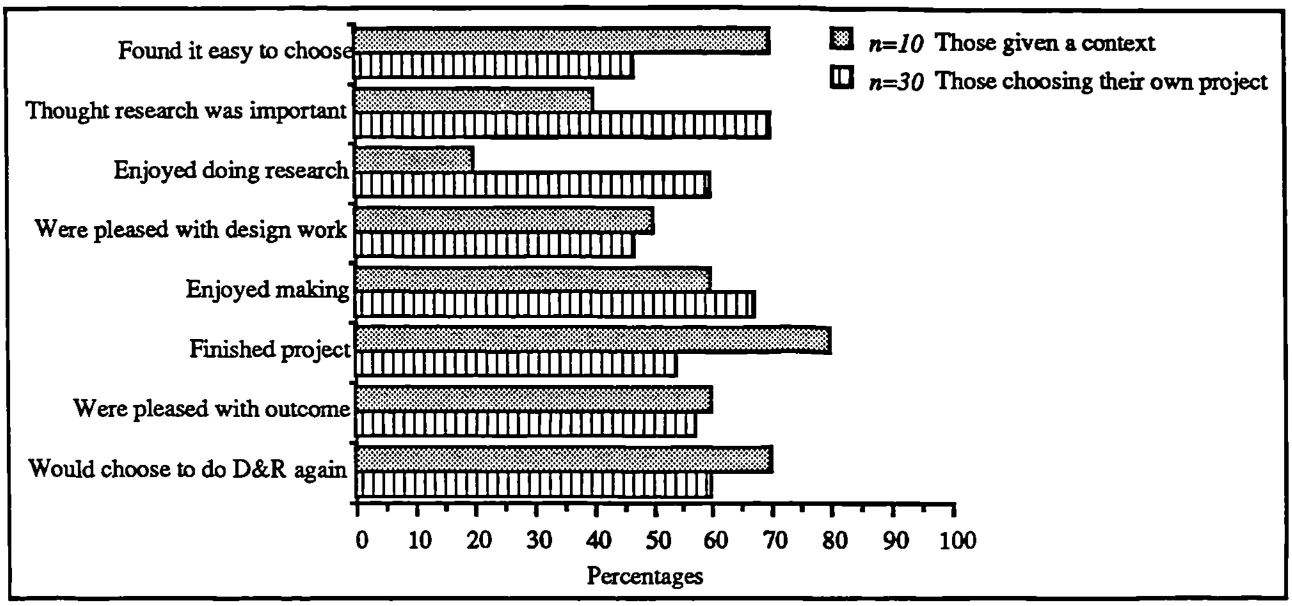


Figure 5.13 Illustrates in a bar chart the percentages of positive comments made by pupils regarding the process. These are grouped into those who were given a context *(n = 10)* and those who were given freedom to choose *(n = 30)* their own design problems to solve

In the context of the design process, as far as the pupils were concerned, the benefits or otherwise of these two approaches can be seen in Table 5.23 & Figure 5.13. Those who were given a context within which to work found it easier to select a project than those who were given freedom. However, a negative effect was identified at the research stage for those who were given a context. Analysis of the data showed that this group did not believe that research was important or relevant, nor did they enjoy carrying it out. When it came to the design work both groups were equally pleased with their work although this only represented fifty percent of each group. A slightly larger proportion of the pupils who were given the opportunity to choose their own projects enjoyed making them, whilst there was a significant difference between the two groups when it came to finishing the manufacturing stage on time. Eighty percent of the 'context' group finished their projects. I would suggest that this was in the main due to the fact that the projects tackled by this group were 'safe' projects. They were set well within the pupils' capabilities and the projects chosen were within areas which could be easily managed by the staff in the schools with the resources and equipment they had available. There was little difference in 'how pleased' the pupils were with their outcomes. One might have reasonably expected that those who had freedom to choose would be more pleased with their final products, but this was not the case. The results of the interviews suggested that in many instances this was because problems had arisen during manufacture because of ill-conceived, un-finished design work that had led to radical changes being made during the manufacturing process. This caused a number of pupils to be disappointed with their outcome. Conversely, one could have expected some despondency regarding the outcome by those who were given their original context, however, this too was not the case. Evidence suggested that in this instance pleasure with the outcome was due to the fact that it was work done for an examination. In the pupils' eyes it was more important that the examination result was satisfactory than that the artifact was something they wanted.

Phase One Conclusion

In the researcher's eyes Phase One achieved what it set out to achieve. The research questions specified for this phase of the study were all met. The research tools used gave the anticipated exploratory and explanatory (Cohen & Manion, 1985) information in a form that was often suitable for statistical analysis. The analysis of that data clarified factors that had been identified in both the Initial Survey and the literature review as problematic for pupils engaged in design and technology project work. It added to the researcher's understanding of pupil and teacher perceptions regarding the design process and project work at Key Stage 4. It also highlighted the intricate relationship between modelling and conceptual skills utilised during various aspects of that process. As was anticipated the collected data added to the breadth and depth of the researcher's understanding of the causes of de-motivation amongst some Key Stage 4 pupils studying design and technology.

To sum up, this part of the study illustrated both positive and negative features that could affect a pupil's motivation when they were involved in their GCSE technology examination project work. These features have been listed under three headings: process; skills; attitudes. The first set concerns the process that pupils used during designing and making activities. The second set concerns the skills that they used throughout that process. Whilst the third set provides early evidence of the affect that a pupil's attitude can have upon their ability to complete their GCSE technology examination project work.

Motivating Features Concerning the Process

1 Being given choice during project selection
2 Being given a context within which to work.
3 Making the product - as long as it is a success
4 Completing the project in time for assessment
5 Working towards an examination result

Demotivating Features Concerning the Process

6 Projects that are too big or too complex
7 Designing and in particular researching and evaluating
8 Products made which are unfit for their purpose
9 Poor time planning - teacher and/or pupil

Motivating Features Concerning Skills

10 Early sketching of ideas
11 Having the skills to produce a finished functioning product

Demotivating Features Concerning Skills

12 Drawing skills in general
13 Writing skills in general
14 Drawing and conceptual skills needed when detailing an idea
15 Orthographic drawing skills
16 Careful lettering skills
17 Written evaluations both conceptual and writing skills
18 Inaccuracy during the process
19 Poor manufacturing skills
20 The relationship between conceptual skills and the knowledge/skill base throughout the project

Positive Personal Attitudes

21 Pupils who dislike project work but are not bored by the process usually complete their projects.

Negative Personal Attitudes

22 Pupils who dislike project work and are bored by the process tend to produce incomplete project work

These are summarised diagrammatically as:

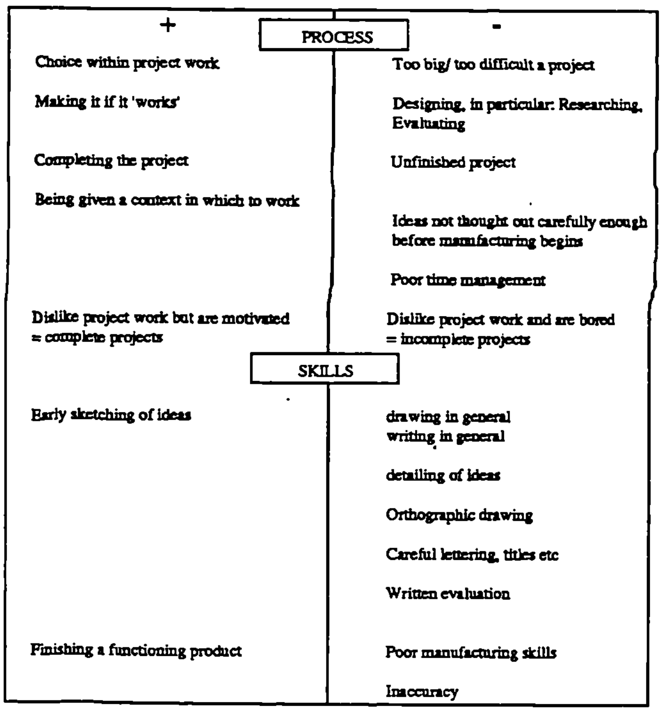


Figure 5.14 Illustrates aspects of project work identified during Phase One that can affect motivation

Some of these factors (Items 4, 7, 9, 12, 13, 17, 19, 20) relate well to the possibilities discussed earlier during the literature review. In particular it confirmed suspicions that had been raised concerning the motivational effect of certain aspects of the conceptual, knowledge and skill base needed when carrying out design and technology project work.

Others (namely Items 1, 2, 3, 5, 6, 8, 10, 11, 14, 15, 16, 18, 21, 22) are new. As expected, as well as providing answers to the questions posed at the start of Phase One, the analysis of the collected data highlighted a number of new questions, new thoughts and speculations for consideration during Phase Two . Whilst at the same time it re-affirmed the importance of finding answers to several existing questions which had already been planned for answering during Phase Two of the research project (see question tree Appendix 5.1).

Chapter Six

Phase Two

Introduction

From the material analysed, during both the literature review and Phase One of the research project, a picture emerged which suggested that a complex series of inter-related factors were affecting pupil motivation when they were engaged in design and technology project work. Phase One had specifically targeted pupil's and teacher's perceptions of the process adopted by the pupils when tackling GCSE design and technology project work. From the analysis of the collected data it was apparent that certain aspects of the design process had formed stumbling blocks for a large number of pupils, even though some of those pupils were able to complete their work and therefore appeared to be successful. The search of the literature hinted at some of these problems although in the main the majority of writers in the 1970's and 80's were concerned with encouraging teachers and thereby pupils to become involved in project work as it was seen as the way forward for the subject area in a school situation. It was generally believed to be a motivating activity during which the necessary skills, knowledge and concepts could be taught (Design Council, 1980; Kimbell, 1982; H.M.I, 1983; Down, 1986a). By the early-1990's a few writers were beginning to make reference to there being some problems associated with project work in design and technology (Barlex, 1987; Grieve, 1993; Chidgey, 1994; Hennessy, McCormick, & Murphy, 1993) although much of the writing was targeted at problems associated with the introduction of the National Curriculum in Technology.

In addition to the approach taken to designing, research has indicated that many other factors affect a pupil's performance and learning during design and technology project work (Naughton, 1986; D.E.S., 1989; N.C.C., 1993). APU (1991) suggested that the factors could be divided into two types; those attributes that a pupil brought with them: their gender; general ability; curriculum experience - and the attributes of the task itself: its context; its structure. Whilst Curry (1993), referring to learning styles in general, organised the factors into three main types which he likened to layers of an onion. He suggested that learning behaviour was controlled by the central personality dimension, translated through the middle information processing dimensions and then, *" ...given a final twist by interaction with environmental factors encountered in the other strata" (Curry, 1993).*

In the context of design and technology the complex relationship between key factors such as a pupil's knowledge base, level of communication skills, conceptual skills, creative ability, cognitive style, goal orientation and such external forces as culture, context, parental and teacher expectations cannot be underestimated. Nor can the effect of attitude upon motivation be ignored. However, to identify which attitude has caused de-motivation and then determine whether it is internal or external, stable or fluctuating and whether it can be controlled or is uncontrollable is a difficult task (Weiner, 1992). To add further to this complex picture there are also the intricate gender differences which recent research has highlighted (for example: A.P.U., 1991; Sylva, 1992). For this research study 'gender' has been taken to indicate biological gender. This is in contrast to behavioural or learning gender style where gender is seen as a continuum rather then as a binary divide (Durey, 1995).

In an achievement context such as school, pupils show either helpless or mastery patterns of behaviour when confronted by difficult tasks (Sylva, 1992; Licht & Dweck, 1983). These patterns of behaviour are not necessarily related to levels of intelligence (Weiner, 1992). Learned helplessness (Seligman, 1975) does not only affect the less intelligent. Research would have us believe (Licht & Dweck, 1983) that in a school situation there is a tendency for girls to acquire helpless orientation when they are faced with the possibility of failure. Boys have been shown to attribute their failures to external causes whilst girls blame their own inadequacies. Dweck and Leggett (1988) suggested that in a challenging achievement situation mastery orientated pupils pursued the *"learning goal"* of improving their ability whereas helpless pupils pursued the *"performance goal"* of proving their ability.

The assessment of pupil performance forms the backbone of GCSE project work. Educational philosophers would have us believe that the assessment used to judge pupils' work should not dictate the curriculum content (T.G.A.T, 1987), rather it should be designed to develop capability and test competence (S.E.C., 1986; Sutton, 1991; N.E.A.B., 1993). However, the importance of the examination results to pupils and teachers alike dictate that the nature of assessment and its criteria influence what is learnt and how it is taught (Scott, 1990; Gipps, 1990). Additionally, the need for accountability has led assessment to become overly objective (Wiliam, 1992). As far as examination syllabuses have been concerned, this has lead to the use of a prescriptive design process with a very specific list of criteria to be met. Layton (1991) aptly suggested that if teachers were not careful the process could impose *"a procrustean regime"* on the way pupils designed. Pupils have become 'outcome driven', with the process becoming a series of products. To obtain good examination grades pupils have had to provide evidence that each stage of the specified process has been addressed, irrespective of whether it was appropriate to the design of their particular product or not.

Set against this background Phase Two of the project was designed to be carried out during the academic year which followed Phase One.

Aims of Phase Two

The aims for Phase Two have been divided into two sections. The aims in section one are subdivided into those that tend to be pupil dependent and those that tend to be teacher or externally dependent. Section two contains two additional aims. The first is concerned with pulling together the various strands of the research in order to quantify the importance of the identified factors that cause de-motivation in Key Stage 4 pupils engaged in design and technology. The second aim is to predict teaching and learning strategies which might alleviate the situation identified.

Section One Aims

Pupil Dependent Aims

* To explore whether a pupil's motivation is affected by internal factors such as:
  * creative ability;
  * goal orientation;
  * cognitive style.

* To revisit, having taken into consideration the analysis of Phase One data, whether a pupil's motivation was affected by their:
  * design capability;
  * manufacturing capability.

Teacher or Externally Dependent Aims

* To explore whether a pupil's motivation is affected by externally dependent factors such as:
  * the design process specified by GCSE Examination Boards;
  * the relationship between the knowledge base and the design process taught;
  * the balance of time given to the various aspects of the design process;
  * the teaching strategies adopted by the individual teachers during project work;
  * the delivery programmes devised by the schools;
  * the relationship between the teacher and their pupils;
  * the teachers design ability, knowledge base and creativity;
  * the teacher's motivation.

Section Two Aims

* To explicate the key factors which have been observed to cause de-motivation of Key Stage 4 pupils when they are engaged in design and technology project work.
* To predict teaching and learning strategies that could help to improve the situation regarding the de-motivation of Key Stage 4 pupils.

Method
Methods of Examining the Issues

Phase Two sought to examine the issues raised during the review of the literature, the Initial Survey and Phase One of the project through the following means:

* use of documentary sources, such as pupil's project work, examination syllabuses, teacher handouts, examination results,
* questionnaires
* interviews
* observation of pupils and teachers
* goal orientation test
* cognitive style analysis test
* creativity test

Data Collection Methods

Data was collected in the following manner:

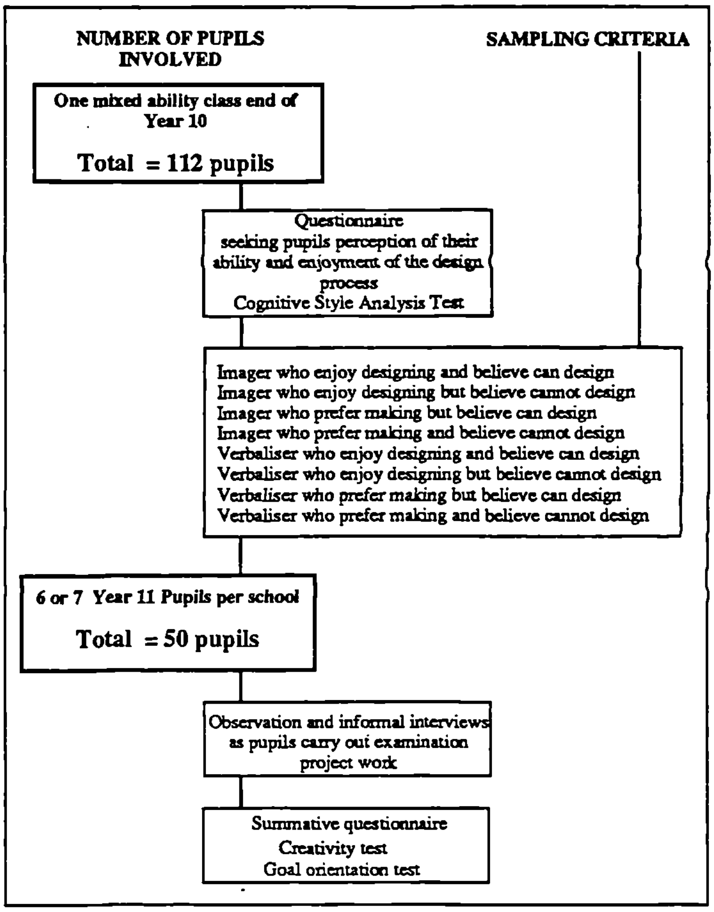


Figure 6.1 Illustrates the research activities in the eight chosen schools during Phase Two

The data collection was organised to be carried out during the academic year 1994-5. It was targeted at the same eight schools who had been involved in Phase One of the study the previous year. In preparation for this a new sample of Year 10 pupils who were about to embark upon their Technology examination projects was identified. Being the first year that it was compulsory for all pupils to study Technology at Key Stage 4 it was possible for the teachers to select a single mixed ability technology class from their school and for that chosen class to be representative of the total Key Stage 4 cohort within that particular school.

Once the class was selected an appropriate sized sample had to be chosen. The main thrust of data collection during this phase was designed to be through observation of individual pupil's whilst they carried out their examination project. It was therefore important that the number of pupils in the sample was large enough for statistical purposes but small enough to be managed by a single researcher (Bell, 1987; Cohen & Manion, 1985).

The selection of the pupils was made in the middle of the summer term when they were in Year 10. The timing of this activity was chosen in order that the sample would be ready for observation to begin at the start of the examination project work period. In some schools this was to be during the later part of the summer term whilst in others the start of the project work was targeted to begin during the early part of the following academic year when the pupils were in Year 11.

The sample was chosen using three data-gathering instruments which identified: pupil perception regarding their enjoyment of designing and making; pupil perception of their personal ability in designing and making; each pupil's predominant cognitive style; the teachers' perception of their pupils' design ability. In order to obtain this information pupils from the chosen class in each school were asked to fill in a questionnaire *($n = 124$)* during one session and complete a Cognitive Styles Analysis (CSA) Test *($n = 115$)* on a second occasion. Pupil absenteeism gave a final sample size of 112 (eighty-five boys and twenty-seven girls), all of whom had participated in both tests. Teachers' perceptions regarding pupils' ability to design were gathered from a single sided A4 sheet using a two dimensional grid classification. Information regarding timing of the major project was also collected in order that the researcher could organise data collection from the chosen sample (Figure 6.2).

The questionnaire assessed the pupil's enjoyment of designing and making and the pupil's perception of their overall ability when using design processes. The format for these questions was identical to that used during an earlier phase of the study (see Figure 5.2 page 164). Pupils responses were once again located on a scale of fixed alternatives which allowed a comparison to be made between the two cohorts of pupils. A new set of specific scale questions regarding the pupil's conceptual and modelling skill levels whilst designing were also included. These questions were based upon an analysis of the data taken from the interview sessions during Phase One. The new questionnaire was trialed by two separate Year 10 classes taken from the schools involved in the research project.

Pupils Design Ability - NOT Make ability

Code Name	very good	good	average	poor	very poor	

Day and Time when above pupils come into the department to "do" their major design and make task for their GCSE

Day .... Start of Lesson .... End of Lesson ....

Day .... Start of Lesson .... End of Lesson ....

Date when this Task will begin ....

Date when this task will finish ....

Figure 6.2 Illustrates the A4 sheet which gave the Teachers' perceptions regarding their pupils' ability to design

The classes were selected as they were not to be the target of the next phase of the research study. The final layout of the questionnaire can be found in Figure 6.3.

Figure 6.3 An example of the questionnaire given to 124 Year 11 pupils in the eight chosen schools at the start of Phase Two

NAME

Please could you fill in this questionnaire to help me in my research. The information that you provide will be strictly confidential and will only be used for statistical analysis in my research.

1 Are you male or female? Please tick in the appropriate box.

male	female

2 Indicate with a tick on the chart below, how much you have enjoyed each of the following aspects of design and technology project work

	enjoy a lot	enjoy a little	do not enjoy very much	do not enjoy at all	haven't done this
selecting a project					
researching for a project					
thinking of a number of different solutions					
working out the details of your chosen idea					
making your final chosen solution					
making your chosen solution work					
using tools and equipment in the workshops					
evaluating your project					
putting together your final folio of design work					
writing up your report					

3 Below is a list of four different aspects of design and technology project work. Using the numbers 1,2,3, and 4, put the list into rank order where:

1 = the aspect you enjoy the most, 2 = the aspect you enjoy second best,
3 = the aspect you enjoy third best, 4 = the aspect you enjoy least.

	Rank Order
Research	
Design	
Make	
Evaluate	

page 1

4 Indicate with a tick on the chart below whether you agree or disagree with each statement.

Statements about designing	strongly agree	agree	unsure	disagree	strongly disagree
1 I usually find it easy to think of lots of different ideas to solve my design problems					
2 I usually find it easy to draw my ideas on paper					
3 I find freehand perspective drawing difficult					
4 I enjoy thinking of new ideas					
5 I do not mind having to draw when I am designing					
6 I usually find it easy to get my free hand perspective drawings to look right					
7 I often think of unusual design ideas					
8 I enjoy thinking about a design problem					
9 My drawing skills are not very good					
10 I dislike doing careful detailed drawings because they take too long					
11 I dislike doing plans and elevations because they have to be neat					
12 I find drawing easy to do					
13 The drawing part of the project gets boring after a while					
14 When I am working on my chosen idea I enjoy doing careful sketches because it helps me to work out the details					
15 I often find that I do not know the best materials to make my chosen idea from					
16 When I am working out my chosen idea I enjoy doing careful sketches because I like doing that type of drawing.					
17 I find doing plans and elevations boring					
18 I like doing neat drawings					
19 I try to avoid doing plans and elevations					
20 I find it difficult to draw accurate plans and elevations					
21 I enjoy doing plans and elevations					
22 I need a lot of help from the teacher with my plans and elevations because I find them difficult to do					
23 I am usually proud of my drawings					
24 I like having to concentrate on one thing for long periods of time.					
25 Plans and elevations are too complicated to do					

page 2

Cont.

Statements about designing	strongly agree	agree	unsure	disagree	strongly disagree
26 Plans and elevations are too time consuming					
27 I rarely need to ask my teacher for help when I am working out how to make my chosen design					
28 I enjoy doing a presentation drawing of my chosen design					
29 I dislike having to do presentation drawings because they take too long to do					
30 I am usually proud of my presentation drawing of my chosen idea					
31 I avoid doing presentation drawings if I can					
32 I enjoy writing notes beside my drawings to explain how my ideas work					
33 I find writing notes beside my ideas easy to do					
34 I find it difficult to write notes beside my ideas because I don't always know how things work					
35 I don't know what to write beside my ideas					
36 My writing on design sheets is untidy					
37 It is easy to think what to write in an evaluation					
38 I dislike looking back on the unsuccessful aspects of my project for my evaluation					
39 I find it easy to explain my thoughts when I am writing my evaluation					
40 Evaluations take me too long to do					
41 It is difficult to think of anything to criticise about my design work when I write my evaluation					
42 Evaluating design projects is a waste of time					
43 In my evaluations I do not mind saying that my design has not worked					
44 I find writing evaluations of my design projects easy					
45 I don't like having to write in any of my subjects at school					
46 In my evaluations I write anything just to fill up the space					
47 My evaluation is not always truthful					
48 An evaluation is a good way of finishing a design project.					

Thank you very much for your co-operation in filling in this questionnaire and providing me with statistical information for my research.

E Stephanie Atkinson

Figure 6.3 cont. An example of the questionnaire given to 124 Year 11 pupils in the eight chosen schools at the start of Phase Two

The question type, the analysis technique to be used and the data that would be collected can be seen in Figure 6.4.

Sample	Source	Question Type	Analysis Technique	What data was collected
Pupils (124)	Questionnaire			
	1	classification	nominal scale	Background data - male /female
	2	2-dimensional grid classification (2DGC)	ordinal scale	pupils perception of how much they enjoyed each aspect of the design process
	3	rank order	ordinal scale	rank order of pupil enjoyment of four areas of the design process
	4 (1-48)	2-dimensional grid classification (2DGC)	ordinal scale	pupils perception of how much they agreed with each statement concerning the drawing and writing skills they used during the design process

Figure 6.4 Illustrates the source, question type, analysis technique and what data was collected from the questionnaire given to 124 Year 11 pupils in the eight chosen schools

The computer-presented, self-administered CSA test was designed by Riding in 1991. Cognitive style had been shown to be closely related to an individual's ideas and attitudes (Riding & Cheema, 1991). The perception and evaluation of information were believed to be integral to the act of designing, therefore each pupil's predominant cognitive style was seen as a possible indicator of performance and motivation during engagement in design and technology project work. It was used to assess two fundamental cognitive style dimensions: wholist-analytic and verbal-imagery (Riding, 1991). The wholist-analytic style he explained was concerned with whether an individual tended to process information in wholes or parts, and the verbal-imagery style with whether an individual was inclined to represent information during thinking verbally or in images. Unlike other learning style analysis test designs that assess positively only one end of a dimension the CSA test was designed to positively assess both ends of the wholist-analytic and the verbal-imagery dimensions.

Each participating school provided a quiet corner in the design and technology department in which a pupil could complete the CSA test with the minimum of distraction (Riding & Cheema, 1991). In order that no differences could be identified between the presentation of the test from one pupil to another, the researcher provided an IBM 350 Thinkpad computer for the use of each respondent in turn. The researcher remained in the room whilst the pupils were tested. A position which avoided the appearance of watching the pupils was adopted as it was believed that being watched was likely to fluster some pupils when mistakes in the test were made.

Data pertinent to the three separate selection factors, using information from the CSA Test and the questionnaire, were entered into a new data base (see Appendices 2.2 & 3.4). The data allowed the selection of an appropriate sample to be made. Fifty pupils were selected according to a matrix of eight possible pupil types. Four categories of imager and four categories of verbaliser were identified. Imagers and verbalisers were further divided into those *who enjoyed designing and those who preferred making. These* categories were then further sub-divided into those who believed that they could design and those who believed that they could not. Whilst not all pupil types were evident in each school the proportion of boys to girls in the selected sample remained representative of the overall sample. Due to the nature of the research project the spread of the sample as far as each category was concerned was chosen to be weighted (2:3) in favour of pupils who were not positive about the design process (see Figure 6.5).

School Code	Imagers A	B	C	D	Verbalisers E	F	G	H	Categories
007	-	A	A	A	W	A	A	W	A = Imagers who enjoy designing and believe can design B = Imagers who enjoy designing but believe cannot design
021	W	-	A	W	A	W	W	-	C = Imagers who prefer making but believe can design D = Imagers who prefer making and believe cannot design
031	-	-	W	A	A	W	A	W	
032	W	-	A	W	-	A	A	A	
035	-	W	A	A	-	A	A	W	E = Verbalisers who enjoy designing and believe can design F = Verbalisers who enjoy designing but believe cannot design
036	W	A	-	A	-	W	A	A	G = Verbalisers who prefer making but believe can design H = Verbalisers who prefer making and believe cannot design
047	W	A	W	W	A	-	A	A	W = Wholist A = Analyst
049	A	-	A	A	A	-	A	W	

Figure 6.5 Illustrates the final sample of fifty pupils identified using a matrix of eight pupil types

A case study approach based on observation and informal interviews was chosen as an appropriate method of collecting data during Phase Two (e.g. Cohen & Manion, 1985; Bell, 1987; Robson, 1993). It gave the researcher the opportunity to concentrate on identifying, or attempting to identify, the various interactive processes that were at work whilst the pupils were engaged in their project work. It allowed the interplay between teacher strategies and pupil strategies to be observed in order to identify reasons for the de-motivation that had been observed and reported at earlier stages of the project. During the project work the effect of examination assessment criteria, delivery programmes and teaching strategies were scrutinised. Pupils' level of skill, knowledge and understanding were observed. The question of whether strategies that pupil's adopted were based on their levels of creativity, their goal orientation, their preferred learning style, upon a cocktail of all of these or upon other factors as yet unidentified were all examined.
It was recognised by the researcher that in order to tease out further the reasons for de-motivation at Key Stage 4 it was essential that the various *"multifarious phenomena"* (Cohen & Manion, 1985) involved were observed over time and that this could be accomplished using a case study approach. In this instance the length of the case study was governed by the time taken over the examination project work carried out by the pupils. What was to be observed was the progress of the selected sample throughout the examination project work. The form the observation took was peculiar to this research project. The two principle types of observation, participatory, and non-participatory described in six separate case studies by Cohen and Manion (1985) were not wholly appropriate in themselves. In this instance, the researcher used a combination of non-participatory observation and loosely structured interviews. She sat at the back of the class coding up observations at regular intervals in a non-participatory manner. However, she also talked to the pupils and teachers during each session using very informal

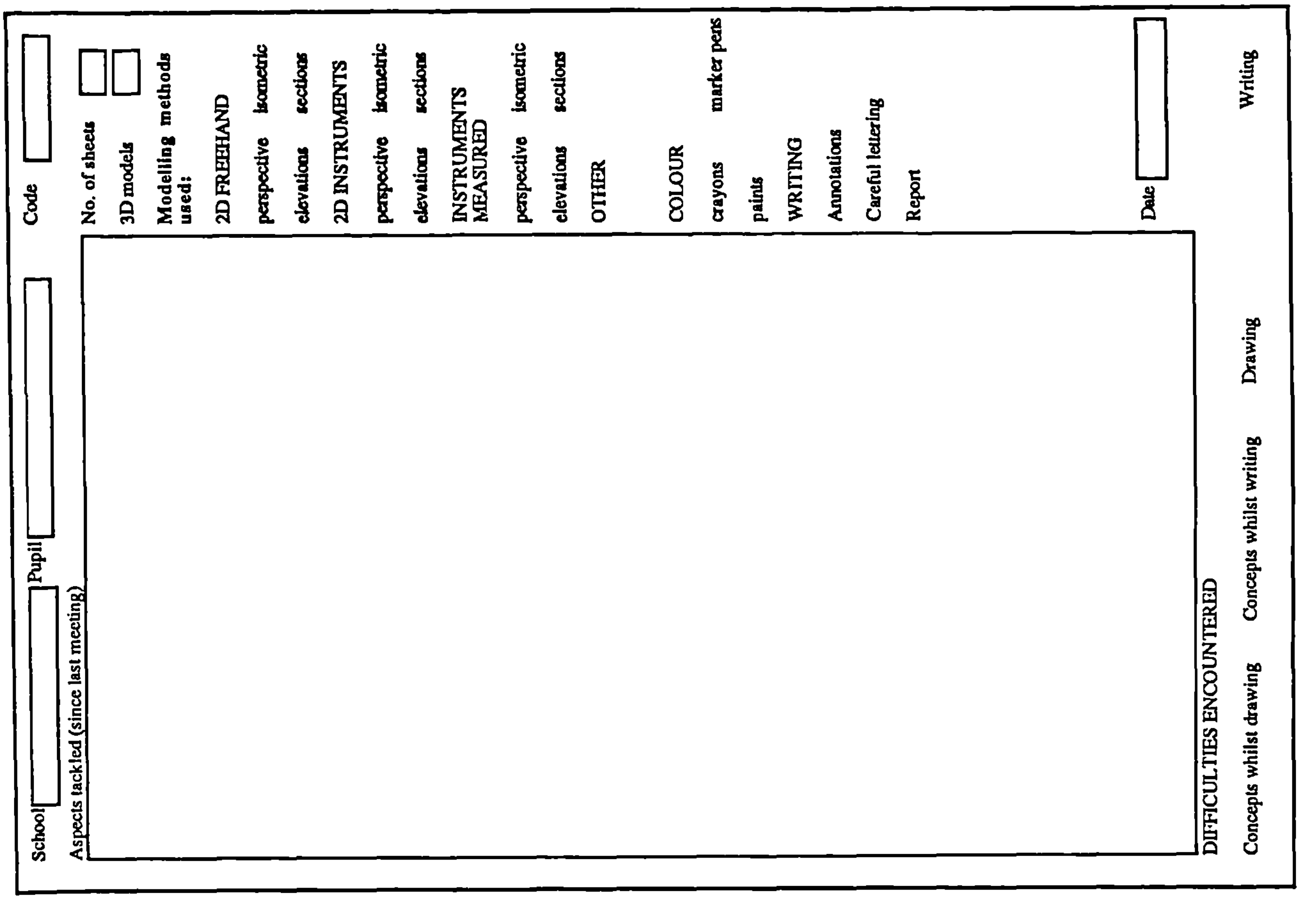
interview techniques. The structure of the interviews varied, from pupil to pupil, teacher to teacher, and from session to session, depending upon the progress made in the project work by each individual member of the sample.

Observations regarding the pupil's skill levels, progress made since the last visit and the important points discussed during the conversations with the pupils were recorded in both a drawn and written format on observation sheets especially designed for the purpose (see Figure 6.6 for copy of the sheets and Appendix 4.3 for examples of the completed sheets). The design sheets, reports and practical activities which the pupils produced were recorded where appropriate. Photographic (Appendix 4.4) processes were used for this purpose. These gave a valuable second source of information to support, illustrate and validate conclusions drawn from the observation sessions. This type of evidence needed to be collected at regular intervals as the drawings completed at the early stages of the design process was often re-worked or added to at the 'tidying-up' stage of the project and therefore vital evidence was found to disappear.

Observation of and discussion with the individual teachers throughout the project work period allowed the researcher to build up a composite picture of the teacher's role throughout the activity. Listening to teacher inputs, analysing the few hand outs given to the pupils (see Appendix 7.1) and talking to the individual teachers gave the researcher an understanding of the delivery programme utilised and the teaching strategies adopted. The information collected from the teachers also gave the researcher an insight into the teacher's own understanding of the design process and a means of testing one source of information against another in order to cross-validate and improve the accuracy of the findings (Robson, 1993).

Throughout this observation period both quantitative and qualitative data were collected. These data were analysed using a variety of different methods. The quantitative data was explored in order to find patterns, relationships and differences. This was mainly achieved by using a variety of statistical analysis techniques to be found in the powerful software package, StatView.

In the case of the qualitative data these were treated in two ways. The review of the literature had explained that there was no clear and accepted set of conventions for analysing qualitative data corresponding to those observed with quantitative data (Robson, 1993). Although several methods in which qualitative data could be dealt with systematically were advocated by qualitative research methodologists (e.g. Yin, 1989; Tesch, 1990).



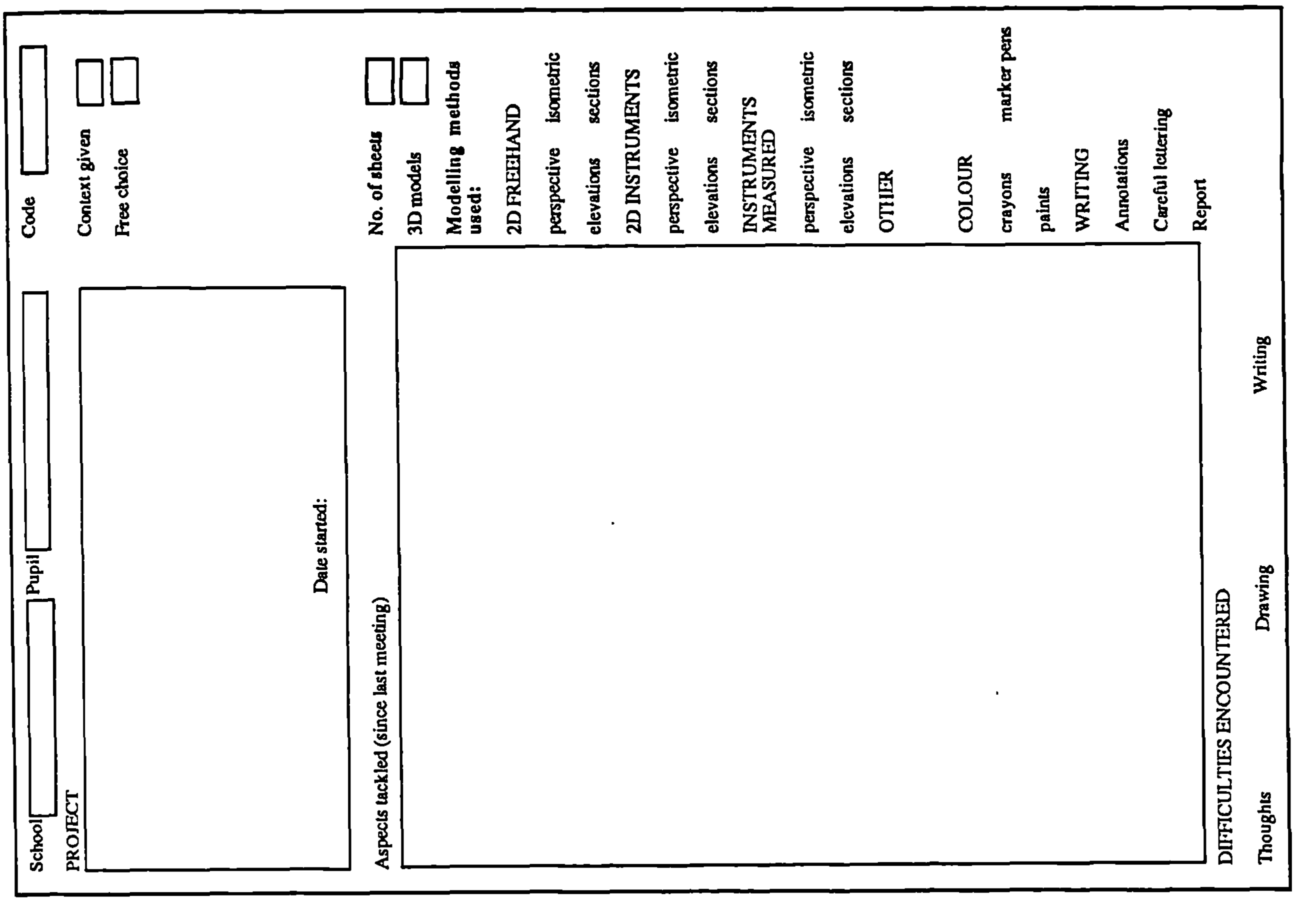


Figure 6.6 Illustrates the two observation sheets used throughout Phase Two

Where appropriate the data collected during the observation period were organised in such a manner that they could be translated into numbers and in that form they could be treated as quantitative data. However, some aspects of the data were more suited to remain in the form of words and pictures, being useful in supplementing and illustrating the quantitative evidence collected. Support for this route was found in the writing of Robson (1993) who pointed out that small amounts of qualitative data used as an adjunct within a largely quantitative study did not always justify detailed and complex analysis. *"Often the need is simply to help the account 'live' and communicate to the reader through the telling quotation or apt example" (Robson, 1993).* It was also the case that in certain sections of the study the qualitative data was able to stand in its own right and was not merely supportive adjuncts to the collected quantitative data.

Once the project work had been handed in for assessment the researcher visited the eight schools twice more. There were four purposes to these visits. The researcher required the pupils to complete: a creativity test (Appendix 1.4); a goal orientation test (Appendix 1.3) that had been used during Phase One; and a summative questionnaire (Appendix 1.5). It was also necessary for the researcher to assess the drawing and writing capability of pupils through scrutiny of the finished design folios. Each pupil was given a score for both skills independently of one another (see Appendix 2.2 for raw data). The maximum score that could be achieved was four. A discussion with the teacher responsible for the pupils enabled verification of the researcher's findings.

The goal orientation and creativity test had been left until this stage of the research project on purpose. The researcher was aware that throughout the observation period she must not encroach upon the time available for the pupils to work on their examination projects. This was in order that the pupils in the sample were not disadvantaged in comparison to the rest of their class.

As far as the creativity test was concerned the researcher came to the conclusion after reviewing the literature that there was unlikely to be a perceivable difference in the pupils levels' of creativity if tested before or after the observation period. In fact as the sample chosen had pupils in it who disliked drawing and believed they had poor drawing skills, it was felt by the researcher that the non-judgmental relationship she wished to pursue during the observation period might easily have been affected by the pupils knowing that the researcher was aware of their inadequate drawing skills prior to that observation period.

The test was in two parts (Appendix 1.4). The first section was used only to stimulate the pupil's creativity and not to be scored. The test was taken from De Carlo's (1983) *Psychological Games*. In the original test there were thirty circles illustrated each containing images for the viewer to interpret. De Carlo suggested that there were *"no 'right' answers, only witty, daring or unusual interpretations..."* In the creativity test used in this research project only twelve of the circles were selected (see Figure 6.7) as the researcher did not wish that section of the test to take too long. Figure 6.8 gives examples of interpretations of the given images by ten of the pupils.

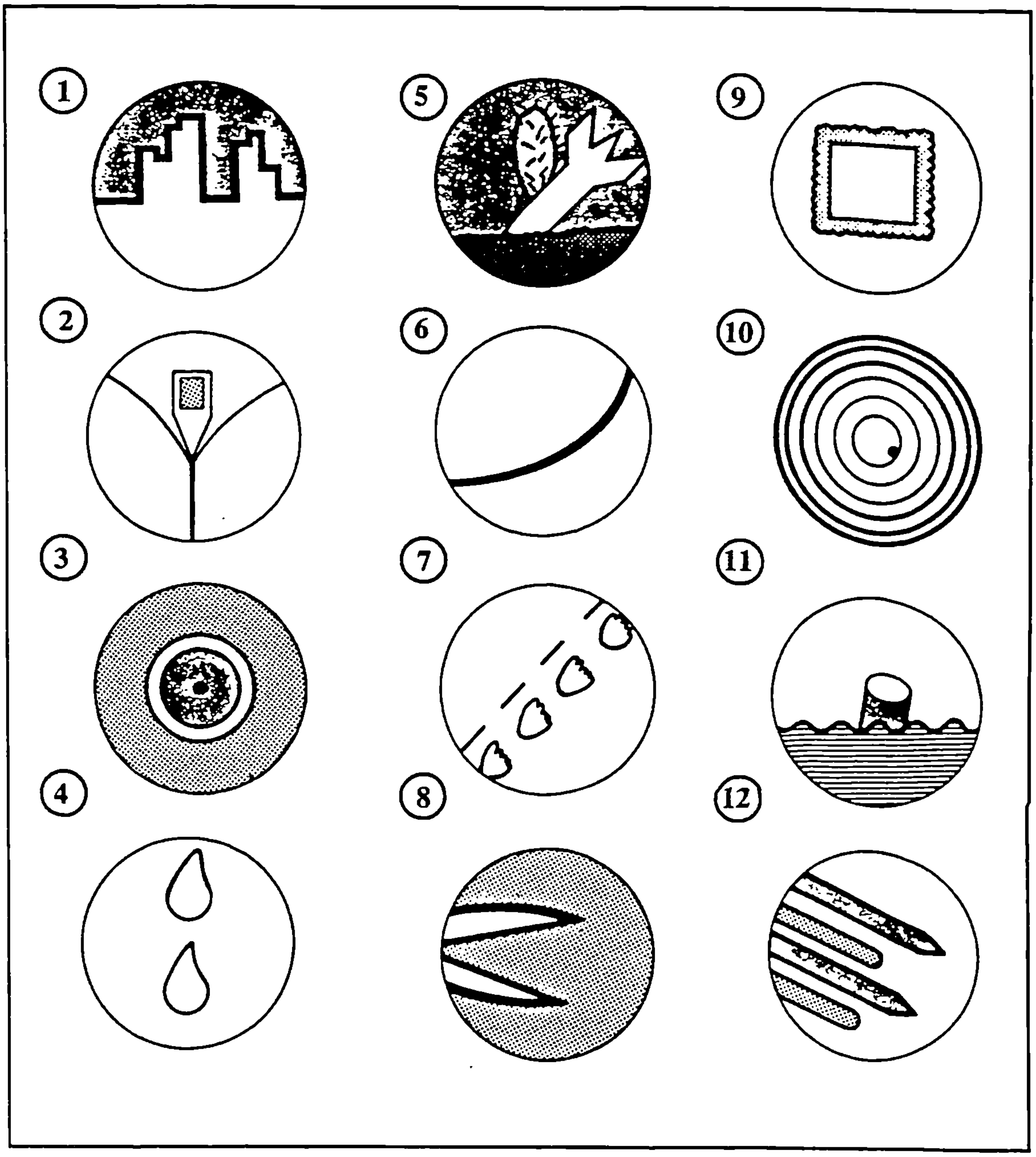


Figure 6.7 Shows the twelve illustrations used in the first half of the creativity test

Illustration 2
1 A jam packed bag being unable to close it and it is bursting open.
2 A zip being zipped up
3 A bus stop with two joining hills in the background
4 A zip on a coat
5 An upside down bottle going into an incinerator
6 A zip
7 A zip pulled up on a jumper
8 A boat between two waves
9 A butterfly in a bubble
10 A peach

Illustration 8
1 A bird waiting to be fed
2 Part of a pair of scissors
3 A pair of scissors lying flat.
4A rabbit's ears
5 A plant leaf wrapped round a ball
6 A claw
7 The beak of a pelican
8 Power ranger
9 A ball with a picture of a person on it with only the legs showing
10 A bunny rabbit just going to look in his burrow

Illustration 11
1 A glass of water with a hollow biro pen floating in it.
2 A pipe sticking out of water
3 A funnel of a sinking ship
4 A cigarette sinking in water
5 A can floating in the sea
6 A toxic can in the sea
7 A ship sinking
8 A submarine's telescope
9 A sinking ship
10 A cigarette which has been dropped in a pond

Figure 6.8 Gives examples of interpretations of three of the given images by ten of the pupils

The second section of the test was based on the then unpublished PhD work of Oxleigh (1993). The pupils were each given a sheet of paper on which twelve squares were drawn. Inside each square there were three marks, two short straight lines and one short curved line. Each square had the same three lines placed in identically the same positions (Figure 6.9). The sample were asked to produce twelve different images/pictures, either abstract or representational utilising all three lines in each composition. They were asked to work as individuals with no reference to each others work. They were told that it was the variety which was important not the quality of drawing. The pupils were also asked to give the individual images titles if they believed it was appropriate (see Figure 6.10 for examples of several pupils created images, Appendix 1.4 for Creativity test pro-forma and Appendix 4.5 for examples of pupil's individual contributions).

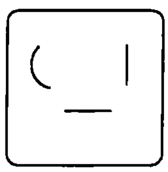
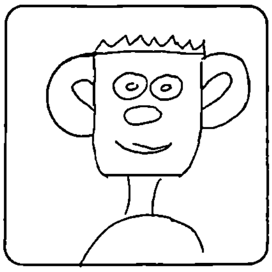
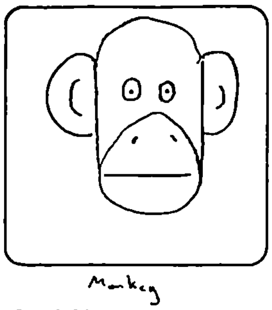


Figure 6.9 Illustrates an example (not full size) of the square and lines around which the pupils created their images

One of 44 cups, mugs or glasses

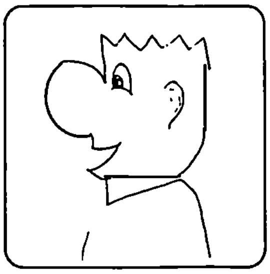


One of 20 full faced humans



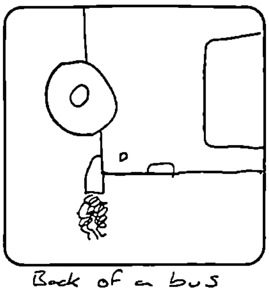
One of 18 full faced animals

One of 17 skylines with either the sun or the moon

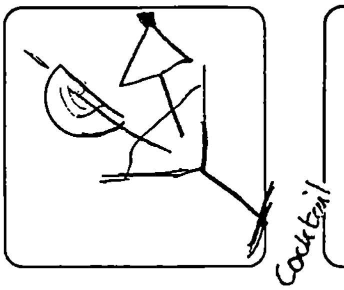


One of 16 side views of a face

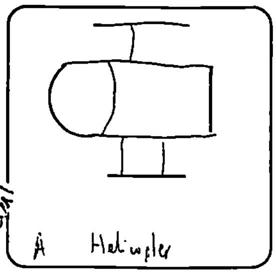
One of 14 balls plus a foot



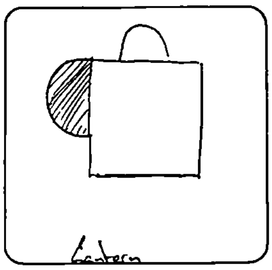
One of 11 back ends of a car, lorry or bus



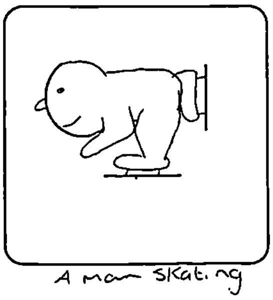
One of 5 glasses, vases drawn in this way



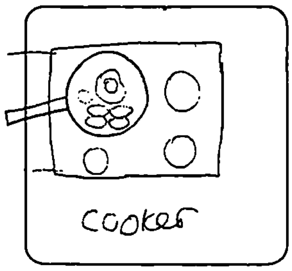
One of 5 helicopters



One of 3 lanterns or torches drawn in this way



One of 3 people skating



The only plan view of a cooker although 2 others used plan views of roads

Figure 6.10 Illustrates some examples of pupils' created images (not full size)

Scoring was carried out by the researcher. In the first instance a coded photocopy of each pupil's sheet was cut into individual images. Similar images from the total sample were then grouped together. Each set was then counted and placed in numerical order. A score was given to each set with the one obtaining the least responses being given the highest score. This score decreased as more and more images were counted in each group. The pupils individual score could then be calculated. Pupil's with high scores were considered more creative than pupils with low scores. (see Appendix 2.2 for Pupil Creativity Scores)

As far as the goal orientation test was concerned it was a repeat of the questionnaire used during Phase One of the research study. The test set out to assess important behavioural characteristics associated with accomplishing goals (see Appendix 1.3 for questionnaire). This was based on the work of Atman (1986) and is described in more detail during both the review of the literature and the Method Chapter associated with Phase One. When completed the attitude scale provided a profile for each pupil showing their individual scores for the interwoven stages of reflecting, planning and acting. The researcher realised that in this instance having to complete the test after some of the sample had failed to complete their examination project work might affect their responses to the questions. However, when the results were compared to those obtained from a similar sample the year before this was found not to be the case. This was possibly due to the fact that the questions were not design and technology specific and were targeted at goals identified by Atman (1986) that concerned life in general. The scoring of the test was carried out by the researcher in accordance with Atman's instructions provided with the test. Support for the acceptance of the findings was found when the results of the goal orientation test and the observed motivational levels of the pupils were compared.

The summative questionnaire was related entirely to the GCSE examination project work that the sample had just completed. It was designed to provide the researcher with three types of information. There were questions concerning the design and make process used by the pupils, the pupil's motivation during the project, and questions related to the pupil's thoughts regarding the part their teacher had played during the project work. The questionnaire was designed in such a way as to encourage pupils to participate fully (Bell, 1987). The layout was based on earlier successful designs whilst the questions themselves were trialed with a cohort of pupils who were not part of the sample being scrutinised. The question type, the analysis technique and the data to be collected can be found in Figure 6.11.

Figure 6.11 Illustrates the source, question type, analysis technique and what data was collected from the questionnaire given to 50 Year 11 pupils in the eight chosen schools

Sample	Source	Question Type	Analysis Technique	What data was collected
Pupils (50)	Questionnaire			
	1	rated using evaluative factors (REF)	ordinal scale	whether pupils were pleased with their design portfolio
	2	2-dimensional grid classification (2DGC)	ordinal scale	pupils perception of how pleased they were with each aspect of the design process
	3	REF	ordinal scale	whether pupils were pleased with the making of their project
	4	open ended	Researcher's categories from collected data to produce quantitative data (RCQD) - nominal scale	the aspects of making the pupils were pleased with.
	5	open ended	RCQD - nominal scale	the aspects of making the pupils were disappointed with.
	6a	REF	ordinal scale	how well the pupil believed they had done in their portfolio
	6b	REF	ordinal scale	how well the pupil believed they had done in their practical work
	7	REF	ordinal scale	whether pupils believed that the design process they had used was the best way of coming up with a good solution
	8	REF	ordinal scale	whether pupils had been bored or not with their examination project.
	9	REF	ordinal scale	whether pupils understood how things worked in order to design successfully
	10a	yes / no	nominal scale	whether pupils were motivated to finish their project.
	10b	open ended	RCQD - nominal scale	if yes to 10a- why was the pupil motivated if no to 10a - why not
	11a	yes / no	nominal scale	whether the pupil believed that the teacher had affected how much they had enjoyed their examination project
	11b	open ended	RCQD - nominal scale	if yes to 11a - the pupils were asked to give example
	12	yes / no	nominal scale	were there other reasons for not enjoying the project work
	12b	open ended	RCQD - nominal scale	if yes to 12a - the pupils were asked to give example
	13a	REF	ordinal scale	pupil perception of their whether they had enough practical knowledge to show how ideas would work on design sheets
	13b	REF	ordinal scale	pupil perception of their whether they had enough practical knowledge to show how ideas would be made on design sheets
	14	yes / no	nominal scale	pupil perception of their whether they had enough practical skills to make their project
	15	open ended	RCQD - nominal scale	what difficulties pupils encountered whilst making their project
	16	REF	ordinal scale	pupil perception of whether they knew exactly how they would make the product before they began the manufacturing process
	17	REF	ordinal scale	Whether pupils believed that they needed the teachers help whilst making.
	18	open ended	RCQD - nominal scale	Which aspects of the project needed most help

Cont.

Sample	Source	Question Type	Analysis Technique	What data was collected
	19a	yes / no	nominal scale	Pupil perceptions regarding the usefulness of teacher hand outs.
	19b	REF	ordinal scale	Whether pupils believed that the hand outs helped them to meet the assessment criteria for the examination
	20	REF	ordinal scale	Whether pupils believed that their teacher was enthusiastic about their project
	21	REF	ordinal scale	Whether pupils believed that their teacher's enthusiasm or lack of it affected how well they worked on their project
	22	yes / no	nominal scale	Whether pupils believed that their teacher was able to give enough help with their project
	23	open ended	RCQD - nominal scale	If No to 22 - why pupils thought that was.
	24a	REF	ordinal scale	Whether pupils found it easy to make their chosen idea
	24b	yes / no	nominal scale	whether pupils had a picture in their minds of what their chosen idea would look like before they started making it
	24c	REF	ordinal scale	whether the pupils believed that their project turned out exactly as expected
	24d	yes / no	nominal scale	whether the pupils believed that the outcome was exactly like their drawing before they started manufacture
	24e	REF	ordinal scale	whether the pupils believed that they knew when they started making their project the detail of how it was all going to be joined together
	25a	yes / no	nominal scale	whether pupils had finished all their portfolio, practical work and evaluation by the first deadline set by the school
	25b	classification	nominal scale	If no to 25a - which of the three aspects were incomplete
	26a	yes / no	nominal scale	whether pupils had been given the criteria for assessment
	26b	REF	ordinal scale	If yes to 26a - whether pupils believed they had understood the criteria
	26c	REF	ordinal scale	If yes to 26a - whether pupils believed the criteria were helpful in their designing
	26d	REF	nominal scale	If yes to 26a - whether pupils believed that knowing the criteria helped them achieve a better mark
	27	open ended	RCQD - nominal scale	Which aspects of the project did the pupils find most difficult
	28	open ended	RCQD - nominal scale	Which aspects of the project did the pupils believe gave them the most pleasure
	29	REF	nominal scale	whether if pupils were given the choice of options agin would they choose to take technology

Key:
REF = Rated using Evaluative Factors.
2DGC = Two Dimensional Grid Classification
RCQD = Researcher's Categories from Collected data to produce Quantitative data.

Figure 6.11 Illustrates the source, question type, analysis technique and what data was collected from the questionnaire given to 50 Year 11 pupils in the eight chosen schools

The final set of data to be added to the database during this phase of the research concerned the examination project work marks. Once the school results had been finalised through cross-moderation the researcher requested the marks for each of the one hundred and twenty-four pupils involved in the original Phase Two sample.

Throughout Phase Two as each set of data was collected it was coded in a suitable form and checked for inaccuracies. It was then entered into a single data base that was used in a variety of statistical analysis tests. The power of the data base software package, FileMaker Pro, was fully appreciated as a single file was able to deal quite happily with one hundred and ninety fields allowing the researcher to sort and select features, and find or display groups of data in order that a number of calculations and summaries could be carried out. The collected data were also imported into StatView in order that a number of different parametric and nonparametric tests could be performed and a number of methods of presenting data could be utilised. The parametric tests included : one sample hypothesis tests (both the t-test and the chi-test); paired and unpaired comparisons; and the binomial test. Whilst the nonparametric test used was the Spearman rank correlation coefficient test.

Through the use of these two software packages the relationship between the data relating to the key factors identified as affecting motivation was tested. These factors and relationships were also viewed in the light of the examination project work results achieved by the pupils whilst certain aspects of the data were also used as a cross-check with data collected at the selection of the sample stage in order to add support to the conclusions drawn from the analysis.

Phase Two Results and their Discussion

Phase One had enabled the researcher to develop a greater understanding of pupil and teacher perceptions regarding various aspects of the design process used during GCSE examination project work in design and technology. The analysis of Phase One data and the ensuing discussion had begun to unravel the complex picture concerning the motivational factors that had been identified during the literature review.

Phase Two was designed to carry out two tasks. Firstly it was designed to explicate the motivational factors further through observation of the pupil's ongoing activity during their GCSE Technology examination project. Secondly it was planned that out of the analysis of the data collected the picture concerning pupil motivation could be re-assembled. This was necessary in order that the researcher could suggest teaching and learning strategies that could help to alleviate the problem of de-motivation witnessed amongst many Key Stage 4 pupils.

As explained in the Method Section of this chapter the Phase Two sample of pupils was chosen using a questionnaire and a CSA test. The result from the CSA test showed that there was little difference in the proportion of verbalisers to imagers in the total sample. However, it was interesting to note a gender difference in that there was ten percent more imagers in the sample of girls and five percent more verbalisers in the sample of boys (Table 6.1).

	Verbaliser		Imager		Totals
	Boy	Girl	Boy	Girl	
Analytic	56% (25)	58% (07)	45% (18)	67% (10)	54% (60)
Wholist	44% (20)	42% (05)	55% (22)	33% (05)	46% (52)
Totals	53% (45)	44% (12)	47% (40)	56% (15)	100% (112)

Table 6.1 Indicates the cognitive style of the sample *(n = 112)* grouped by gender

When the wholist-analytic dimension was added to the equation the results were not as clear cut. There continued to be no significant difference in gender between wholist and analytic verbalisers, although, a gender difference between wholist and analytic imagers was noted. Sixty-seven percent of the girls and only forty-five percent of the boys were found to be analytic (Table 6.1).

	Boys Percentages	Girls Percentages	Total Percentages
Enjoyed and achieved	22% (19)	26% (7)	23.2% (26)
Enjoyed but couldn't achieve	14% (12)	15% (4)	14.3% (16)
Didn't enjoy but achieved	13% (11)	22% (6)	15.2% (17)
Didn't enjoy and couldn't achieve	51% (43)	37% (10)	47.3% (53)
Totals	100% (85)	100% (27)	100% (112)
Individual Column Chi Square	668.750	118.750	894.000
P - Value	<.0001	.0006	<.0001

A one sample *chi* - square test was carried out on the data obtained. Each column of data was dealt with separately. In the case of the boys results the value of x^2 was found to be significant at the 0.01% level for a two tailed test (x^2 = 668.750, *df* = 3), i.e. *p* ,<0.0001. In the case of the girls results the value of x^2 was found to be significant at the 0.06% level for a two tailed test (x^2 = 18.750, *df* = 3), i.e. *p* ,<0.0006. In the case of the total sample results the value of x^2 was found to be significant at the 0.01% level for a two tailed test (x^2 = 894.000, *df* = 3), i.e. *p* ,<0.0001 and so it was concluded that a significantly large number of pupils believed that they were poor at designing and did not enjoy the activity.

Table 6.2 Illustrates pupils *(n = 112)* perceived enjoyment and capability to achieve good results in their project work. The statistical test indicated that a significantly large proportion of the pupils believed that they were poor at designing and did not enjoy the activity

The results from the pupil questionnaire at the end of year 10 showed that at that time there was no statistically significant gender difference regarding pupils perceived ability or their enjoyment of designing. Although, a significant large number of the total sample believed that they were poor at designing and did not enjoy the activity. Fifty-one percent of the boys and thirty-seven percent of girls were found to be in this category (Table 6.2).

When the data regarding the pupil's perceived enjoyment of each aspect of the process from Phase One and Phase Two were combined, and the opinions of their teachers regarding their pupils enjoyment levels were added, it was interesting to note the similarities between the results. In support of the findings regarding rank order, both pupils and teachers gave high scores to the making aspects of the process and low scores to writing up reports for their project (Table 6.3 & Figure 6.12) although it should be said that teachers often misjudged their pupils' level of enjoyment of the process.

	The Process	Pupils 1993-4 *n = 179*	Pupils 1994-5 *n = 112*	Teachers *n = 8*
1	Selecting a project	2.93	2.39	3.29
2	Researching a project	2.59	2.49	2.71
3	Thinking of a number of ideas	2.63	2.53	2.86
4	Working out the chosen solution	2.92	2.71	2.43
5	Making the chosen solution	3.27	3.07	**3.86**
6	Making the chosen solution work	3.28	3.08	3.14
7	Using tools and equipment	**3.54**	**3.39**	3.71
8	Evaluating the project	2.47	2.02	2.00
9	Putting together a folio	2.73	2.56	2.71
10	Writing the report	*2.10*	*1.91*	*1.57*

Table 6.3 Indicates the mean scores for enjoyment of the various identified aspects of the process from three different samples. Pupils in 1993-4 (*n = 179*), Pupils in 1994-5 (*n = 112*) and the teachers (*n = 8*) in 1994-5. The maximum score possible is 4. The figures in bold indicate the highest mean score recorded for each sample

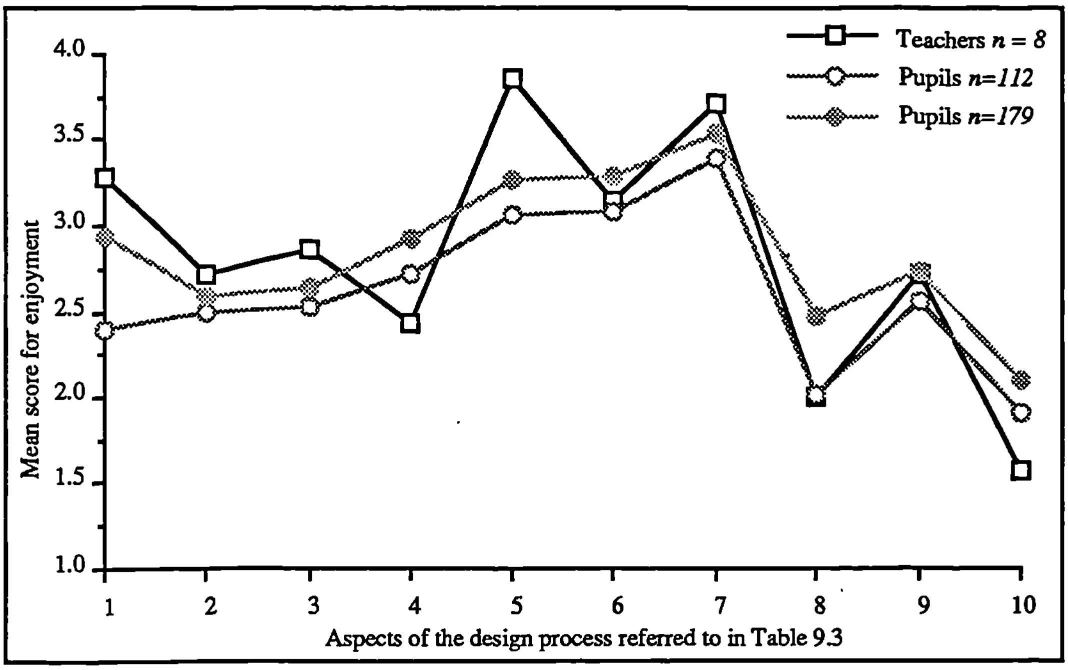


Figure 6.12 Presents a graph of the data from Table 6.3 regarding enjoyment of the process by the three different samples

When the data from the CSA test and the data concerning pupils enjoyment of the process of the total Phase Two sample of 112 pupils were combined, little gender difference was identified between verbalisers and imagers. However, when the 'perceived capability' factor was added to the analysis some differences were detected. A significantly large number of boy imagers believed that they were incapable of achieving good results whilst designing (Table 6.4). Girl imagers and both girl and boy verbalisers were evenly split with approximately half of each sample suggesting that they could design successfully and half believing that they could not.

	Verbalisers Boys	Verbalisers Girls	Imagers Boys	Imagers Girls	Totals	
Can	23	5	15	6	49	44%
Cannot	22	7	25	9	63	56%
Totals	45	12	40	15	112	100%
Chi Square	.500	2.000	50.000	4.500	98.000	
p - Value	.9590	.3146	<.0001	.0678	<.0001	

A one sample *chi* - square test was carried out on the data obtained. Each column of data was dealt with separately. In the case of the boys results the value of x^2 was found to be significant at the 0.01% level for a two tailed test ($x^2 = 50.000$, $df = 2$), i.e. p ,<0.0001 and so it was concluded that a significantly large number of boy imagers believed that they were incapable of achieving good results whilst designing.

Table 6.4 Indicates the perceived design ability of the pupils *(n = 112)*. The table also illustrates that a significant number of boy imagers believed that they were incapable of achieving good results whilst they were designing

Analysis of the data collected during the Case Study period helped to support, clarify and develop the researcher's understanding of the complex picture of de-motivation witnessed amongst Key Stage 4 pupil's during earlier phases of the research project. This analysis has been reported in sections in what is hoped will be a coherent manner for the reader.

The Effect of a Pupil's Creativity Level upon Motivation and the Strategies They Adopted Whilst Engaged in Project Work

As a result of earlier thoughts and conclusions during Phase One the researcher wrote a paper (Atkinson, 1994) indicating that there was a connection between a pupil's creativity level and the strategies pupils adopted whilst engaged in project work at key stage 4 Evidence collected during Phase Two confirmed this assumption. Observation of the pupils throughout their examination project work supported the researcher's belief that pupils could be separated into those who were creative and those who were not very creative and that within each of these categories there were two sub-groups (Figure 6.13). The inherently creative could be divided into those who were able to design within the constraints of the GCSE examination process model, and those who were inhibited by such a structured approach (Figure 6.14).

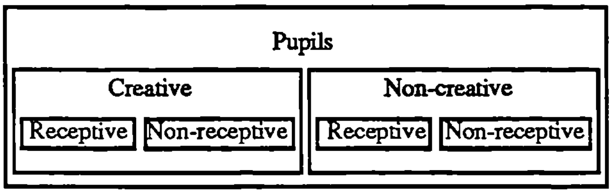


Figure 6.13 Illustrates the two categories and four subgroups into which pupils can be placed in terms of their creativity

In the second category, also to be seen in Figure 6.14, that encompassed the majority of pupils, there were those who were not creative nor were they receptive towards working with the design process model offered to them. This group were seen to become increasingly demotivated as the project work progressed. The other sub-group were willing to accept the design methodology taught although they too were not naturally creative. At the start of the project these pupils were motivated because they wished to produce satisfactory outcomes of which they could be proud. However, as time progressed they too became increasingly dissatisfied with the process they had been asked to adopt. This group tended to maintain their motivation by concentrating upon achieving a good examination result instead.

Observation of those who were inherently creative (at least insofar as that was measured here) but able to work within the constraints of the examination structure showed that they had the motivation to persevere however difficult the task became. Within the group who were creative but found the structure of the process inhibiting, there were those who failed to become involved in their work for the majority of the course and then, although demotivated, produced a good project at the last minute. There was also an equal number of pupils with high levels of creative ability who never came to terms with the approaches adopted. They failed to produce anything of merit ending up with no finished project and a sceptical view of the design process they had been expected to use.

The groups who were not naturally creative needed external encouragement to help them through the process. The progress of these groups was seen to be affected by a number of key factors specific to the task of designing and making. Factors such as a pupil's level of conceptual skills and both two and three dimensional modelling skills. The evidence from the research would suggest that the lynch pin that could cause these factors to fall into place for the pupil, was the teacher.

An enthusiastic, skilful teacher was able to help pupils to approach project work positively and achieve successful outcomes. The teacher needed to:

* have a thorough understanding of designing beyond the requirements of the examination assessment criteria;
* enhance and encourage creativity;
* deflect pupils from using inappropriate forms of modelling whilst designing;
* enable pupils to plan their manufacture processes in order that outcomes were produced that not only satisfied examination criteria but also produced products of which the pupils could be proud.

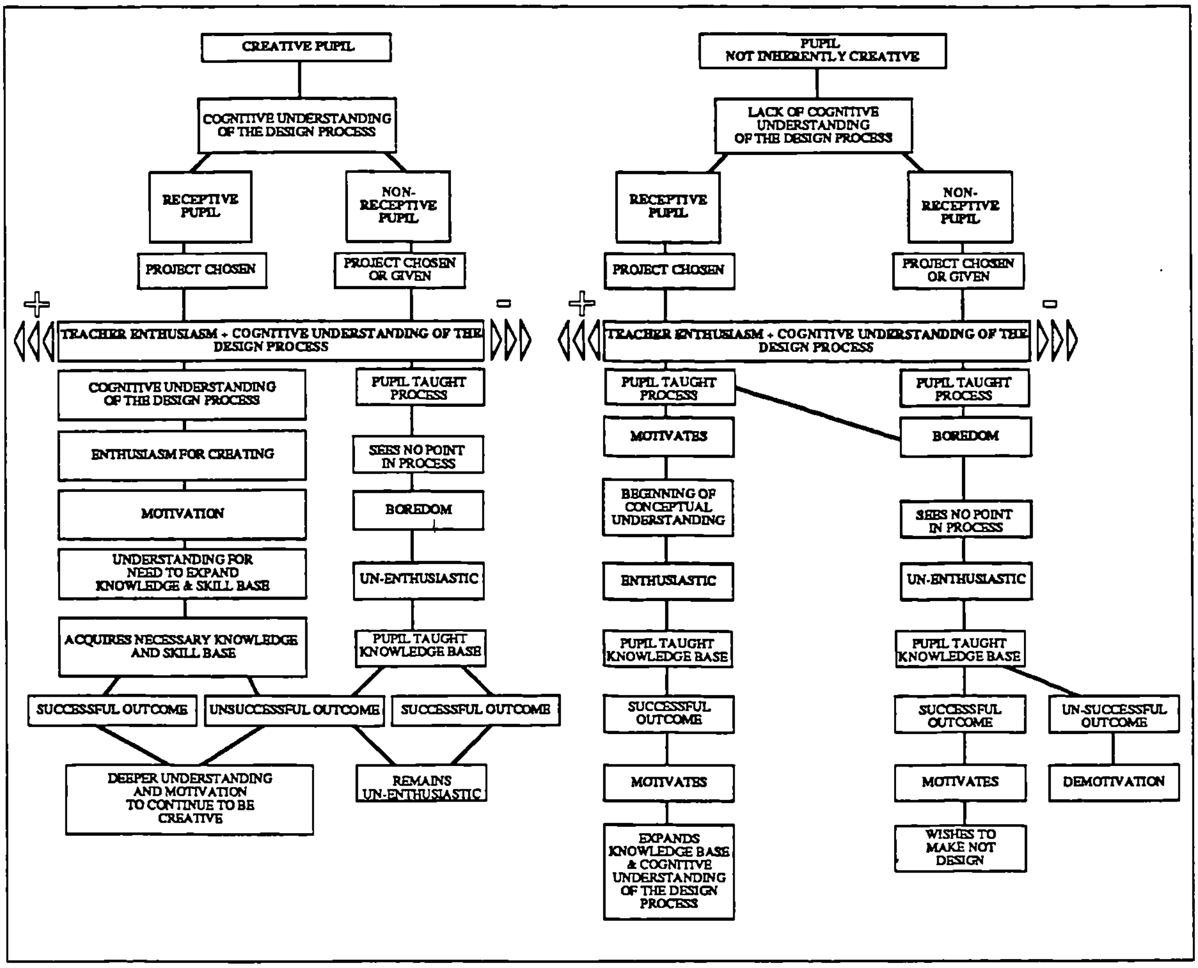


Figure 6.14 Illustrates diagrammatically the motivational pathways through the design process for those pupils who were creative and those who were not creative

It was also apparent that those pupils who had had adequate skills inputs during years 7 - 9 were able to tackle new processes and manufacturing techniques with more confidence than those for whom, during years 10 and 11, accuracy in even the most basic of manufacturing processes proved difficult.

Delivery Programmes

Observation throughout the duration of the examination project work also gave the researcher the opportunity to investigate the delivery programmes devised by each school to enable pupils to cover all the examination syllabus requirements. These took into account resources, staff specialisms, time-tabling restrictions, and whether Information Technology was to be examined as part of a GCSE examination, or assessed only to meet NC requirements. The programmes were also designed to give parity of time to units of work carried out by different teaching groups.

The delivery programmes adopted fell into three categories. Type one *(n = 2)*, devoted all of the technology lessons every week to completing one aspect of the syllabus before moving on to the next unit of work. Type two *(n = 3)*, split the technology time each week equally between Core and Extension work. Type three *(n = 3)*, integrated the Core and Extension work, devoting the majority of time in year 11 to a single project.

Each school followed examination guidelines concerning the number of teaching hours to be allocated to the design and technology project. However, the actual amount of time used for the project varied greatly from pupil to pupil. The differences being accounted for by the amount of 'extra' time pupils were willing to spend on their projects both at home and in school.

Project deadlines were managed differently in each school. Some schools displayed all the necessary completion dates at the beginning of the academic year, whilst in others project deadlines were not referred to until hand-in dates were imminent. Evidence from the study would suggest that these differences, when combined with the teaching strategies adopted by the schools, did have an effect upon the pupil's ability to manage their project work and upon their motivation to do so.

Approaches to Designing Adopted in Relation to the Observed Teaching Strategies
Through observation of approaches to designing adopted by the pupils it became apparent that teachers utilised one of two strategies to enable their pupils to meet deadlines and address the Examination Board's assessment criteria. Analysis of the two approaches suggested that in one the teacher tended to act as a collaborator, whilst in the other a more 'interventionist' mode of teaching was adopted (Figure 6.15).

No matter which teaching strategy was employed the start of the projects were seen to follow a similar pattern. Examination Boards suggested contexts and pupils identified their own opportunity or need to address. This was an important aspect of the process as it still gave the pupils ownership of their projects (Hennessy, S., McCormick, R. & Murphy, P. 1993; Kimbell, 1994). This freedom to choose their own projects having been identified as an important motivational factor in earlier phases of the research (Atkinson, 1994). Although it had also been established that to give too much freedom of choice led many pupils into choosing over-ambitious projects that were rarely completed

(Barlex, 1994). A context was observed to help give direction to pupils' thoughts and a framework within which teachers could advise pupils to operate.

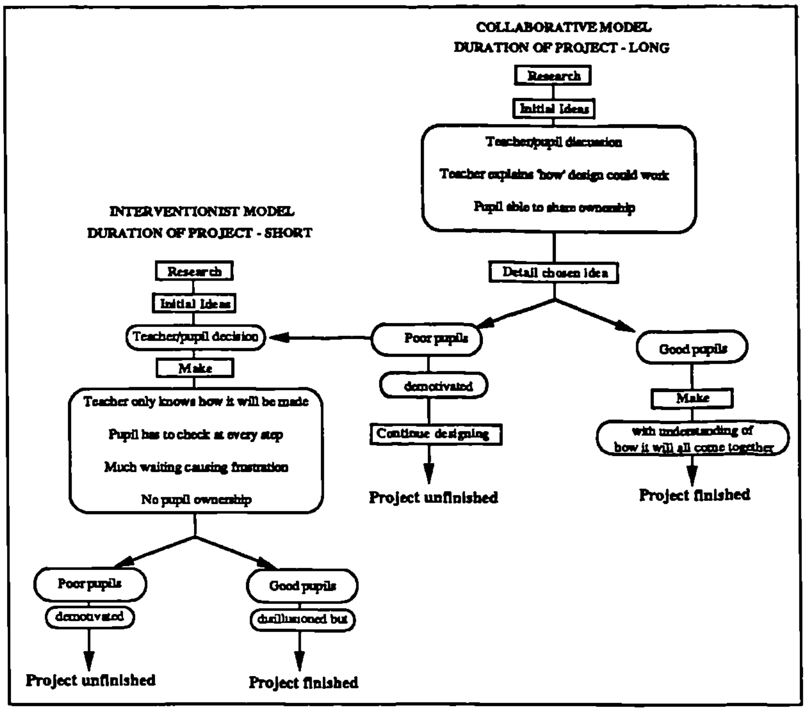


Figure 6.15 Illustrates the model of the two teaching strategies that were adopted in the schools observed in Phase Two

All teachers discussed examination criteria, and then work was begun on briefs, specifications, analysis of the chosen brief and research. Observation of the sample indicated that girls enjoyed this aspect of the project more than boys. This finding supported the APU research of 1991 (APU, 1991). The girls tended to feel safe working within the reflective, evaluative research and analysis phase whilst the majority of the boys were looking forward, past the design activity, to the manufacturing period ahead.

All pupils were encouraged to carry out research and analyse their findings in order to devise a specification for their outcome. However, in the researcher's opinion too much time was given to inappropriate research in the majority of schools. In an attempt to provide research materials for the pupils who were unwilling or unable to acquire their own, teachers supplied catalogues, magazines, text books, and in some instances CDROMs. Catalogues and magazines for pupils to carry out their market research, text books for information on materials and processes and CDROMs mainly for historical and background information. The 'cut and paste Argos catalogue' style of research and the copying of pages of diagrams and explanatory notes on a wide variety of materials and processes provided pupils with unchallanging areas within which to work. They made little attempt to analyse whether the collected data was appropriate to the task in hand. As the teacher provided it then the pupils considered it must be appropriate. Evaluative annotations were found to be limited due, in part, to the inappropriateness of the data collected. Evidence would suggest that many pupils became bored and demotivated by the perceived irrelevance of research and the fact that they wished to make progress to the manufacturing stage of the process.

At the initial ideas stage of the project in each school pupils formulated several ideas to meet the requirements of the brief. The amount of time allocated to this section of the work varied considerably depending upon which delivery programme had been adopted by the school. In some schools early ideas were a series of hurried sketches whilst in others a number of sheets were presented with re-worked drawings and carefully prepared notes. On the whole, whether pupils were only given a short or a long time to complete this aspect of the process, they were enthusiastic as they were able to use their creative abilities without the constraints of having to know how they would make their ideas work. Very few boys and even fewer girls concerned themselves at this stage with the intricacies of constructional details regarding how their ideas could be manufactured.

Once initial ideas had been drawn, the next observed stage was for the pupil to choose which idea to develop. This was normally carried out with the teacher's assistance. Through a combination of observation and discussion five separate factors were identified that influenced the advice teachers gave to the pupils: the teachers' personal technological capabilities; their understanding of how each different idea could or could not be manufactured given the school resources; the amount of time available; the teacher's knowledge of the pupil's manufacturing capability; the teacher's personal vision of what they believed was represented on the pupils design sheet.

It was at this point in the process that the important differences between the two teacher strategies became evident. In schools where teachers utilised an 'interventionist' approach, where speed was crucial, pupils tended to move very quickly from initial ideas to the manufacturing stage. Very few pupils produced carefully detailed drawings. Development of the chosen idea was carried out as manufacturing took place.

Ill defined, but often in the context of the pupils existing technological or constructional understanding, adventurous ideas meant that pupils were working in areas which were beyond their technological capability. It was at this point that these pupils lost ownership of their idea. Decisions were made in a piecemeal, interventionist, manner by the teacher. In an attempt to support all pupils throughout this aspect of their work teachers were seen to develop a strategy in which they designed solutions to pupil's problems in their heads, as the need arose. This resulted in pupils having to rely heavily upon the teacher during the manufacturing stage of the process. The common belief that ownership develops a sense of responsibility, pride, and the motivation to succeed was ignored. Often, even capable pupils were unable to take the next step on their own due to the nature of the design process adopted. Teachers became overburdened and frustrated by pupils needing their help.

It was also during this stage that a difference was noted between the reaction of boys and girls to the 'interventionist' model. Girls tended to cope with the lack of ownership of their idea. They did not expect to understand how to tackle the constructional or technical facets of their project. They expected to be shown how to turn their ideas into reality. These girls showed mastery patterns of behaviour (Dweck & Leggett, 1988) with regard to designing, they saw the project as a learning experience or, were able to accept it as a necessary part of their GCSE examination in which they wished to do well. In order to make the necessary progress they tended to make use of extra sessions throughout the manufacturing stage of the project. This they saw as an opportunity to obtain more individual attention from their teacher.

On the other hand, the less motivated girls as Dweck & Leggett (1988) suggested, showed helpless patterns of behaviour. They became disillusioned by their lack of progress, rarely taking advantage of the extra sessions provided. During lesson times they tended to turn their attention to their design folder in order to try to meet the examination criteria as best they could.

In contrast all boys tended to became frustrated with their inability to make progress. The less able boys seemed to become resigned to the situation, making less and less effort as time slipped by. The majority of the more able boys became very impatient. They found it difficult to cope with their lack of control when they were unable to solve manufacturing or technical problems for themselves. One boy expressed the frustration of many when he said *"I am sick of waiting for my turn; I just don't know what to do next"*. Those who were highly motivated did make progress by attending extra sessions when, like the girls, the teacher could give them more individual attention. Others turned to their peers to see how they had completed tasks. Some simplified their ideas until they no longer became a challenge or a learning experience. Many made and re-made pieces of their project, altering their designs to fit their mistakes.

In schools adopting the 'interventionist' model a disappointingly large number of pupils failed to finish their projects by the given deadline. This applied to sixty-seven percent of the boys and sixty-four percent of the girls (Table 6.5). In some schools no extra time was given to complete the deficient aspects of the project, whilst in others pupils were given the opportunity to continue working on them in their own time. Out of this group those who were motivated continued with their projects, although as a number of pupils said *"...only because it is for the examination"*.

	Interventionist Model				Collaborative Model			
	Boys		Girls		Boys		Girls	
Complete	33%	(7)	36%	(4)	60%	(9)	67%	(2)
Unfinished	67%	(14)	64%	(7)	40%	(6)	33%	(1)
Total	100%	(21)	100%	(11)	100%	(15)	100%	(3)

Table 6.5 Illustrates the percentage of boys and girls *(n = 50)* in schools adopting either interventionist or collaborative teaching strategies who completed their projects

In schools where teachers exhibited what has been defined as the 'collaborative' model (Figure 6.15), a pupil's lack of time management skill was not seen as a problem in the early stages of the project. Time was given to individual pupil-teacher discussions. Both boys and girls benefited from this situation. Sketches were often used by the teacher when unclear communication of pupil ideas needed exploring. Detailing of the chosen idea became a 'collaborative' effort between pupil and teacher, with pupils still feeling that they had ownership of their idea. With the help of their teacher they produced carefully detailed drawings which they used in order to make their products.

The majority of those who succeeded in reaching the manufacturing stage of their project were able to complete their work in time for assessment. In the case of the boys, this they achieved with minimum intervention from the teacher. Those pupils who lacked the expertise to realise their products were able to make the necessary progress in collaboration with their teacher. However, when the initial deadline for completion of the projects arrived there were still thirty-nine percent of the sample who failed to finish. For these pupils the problems associated with this model came about through boredom. From a fairly early stage these pupils, particularly the boys and the less able girls, saw the design process stretching interminably ahead of them. The need for interim goals in long term projects was rarely addressed. The manufacturing stage which pupils looked forward to seemed an impossible target to reach. This caused a noticeable slowing down of work rates that only exacerbated the situation. Deadlines came and went.

For some of these pupils, usually those who were disruptive, the teacher moved from the 'collaborative' to 'interventionist' model believing that once involved in making the pupil's interest would be rekindled. However, as has already been pointed out, the 'interventionist' model was rarely successful at the manufacturing stage of the process, with the teacher's availability at each step being essential for the maintenance of the pupil's progress. With large class sizes, and the teachers understandable wish to help the motivated pupils, this was usually impossible, causing these pupils to become even more frustrated and demotivated.

In the total sample ninety-five percent of pupils reached the manufacturing stage by the time the work was assessed. Although, the majority of products produced displayed a lack of craftsmanship or fitness for purpose and many of them were unfinished. When assessment time was reached the majority of finished projects had required pupils to use extra hours of non-timetabled time, after the hand-in-date, in order to complete the manufacturing process. The important stage of evaluation of the outcome was tackled almost as an afterthought and was poorly carried out by the majority of pupils. This was partially due to the lack of any time given to this activity and partially due to the inadequate help given by the teachers with this aspect of the process.

The Correlation Between Performance and the Various Factors

The connection between motivation and performance in examinations is well documented. The belief that behaviour is controlled by the pleasure-pain principle in which people maximise the pleasure linked to success and minimise the pain generated by failure (Weiner,1992) would support the expectation that many of the pupils targeted for this research study would be motivated by their desire to achieve good results in their examinations.

Once the schools had marked the GCSE examination project work and the marks had been moderated it was possible for the next stage of analysis to take place. The first step was to establish whether the marks given to the individual members of the sample were representative of a larger population than the relatively small sample involved in this research study. In order to do this the moderated project work marks for the total sample were entered onto a graph (Figure 6.16). The distribution of marks was then checked against the normal distribution curve achieved by the total candidature for the GCSE Technology examination and found to be similar (NEAB, 1995).

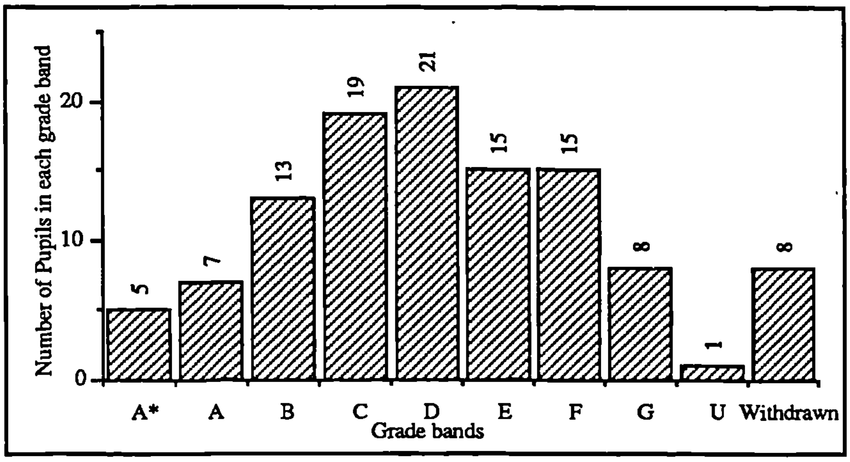


Figure 6.16 Illustrates the distribution of grades for the total sample *(n = 112)*

The data collected during Phase Two allowed five separate correlations to be targeted for discussion. Firstly, the correlation between sampling factors, completion rates and final marks for the project work were assessed. Secondly, clarification was sought regarding the relationship between strategies adopted by teachers, the design process used by pupils, and performance levels in design and technology project work. Thirdly, the correlation between pupil performance and skill levels was investigated. Fourthly, the relationship between creativity and performance levels during design and technology examination project work were examined. Finally, the data collected was analysed using goal orientation and motivation as the grouping categories. These have each been discussed separately in the first instance although it is recognised that in the 'real world' of the classroom all these factors are inextricably intertwined.

The Relationship Between Sampling Factors, Completion Rates and Performance
Analysis of the data collected suggested that gender, pupil type and perceived ability to achieve satisfactory outcomes affected how successfully pupils were able to tackle project work. When the result of completion or non-completion of projects was correlated with the sampling matrix referred to in Figure 6.5, interesting clusters were observed (Figure 6.17). Those pupils who believed that they could design had more chance of completing their projects than those who believed they could not. When cognitive style was used as a starting point, a high proportion of analytic-verbalisers were found within the group of pupils who believed that they could design, whether they enjoyed designing or preferred making. Verbalisers were found to have an equal, and in several instances, better completion rate than imagers. Whilst, it was also noted that one hundred percent of those who preferred making and believed they could not design failed to complete their projects, whether they were verbalisers or imagers.

Design methodologists suggest that designing should be an holistic experience (NC, 1988; APU,1991; NEAB,1993; Kimbell, 1994; Chidgey 1994) and that imaging is central to the development of ideas (APU,1991, Down, 1986; Liddament, 1993; Barlex, 1994; Garner,1994). However the data collected indicated that those pupils who were imagers and wholists were the ones who achieved the poorest results (Table 6.6). Whilst, those who were analytic whether they were imagers or verbalisers tended to achieve high marks. Through analysis of the data collected the researcher was able to identify and quantify the reasons for these features of the results.

As drawing is such an important aspect of designing one might have expected verbalisers to achieve significantly lower marks for their projects than imagers. However, this was not the case using evidence from the well established CSA test (Riding, 1991).

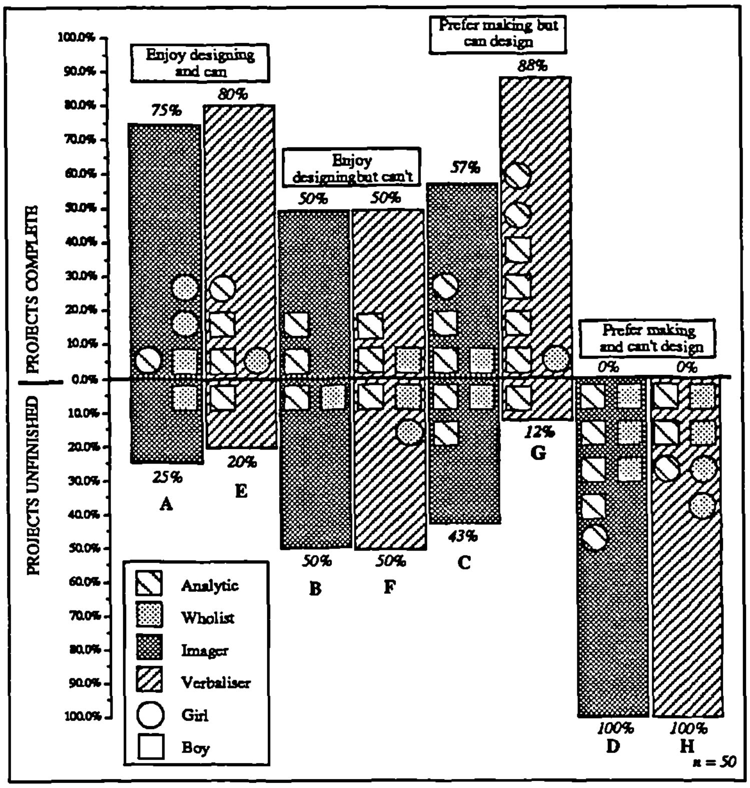


Figure 6.17 Illustrates pupils *(n = 112)* completion and non-completion of their project work when grouped by the sampling matrix found in Figure 6.5

Observation of the pupils working, scrutiny of their design sheets and analysis of the data suggested an explanation for this. Not all imagers were able to draw well. In the sample only forty-six percent of imagers believed they had satisfactory drawing skills, whilst during observation only twenty-one percent were actually found to have adequate skills in this aspect of the process. Nor could the majority of imagers rely upon their writing skills as these were generally found to be unsatisfactory.

Average Mark	Enjoyed designing and can		Enjoyed designing but can't		Prefered making and can design		Prefered making and can't design	
	Analytic	Wholist	Analytic	Wholist	Analytic	Wholist	Analytic	Wholist
Verbalisers	75 (%)	67 (%)	40 (%)	22 (%)	64 (%)	45 (%)	43 (%)	39 (%)
Imagers	88 (%)	48 (%)	62 (%)	20 (%)	66 (%)	36 (%)	32 (%)	28 (%)
	Maximum Mark = 100							

Table 6.6 Illustrates the average mark achieved by the sample*(n = 112 minus eight pupils who were withdrawn from the examination)* grouped by the selection of sample factors

For those imagers who avoided writing the ongoing analysis and evaluation of their ideas was either carried out in their heads or hidden in subtle forms within their drawn images. Access to a pupil's immediate thoughts at the time of the conception of ideas is impractical, nor is it easy to credit these thoughts objectively at a later date during the assessment process. In comparison, those who were verbalisers communicated their thoughts in a form that was more easily interpreted by teachers during assessment, thereby gaining them valuable marks.

On the second point regarding the holistic nature of designing, analysis of the design processes adopted supported the researcher's explanation for the low mean score of wholists. In order to ensure that pupils met each of the assessment criteria, teachers were seen to split the process into easily managed units of work. Observation showed that these were tackled often in isolation before the next aspect of the process was discussed. The holistic nature of the process was therefore fragmented, thus playing into the hands of those who were analytic.

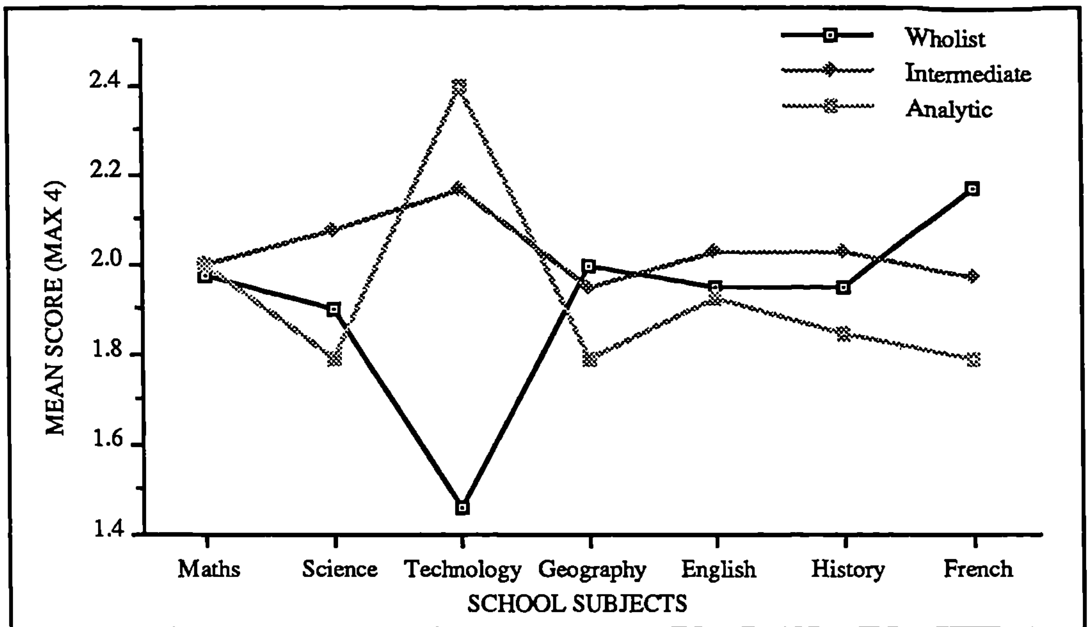
When the relationship between results, selection of sample factors and gender were analysed it could be seen that in all but one category the mean percentage achieved by the girls was considerably higher than the mean percentage achieved by the boys (Table 6.7). This supported the general trend that Riding & Pearson (1994) had identified in their paper concerned with the relationship between cognitive style and intelligence (Figure 6.18). However, it is recognised that the proportion of girls to boys in the research sample is uneven and therefore no statistically sound conclusions should be drawn from the data collected in this instance (Figure 6.19).

	Average Mark	Enjoyed designing and can		Enjoyed designing but can't		Prefered making and can design		Prefered making and can't design	
		Analytic	Wholist	Analytic	Wholist	Analytic	Wholist	Analytic	Wholist
Boys	Verbalisers	71 (%)	58 (%)	40 (%)	21 (%)	68 (%)	43 (%)	39 (%)	35 (%)
n = 85	Imagers	-	34 (%)	62 (%)	20 (%)	62 (%)	34 (%)	32 (%)	24 (%)
Girls	Verbalisers	94 (%)	84 (%)	-	23 (%)	33 (%)	57 (%)	51 (%)	53 (%)
n = 27	Imagers	88 (%)	70 (%)	-	-	70 (%)	50 (%)	34 (%)	44 (%)

Maximum Mark = 100

Table 6.7 Illustrates the average mark achieved by the sample *(n = 112, minus eight pupils who were withdrawn from the examination)* grouped by gender and the selection of sample factors

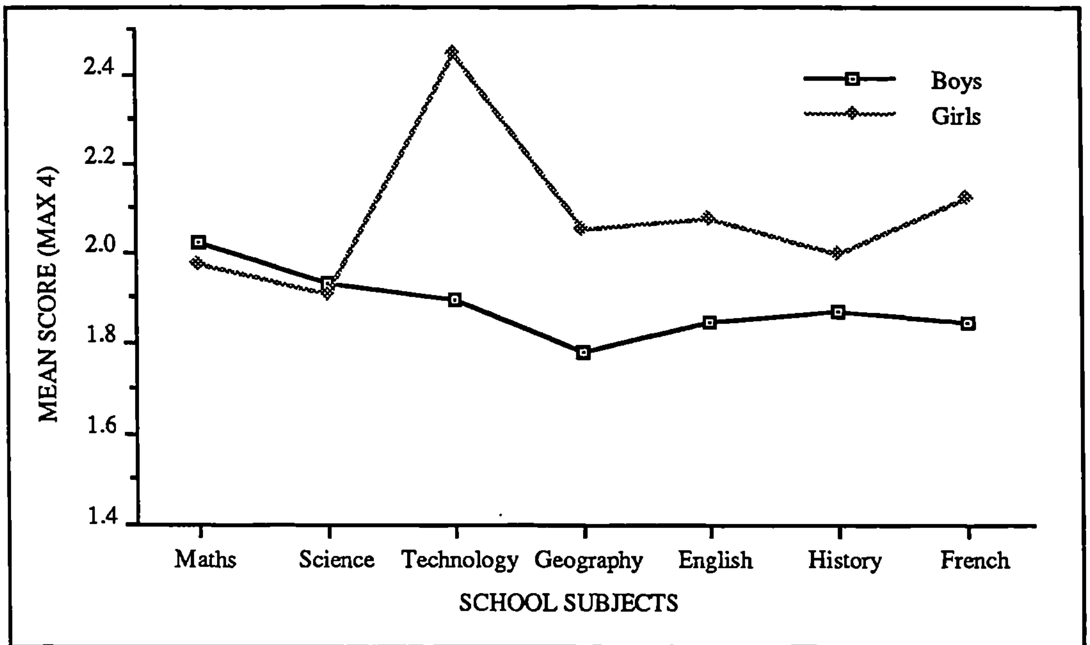
When the relationship between the mean scores for the GCSE Technology and wholist/analytic style were compared with the mean marks achieved in the six school subjects identified in Riding's study interesting comparisons could be made. Technology was found to be the only subject in which analytic pupils had such marked success compared to wholists (Figure 6.19).



MEAN SCORES FOR PERFORMANCE IN SEVEN SUBJECTS & WHOLIST-ANALYTIC STYLE

Style	Maths	Science	Technology	Geography	English	History	French
Wholist	1.975	1.900	1.459	2.000	1.950	1.950	2.175
Intermediate	2.000	2.075	2.167	1.950	2.030	2.030	1.975
Analytic	2.000	1.790	2.400	1.790	1.850	1.850	1.790

Figure 6.18 Illustrates the wholist-analytic cognitive style and subject performance *(n = 119 except in technology where n = 112).* The statistics for Maths, Science, Geography, English, History, French are taken from:Riding, R.J. & Pearson, F. (1994)*The Relationship between Cognitive Style & Intelligence*

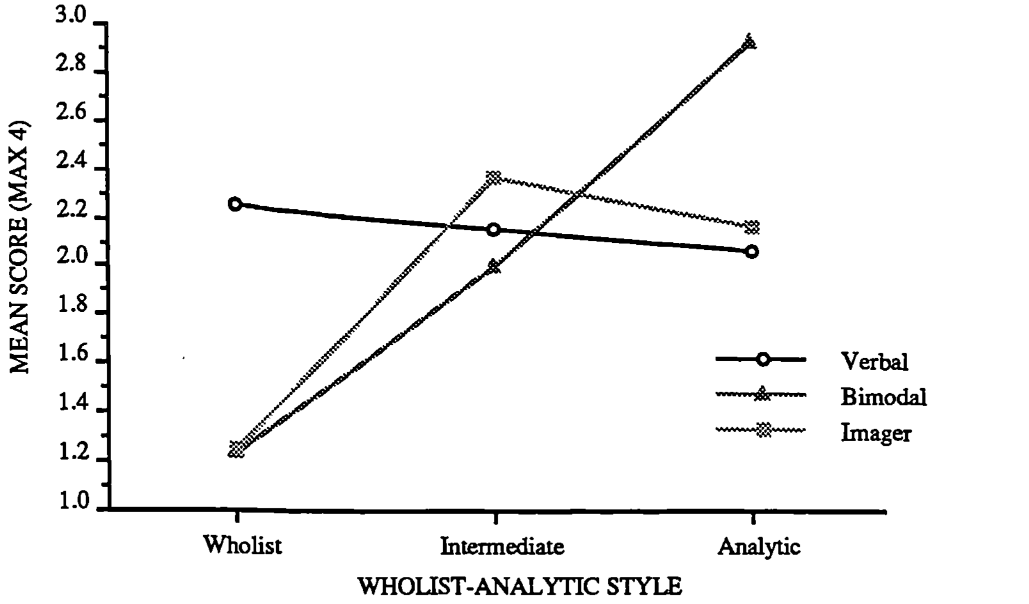


MEAN SCORES FOR PERFORMANCE IN SEVEN SUBJECTS BY GENDER

Gender	Maths	Science	Technology	Geography	English	History	French
Boys	2.025	1.930	1.894	1.780	1.850	1.870	1.850
Girls	1.975	1.910	2.444	2.050	2.075	2.000	2.125

Figure 6.19 Illustrates the differences in subject performance when grouped by gender *(n = 119 except technology where n = 112).*. The statistics for Maths, Science, Geography, English, History, French are taken from:Riding, R.J. & Pearson, F. (1994)*The Relationship between Cognitive Style & Intelligence*

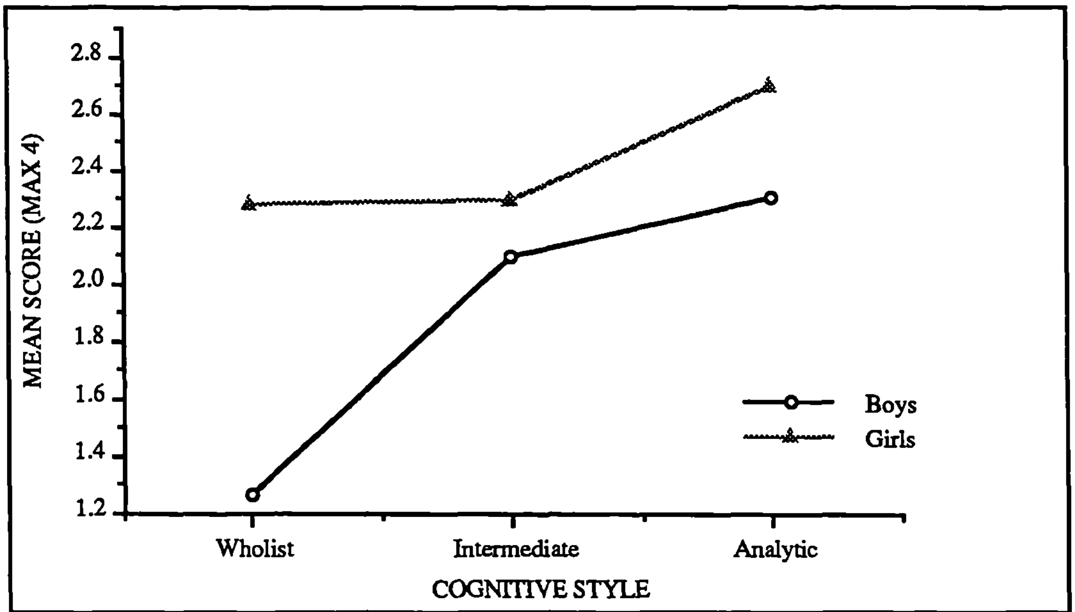
Bimodal pupils, those equally able to use and interpret both imagery or verbal modes of presentation displayed a positive relationship between the wholist/analytic dimension and mean performance scores. Those pupils who were wholist and bimodal achieved a very much lower mean score than analytic/bimodal pupils. Those pupils belonging to the analytic/bimodal category managed to achieve the highest mean score of all the cognitive style categories. The mean scores for verbalisers showed little difference between those who were wholists through to those who were analytic. Whilst imagers, who found themselves at the centre of the wholist/analytic dimension, achieved the highest mean score for imagers (Figure 6.20).



MEAN SCORES FOR PERFORMANCE AND COGNITIVE STYLE

Cognitive Style	Wholist	Intermediate	Analytic
Verbal	2.250	2.167	2.077
Bimodal	1.235	2.000	2.933
Imager	1.250	2.375	2.176

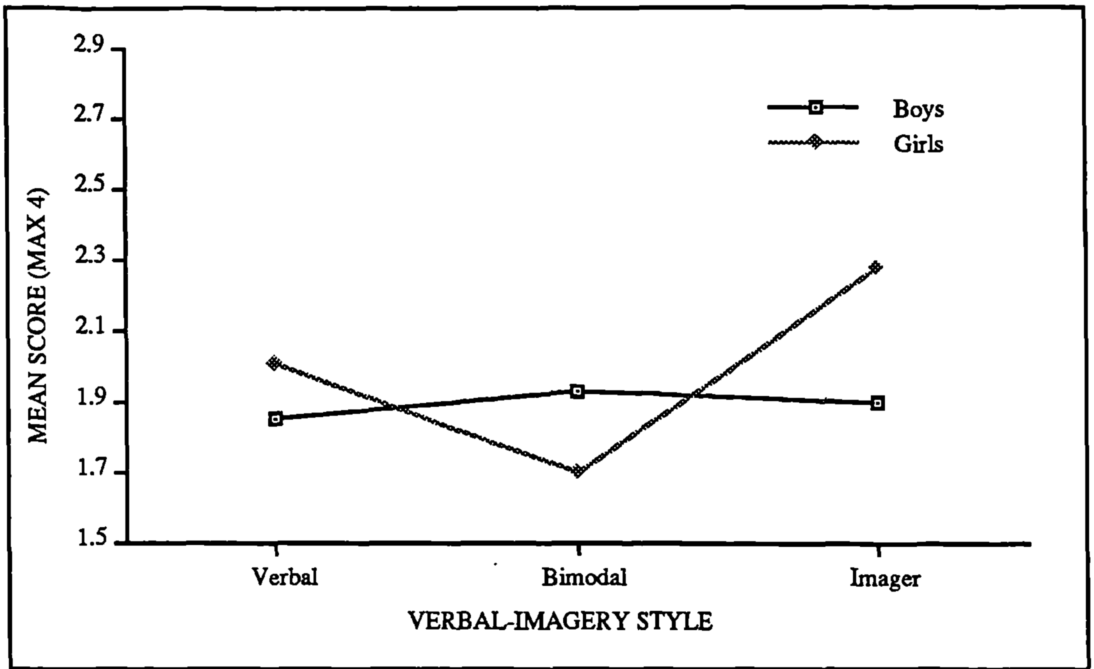
Figure 6.20 Illustrates the relationship between cognitive style and mean scores for performance of the pupils *(n = 112)* during Phase Two



MEAN SCORES FOR PERFORMANCE, GENDER & WHOLIST/ANALYTIC STYLE

Cognitive Style	Wholist	Intermediate	Analytic
Boys	1.267	2.100	2.314
Girls	2.286	2.300	2.700

Figure 6.21 Illustrates the relationship between wholist-analytic style, gender and mean scores for performance of the pupils *(n = 112)* during Phase Two.

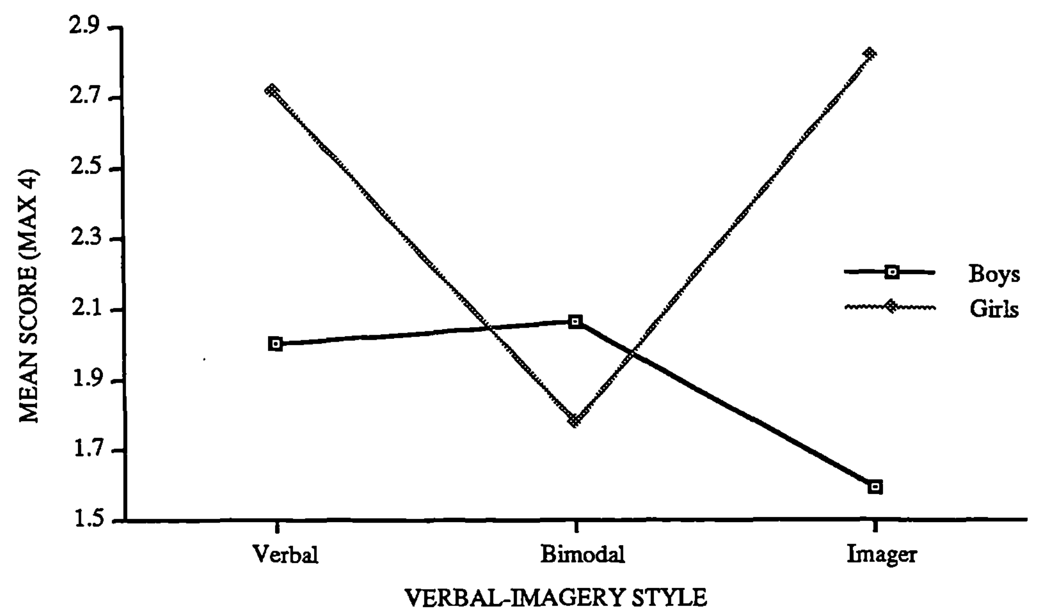


MEAN SCORES FOR PERFORMANCE IN 6 SUBJECTS, GENDER & VERBAL-IMAGERY STYLE

Gender	Verbal	Bimodal	Imager
Boys	1.850	1.930	1.900
Girls	2.010	1.700	2.275

Figure 6.22 Illustrates the mean performance of pupils *(n = 119)* in six subjects when they are grouped by both gender and verbal-imagery cognitive style. The data is taken from the statistics for Maths, Science, Geography, English, History, French found in: Riding, R.J. & Pearson, F. (1994)*The Relationship between Cognitive Style & Intelligence*

When considering the verbal/imagery dimension it was found that in support of Riding' & Pearson's findings (Figure 6.22) the pattern for boys was a mirror image of that for girls when performance was measured against that dimension (Figure 6.23). In the case of the wholist/analytic dimension no such mirror image existed. Girls' mean scores were all higher than those achieved by the boys although in the cases of Intermediate and Analytic pupils both genders followed a fairly similar pattern. This was not the case with pupils who were found to be Wholists. In this instance girls' performance did not drop as dramatically as the boys (Figure 6.21). However, once again the sample size prevents these results from being of statistical interest.



MEAN SCORES FOR TECHNOLOGY PERFORMANCE, GENDER & VERBAL-IMAGERY STYLE

Gender	Verbal	Bimodal	Imager
Boys	2.000	2.062	1.593
Girls	2.714	1.778	2.818

Figure 6.23 Illustrates the relationship between verbal-imagery style, gender and mean scores for performance of the pupils *(n = 112)* during Phase Two

The Relationship Between Teacher Strategies, the Process Adopted, Performance and Motivation

The second correlation, between delivery programmes and strategies adopted by teachers and the design process utilised by pupils during their design and technology project work, provided some interesting results. Using evidence collected during the observation period an analysis of the teaching strategies adopted by the eight case schools indicated that there were three schools who had utilised 'collaborative' approaches and five schools who had utilised 'interventionist' strategies. These had been used as a means of delivering design and technology project work. The two approaches adopted have already been discussed, although relationships between the factors need further clarification.

Evidence would suggest that the speed of the process used by schools adopting an 'interventionist' approach failed to provide pupils with enough time for the maturation of thoughts and ideas at each stage of the process. Although pupils in schools where 'collaborative' strategies were used had the same amount of time for their projects, the evidence would suggest that the spread of this time over months rather than weeks allowed pupils access to this important maturation time. 'Collaborative' approaches also gave teachers time to familiarise themselves with pupils projects. This enabled them to prevent some of their pupils from making unwise design decisions. Whereas many teachers using 'interventionist' strategies were found to be frustrated by their inability to prevent design disasters occurring.

When each of the individual aspects of the design process were viewed in isolation the structured nature of the 'interventionist's' approach was seen to be more successful during early written sections of the project, although, this advantage was not sustained into the design and manufacturing stages (Table 6.8). As was anticipated during observation of the pupils at work, the 'collaborative' approach produced better design strategies in such aspects of the process as initial ideas, detailing the chosen idea, planning for manufacture, and the manufacture of the product itself (Table 6.8). All are aspects in which thinking time was an important factor.

As far as design folders were concerned very few were completed without considerable pressure having been applied by the teachers. Motivated girls and boys in all schools were persuaded to re-work or 'pretty-up' existing work and fill gaps in their design process. The limited time spent on the folder work in the 'interventionist' model meant that the folders, of even those who believed that they could design, presented little evidence of designerly thought at the various stages of the process. In an attempt to present the required evidence for assessment, pupils were encouraged to complete written sections describing their decision making procedures. This was often carried out retrospectively in the pupils own time when they were pulling their design folders together. This method of working gave pupil's an inaccurate message regarding the need for a sound design process in order to achieve the optimum solution to a need.

The design work of those working in schools where a 'collaborative' approach had been adopted displayed two different levels of success within their folders. Those who enjoyed the act of designing produced visually excellent folders which contained creative thinking but also a considerable amount of re-worked and over-worked sheets. Those who did not enjoy designing produced numerous sheets of work attempting to satisfy the examination criteria but showing little evidence of designerly thought and progression in design.

Aspect of the Process	Interventionist Mean	Collaborative Mean
Specification & Analysis	2.355	1.867
Research	2.387	2.000
Initial ideas	1.806	2.200
Detailing chosen idea	1.935	2.867
Planning	1.355	2.067
Manufacture	1.900	2.600
Product	1.645	1.933
Evaluation	1.710	1.800
	Maximum Score = 4	
FINAL MARK SHOWN AS MEAN PERCENTAGES & SCORES		
	Mean %	Mean Score
Collaborative	43.067	1.667
Interventionist	51.844	2.219
Total	49.043	2.027

The individual pupil scores were calculated using the marks achieved in the GCSE technology project work. These were converted into a score using the following formula: 0 - 30 = 1; 31 - 50 = 2; 51 - 70 = 3; 71 - 100 = 4.

Table 6.8 Indicates the differences in the mean scores achieved by pupils for each of the selected aspects of the process in schools adopting the two teaching strategies, 'interventionist' and 'collaborative'

With regard to completion rates, analysis of the data showed that seventy-three percent of those pupils who were entered for the examination in schools that had adopted a 'collaborative' approach to designing and only thirty-five percent of pupils in schools that had adopted an 'interventionist' approach, finished their projects by the schools' initial deadline (Table 6.9). By assessment time this picture had been improved by the majority of schools adopting an 'interventionist' strategy. In these schools pupils were encouraged to finish projects in their own time. This was made possible because project deadlines were set earlier in the academic year than assessment deadlines. In all the schools adopting a 'collaborative' approach hand-in dates had been set to coincide with assessment deadlines thus leaving little flexibility for the few unfinished projects to be completed. This lack of time after the hand-in date may have been one of the reasons why sixteen percent of the sample in schools adopting 'collaborative' approaches in comparison to only three percent of the sample in schools adopting 'interventionist' approaches, were not entered for the examination.

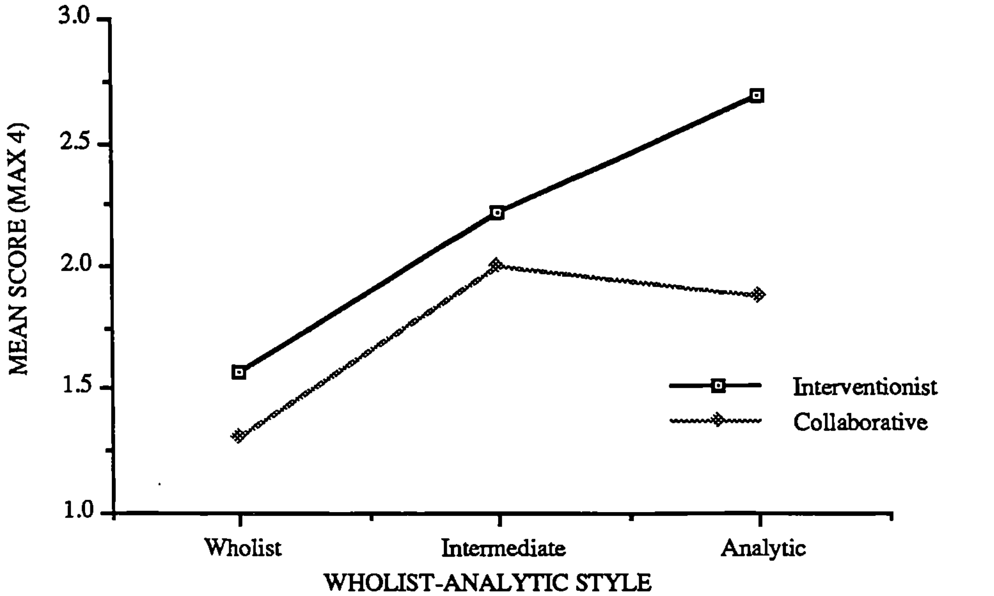
	Collaborative Model		Interventionist Model		Totals
Complete	11	73%	11	35%	22
Unfinished	4	27%	20	65%	24
Total Entered	15		31		46
Pupils Not Entered	3	16%	1	3%	4
Total Sample	18		32		50

Table 6.9 shows the project completion rate for pupils *(n = 50)* in schools in which 'collaborative' and 'interventionist' teaching strategies had been adopted

However, no matter which strategy had been adopted, a disappointing feature of the majority of the products produced was their poor quality both in terms of design and manufacture. No pupil, working with a teacher who had adopted an 'interventionist' approach to designing, could be said to have produced a product that was well designed and well manufactured.

Analysis of the three delivery programmes and two strategies adopted by the schools, indicated that neither the 'collaborative' nor the 'interventionist' model were entirely successful. When the relationship between the two teaching strategies and examination results for the project work were analysed it was found that the mean scores for both groups were disappointingly low, although the data showed that a higher mean score had been achieved by pupils in schools where an 'interventionist' approach had been adopted (Table 6.8). The collected evidence supported the researcher's belief that neither strategy allowed pupils to develop entirely valid approaches to designing. The nature and speed of the process in schools utilising 'interventionist' approaches did not allow for the development and detailing of creative, innovative ideas. On the other hand the slowness of the process, particularly at the design stage, in schools adopting a 'collaborative' model caused pupils to become overly concerned with the process at the expense of well designed outcomes. Analysis of feedback from pupils after they had finished their examination projects showed that although some pupils were able to obtain satisfaction from achieving success in the examination, the vast majority of pupils were sceptical about the validity of the process they had undertaken.

Analysis of the relationship between cognitive style, performance and teaching strategy can be found in Figure 6.24 and Figure 6.25. These provided a clear picture in schools adopting a 'collaborative' approach to designing. In these schools flexible pupils who were not found at the extremes of either cognitive style dimension achieved the highest mean scores. Whereas in schools adopting an 'interventionist' approach to designing the data displayed a positive correlation between the wholist/analytic dimension and performance. Analytic pupils were found to benefit from the fragmented approach to the process that was adopted in these schools. They achieved the highest mean scores (significantly higher than analytic pupils in schools adopting a 'collaborative' approach - see Table 6.10) whilst wholists who were unable to cope as easily with the fragmentation, achieved low mean scores. Verbalisers, who found it easy to use retrospective written evidence in order to make up for a lack of time devoted to the drawn aspects of the process were also found to be more successful in schools using the 'interventionist' model (see Table 6.11).



MEAN SCORES FOR PERFORMANCE & WHOLIST-ANALYTIC STYLE, TEACHER STRATEGY

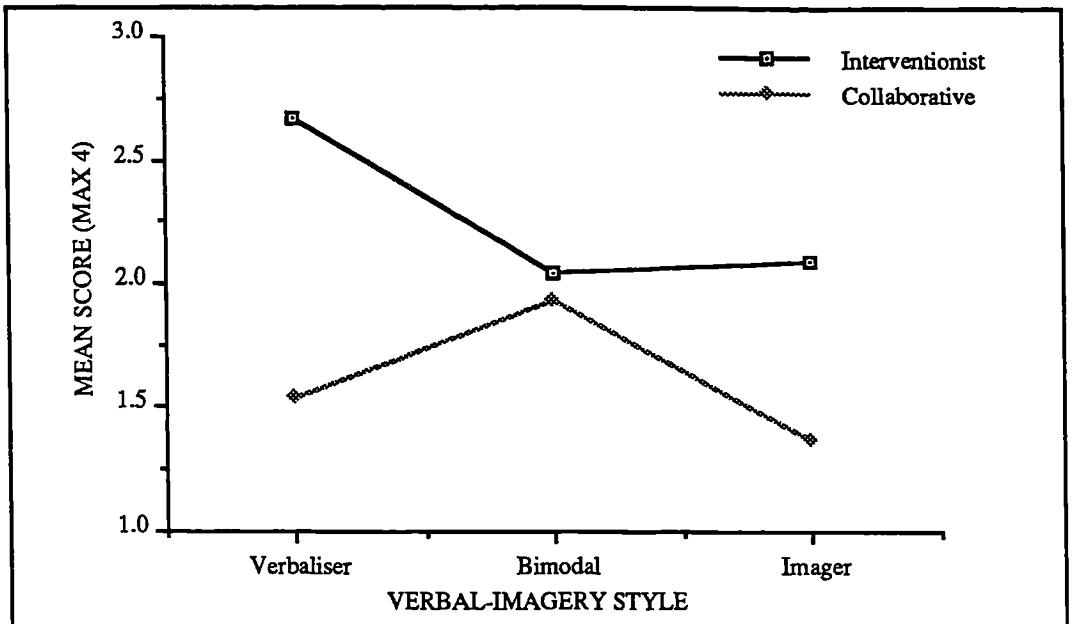
Teacher Strategy	Wholist	Intermediate	Analytic
Interventionist	1.571	2.217	2.690
Collaborative	1.312	2.000	1.875

Figure 6.24 Illustrates the effect of a combination of wholist-analytic cognitive style and teaching strategy upon pupils *(n = 50)* subject performance in design and technology at Key Stage 4

Teaching Strategy	Count	Mean	Variance	Std Dev.	Std. Err.
Collaborative	16	1.875	1.450	1.204	.301
Interventionist	29	2.690	1.365	1.168	.217
Mean diff.		-.815			
df		43			
t - Value		-2.215			
p - Value		.0321			$n = 45$

The mean score for analytic pupils in schools using an Interventionist approach was found to be higher than in schools using a collaborative approach. The difference was significant at the $p = 0.03$ level (two tailed t test; $t = -2.215$, $df = 43$).

Table 6.10 Provides statistical analysis in the form of an unpaired *t*- test for analytic pupils, teaching strategies and subject performance. The mean score for analytic pupils in schools using an 'interventionist' approach was found to be significantly higher than for analytic pupils in schools were a 'collaborative' approach had been adopted



MEAN SCORES FOR PERFORMANCE, VERBAL-IMAGERY STYLE, TEACHER STRATEGY

Teacher Strategy	Verbaliser	Bimodal	Imager
Interventionist	2.667	2.040	2.100
Collaborative	1.533	1.938	1.375

Figure 6.25 Illustrates the effect of a combination of verbaliser-imager cognitive style and teaching strategy upon pupils (*n = 50)* subject performance in design and technology at Key Stage 4

Teaching Strategy	Count	Mean	Variance	Std Dev.	Std. Err.
Collaborative	15	1.533	.838	.915	.236
Interventionist	18	2.667	.706	.840	.198
Mean diff.		-1.133			
df		31			
t - Value		-3.705			
p - Value		.0008			*n = 33*

The mean score for verbaliser pupils in schools using an Interventionist approach was found to be higher than in schools using a collaborative approach. The difference was significant at the p = 0.0008 level (two tailed t test; t = -3.705, df = 31).

Table 6.11 Provides statistical analysis in the form of an unpaired *t*- test for verbaliser pupils, teaching strategies and subject performance. The mean score for verbaliser pupils in schools using an 'interventionist' approach was found to be significantly higher than for verbaliser pupils in schools where a 'collaborative' approach had been adopted

The Relationship Between Pupil Skills, Performance and Motivation

In all schools in the sample, the lack of skills and understanding regarding materials and processes lay at the root of many of the pupil's problems during both the design and the manufacturing stage of their project work. Pupil's ideas, when carried through to the manufacturing stage, caused many of them to work beyond their technological capability. In an attempt to support all pupils throughout this aspect of their work teachers were seen to develop a strategy in which they designed solutions to pupil's problems in their heads, as the need arose. The necessity for pupils to have an understanding of the way forward was given a low priority. This was particularly the case in those schools adopting an 'interventionist' approach where time was at a premium. However well intentioned this course of action may have been, the evidence from this study would suggest that it had a de-motivating effect upon many of the pupils, particularly the boys. Observation would suggest that girls tended to cope with the lack of ownership of their idea. They did not expect to understand how to tackle the constructional or technical facets of their project. They expected to be shown how to turn their ideas into reality. The more able girls saw the project as a learning experience or, were able to accept it as a necessary part of their GCSE examination in which they wished to do well. In order to make the necessary progress they tended to make use of extra sessions through out the manufacturing stage of the project. This they saw as an opportunity to obtain more individual attention from their teacher. However, the common belief that ownership develops a sense of responsibility, pride, and the motivation to succeed would support the use of strategies that would allow all pupils to retain ownership of their idea throughout the project.

MEAN SCORES FOR PERFORMANCE & SKILL LEVEL IN DRAWING AND WRITING

	Drawing skills	Writing skills
Poor skill	1.720	0.778
Average skill	2.700	2.148
Good skill	2.800	3.286

Figure 6.26 Illustrates the effect of drawing skills and writing skills upon pupils *(n = 50)* ability to perform well in their project work

The correlation between specific communication skill levels (as measured, by the researcher, in the design folios produced for the examination) and performance can be found in Figure 6.26. When looked at in isolation it can be seen that writing skills have a positive correlation with performance, pupils who have poor writing skills achieve poor results and pupils with good writing skills achieve good results (see Table 6.12).

Communication Skill	Count	Mean	Variance	Std Dev.	Std. Err.
Good writing skills	14	3.286	1.297	1.139	.304
Poor writing skills	9	0.778	0.444	0.667	.222
Mean diff.		2.508			
df		21			
t - Value		5.954			
p - Value		<.0001			$n = 23$
The mean score for pupils with good writing skills was found to be higher than the mean score for pupils with poor writing skills. The difference was significant at the $p = <0.0001$ level (two tailed t test; $t = 5.954$, $df = 21$).					

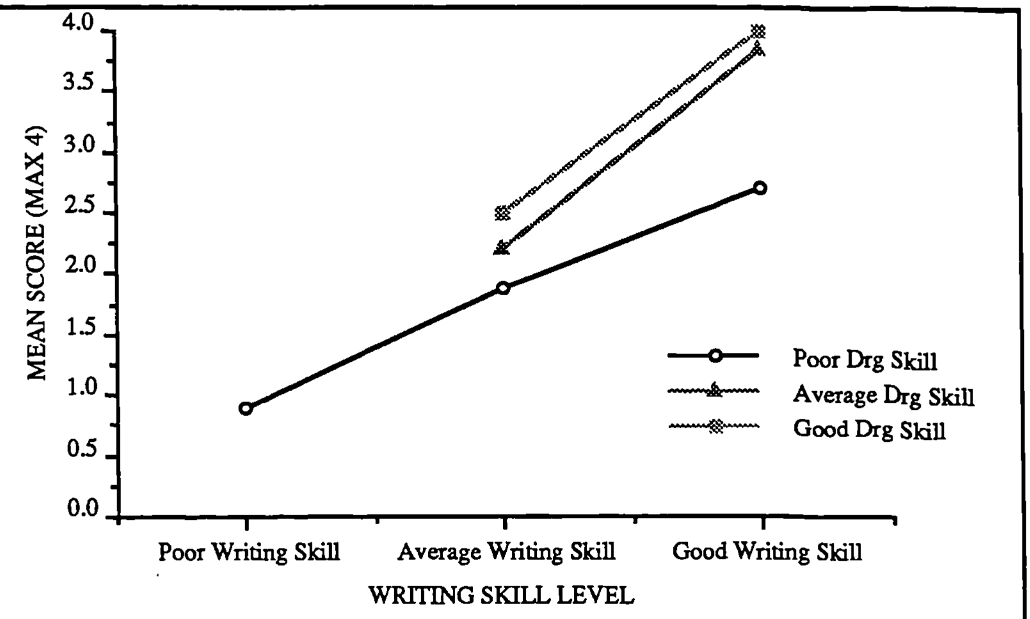
Table 6.12 Provides statistical evidence in the form of an unpaired *t* - test that indicates a significant difference between the mean project score of those pupils who had poor writing skills and those who had good writing skills

It can also be seen that pupils with poor writing skills achieve poorer results than pupils who have poor drawing skills (see Table 6.13). Pupils with good writing skills tend to achieve better results than pupils who have good drawing skills although this was not found to be significantly so in the small sample tested at this stage of the research project. Conversations with teachers during the observation period supported the researcher's belief that there is a tendency for performance in the GCSE examination project to be governed by a pupil's ability to write rather than a pupil's ability to draw. The over use of writing as a means of providing evidence for assessment purposes was also seen to exacerbate the motivational problems encountered by those pupils who had inadequate literary skills.

Communication Skill	Count	Mean	Variance	Std Dev.	Std. Err.
Poor drawing skill	25	1.720	1.460	1.208	.242
Poor writing skill	9	.778	.444	.667	.222
Mean diff.		0.942			
df		32			
t - Value		2.207			
p - Value		.0346			
The mean score for pupils with poor writing skills was found to be lower than the mean score for pupils with poor drawing skills. The difference was significant at the $p = <0.0346$ level (two tailed t test; $t = 2.207$, $df = 32$).					

Table 6.13 Provides statistical evidence in the form of an unpaired *t* - test that indicates a significant difference between the mean project score of those pupils who had poor writing skills and those who had poor drawing skills

When the scores for communication skills were combined it was found that pupils with poor writing skills were only found in the group of pupils who also had poor drawing skills (Figure 6.27). Whereas pupils with poor drawing skills could be found at each writing skill level. The mean scores for pupils with average writing skills increased a small amount as their drawing skills improved. Unfortunately the size of the individual cells illustrated in Figure 6.27 prevented statistical analysis of the data although visually the graph added support to the belief that writing skills were of importance in achieving good examination marks. The mean scores for those who had good writing skills showed that having good writing skills and only average drawing skills still enabled pupils to achieve high marks in GCSE Technology examination project work.



MEAN SCORES FOR PERFORMANCE AND COMBINED SKILL LEVELS

	Poor drg skills	Average drg skills	Good drg skills
Poor writing skills	0.900	-	-
Average writing skills	1.875	2.214	2.500
Good writing skills	2.714	3.833	4.000

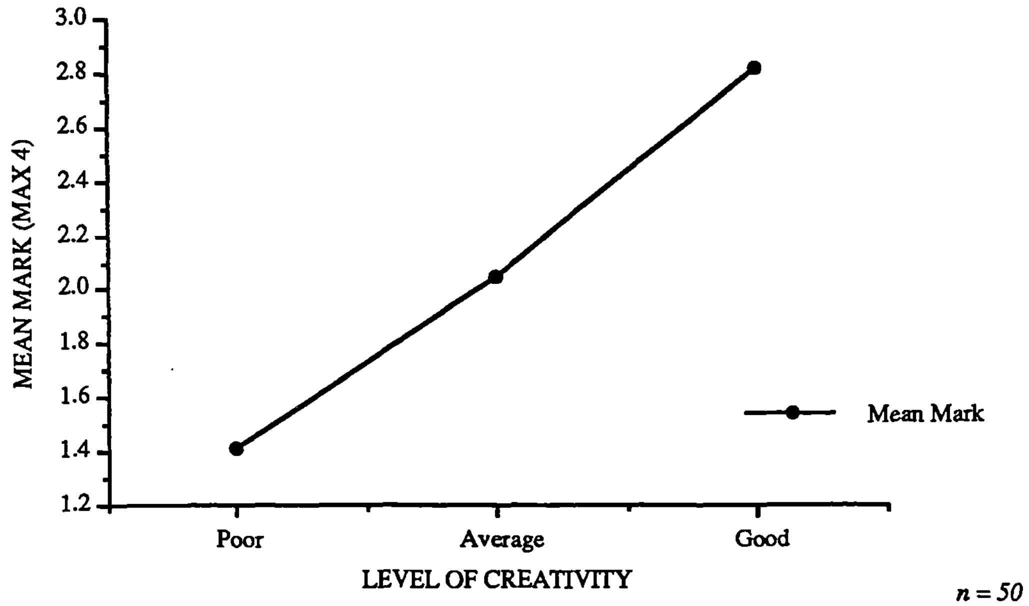
Missing data: Pupils with poor writing skills were only found in the group of pupils who had poor drawing skills.

Figure 6.27 Illustrates the effect that a pupils' *(n = 50)* combination of drawing and writing skills have upon their ability to perform well in their project work

Very few pupils were seen by the researcher to have either average or good manufacturing skills whilst they were making their examination projects. When the relationship between manufacturing skill levels and examination results were assessed it became obvious that poor manufacturing skills had little effect upon overall results. An explanation for this was found when examination assessment criteria were analysed (NEAB,1993; SEC, 1993). On average the examination boards involved in this research, only allocated six percent of the marks to this aspect of a project. The major thrust of the marks awarded in the making section were given for planning rather than carrying out the manufacturing process itself. In the majority of cases this planning was done retrospectively once all the mistakes had been made and folios were being pulled together.

The Relationship Between Creativity and Performance

For the fourth targeted correlation of data during phase two of the study, the relationship between creativity and pupil performance in the examination project work was analysed. The effect of creativity levels upon pupils strategies have already been discussed earlier in this chapter. However, for statistical analysis to take place, specific data was required regarding each pupil's level of creativity. This had been obtained using a combination of two creativity tests. One of these had been identified through a search of the relevant literature (De Carlo,1983), whilst the other was based on the PhD. work of Oxleigh in 1993.



MEAN SCORES FOR PERFORMANCE & CREATIVITY

	Poor Level	Average Level	Good Level
Performance Mean Score	1.412	2.048	2.818

Figure 6.28 Illustrates the effect of a pupil's creativity level upon performance

Above a certain level, intelligence and IQ scores have been shown to have little correlation with levels of creativity (e.g. Osche, 1990). However, the notion that creative thinking requires high levels of motivation and persistence has much support (e.g.Osche, 1990; Sternberg, 1988; Fisher, 1990; Torrence ,1988). There is also a widely held belief that any activity which involves imagination and originality benefits from creative thinking (Fisher, 1990; Torrence, 1988). It was therefore not surprising, in the context of this research, to find a direct correlation between a pupil's level of creativity and performance (Figure 6.28) whilst at the same time demonstrating the validity of the measures used to assess creativity levels. When the data for the total sample was scrutinised it was found that those who were creative achieved a high mean score in their project work whilst those who were not creative achieved a low mean score.

Within the collected data it was noticed that there were some pupils whose project work results did not conform to this pattern. Out of the sample of fifty pupils there were seven who were assessed as creative and yet they achieved very low project marks. Whilst at the other end of the spectrum there were another seven pupils who had been identified as not very creative who achieved very high marks in their projects (see Table 6.14).

	Number of Pupils	Mean creativity score	Mean project work mark
Creative but achieved Low Marks	7	3.571	22.429
Not Creative but achieved High Marks	7	1.714	76.143

In this sample of pupils the mean project work mark for pupils who were not creative was found to be higher than the mean project work mark for pupils who were creative. The difference was significant at the $p = <0.0001$ level (two tailed *chi* - test; *chi* - square= 1442.597 $df = 1$). $n = 14$

Table 6.14 Indicates the mean scores and creativity levels for those pupils ($n = 14$) with marks for their GCSE project work that did not conform to the expected pattern

In order to identify why these pupils did not conform to the expected pattern an analysis was carried out using the collected data concerning these pupils. Each of the identified factors was used in turn as a starting point for analysis. It was hoped that by doing so the researcher would be able to highlight the reasons for the inconsistencies. It was important to establish what was causing those pupils who were not creative to be motivated enough to achieve high marks and those pupils who were very creative to be demotivated enough not to wish to achieve a more satisfactory conclusion to their projects.

In the first instance, data concerning the teaching strategies adopted by each of the schools of the targeted pupils was referred to. However, this analysis did not provide a clear picture of any differences (Table 6.15). It was found that in both groups motivated and non-creative and demotivated creative pupils were fairly evenly distributed between schools adopting both 'collaborative' and 'interventionist' approaches to the project work and in any case, the numbers involved were small.

	Creative but achieved a Low Score	Not creative but achieved a High Score
Interventionist	3	4
Collaborative	4	3
Total	7	7

Table 6.15 Illustrates the number of pupils who were creative and achieved a low score in their project work ($n = 7$) and those pupils who were not creative and achieved a high score in their project work ($n = 7$). The table also indicates whether the pupils were taught in a school that adopted a 'collaborative' or 'interventionist' teaching strategy

For the next analysis the mean score awarded to pupils for their ability to achieve good results in each identified aspect of the process involved in their project work was used.

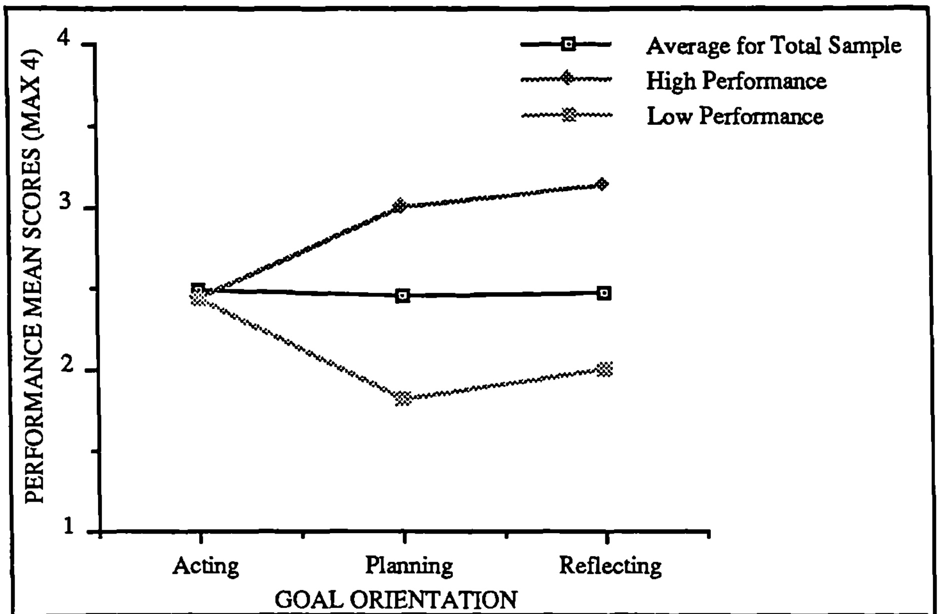
Aspect of the Process	Creative but achieved a Low Score	Not creative but ahieved a High Score
Specification & Analysis	1.429	3.571
Research	1.143	3.286
Initial ideas	1.143	3.000
Detailing chosen idea	1.571	3.429
Planning	1.000	2.286
Manufacture	1.714	2.857
Product	1.000	2.143
Evaluation	0.857	2.143
	Maximum Score = 4	
FINAL MARK SHOWN AS MEAN PERCENTAGES & SCORES		
	Mean %	Mean Score
Creative but Low Mark	22.429	1.286
Not Creative but High Mark	76.153	3.429
Total	49.043	2.027

Table 6.16 Shows mean scores for each aspect of the process achieved by those pupils who did not conform to the expected pattern of results in their GCSE project work

This analysis held no surprises. (see Table 6.16). The majority of mean scores were found to be lower for those who were creative and demotivated than for those who were not. Although an analysis of the data collected in the initial questionnaire did highlight some interesting differences between the fourteen targeted pupils. In line with Weiner's (1992) work on motivation, the data showed that for these two sub-groups their belief, or otherwise, in their own ability, prior to the examination project work, corresponded with their actual performance in that project work. The data showed that all seven of those who achieved high marks but had low creative scores had displayed 'mastery' patterns of behaviour (Dweck & Leggett, 1988). They had believed before they began their projects that they were capable of achieving good results, even though four of them suggested that they disliked rather than enjoyed project work. Whilst in the case of the other sub-group, those who were creative but achieved low marks, only two had believed that they could achieve sound results in their project work. The data also showed that all seven of the pupils in this sub-group had specified that they did not enjoy the project work they were asked to carry out during their design and technology lessons. Again numbers were small so caution is needed in arriving at conclusions.

The Relationship Between Goal Orientation and Performance

As has already been explained, the final sample of fifty pupils had been asked to complete a goal orientation index. This was based on Atman's work regarding goal accomplishment and was chosen as it was seen as relevant to this research study (Atman, 1986, 1993).



	Average Mean scores for total Sample $n = 50$	Mean Scores for those who achieved Low Marks $n = 16$	Mean Scores for those who achieved High Marks $n = 16$
Acting	2.489	2.438	2.438
Planning	2.444	0.981	3.000
Reflecting	2.467	0.966	3.125

Figure 6.29 Illustrates the mean scores achieved by pupils for their GCSE project work when grouped by goal orientation characteristics

Once these indexes were completed the evidence was analysed in a variety of ways. In order to do this the mean scores of the total sample for reflecting, planning and acting were calculated. The first analysis involved a three way comparison. The mean scores achieved by the total sample of fifty pupils, the mean scores achieved by those who had achieved high scores in the project work and the mean scores of those who had accumulated low scores were each used. As can be seen from Figure 6.29, pupils Goal Orientation Index indicated that their ability to 'act' remained constant whichever group they belonged to. However, with regard to results for 'planning' and 'reflecting' there were significant differences between those who performed well and those who did not (Table 6.17 and Table 6.18). The Goal Orientation Index results indicated that those pupils who had achieved high marks for their project work were capable of planning and reflecting whilst those who achieved low marks struggled with these aspects, particularly with their ability to plan. This latter result could possibly help to explain why so many of the pupils from the group achieving poor marks failed to complete their work by the initial deadline.

Performance Level	Count	Mean	Variance	Std Dev.	Std. Err.
High performance	16	3.000	1.333	1.155	.289
Low performance	16	1.125	0.783	0.885	.221
Mean diff.			1.875		
df			30		
t - Value			5.155		
p - Value			<.0001		

The mean 'Planning' score for High performance pupils was found to be higher than the score for Low performance pupils. The difference was significant at the p = <0.0001 level (two tailed t test; $t = 5.155$ $df = 30$). $n = 32$

Table 6.17 Shows an unpaired t - test of the mean scores for the goal orientation characteristic - planning, achieved by the sixteen high performance pupils and the sixteen low performance pupils

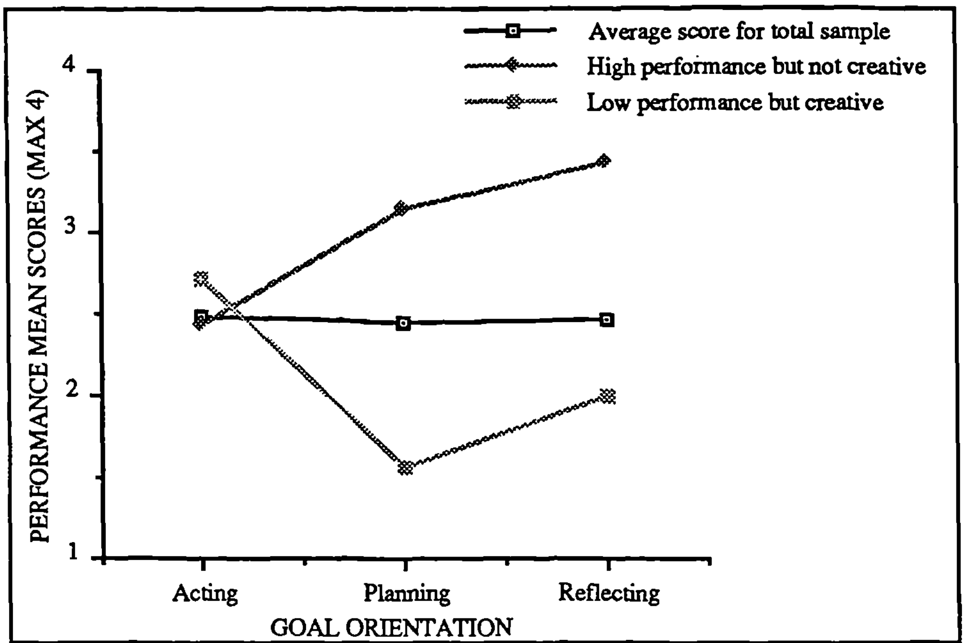
Performance Level	Count	Mean	Variance	Std Dev.	Std. Err.
High performance	16	3.125	0.917	0.957	.239
Low performance	16	1.312	1.163	1.078	.270
Mean diff.			1.812		
df			30		
t - Value			5.028		
p - Value			<.0001		

The mean 'Reflecting' score for High performance pupils was found to be higher than the score for Low performance pupils. The difference was significant at the p = <0.0001 level (two tailed t test; $t = 5.028$, $df = 30$). $n = 32$

Table 6.18 Shows an unpaired t - test of the mean scores for the goal orientation characteristic - reflecting, achieved by the sixteen high performance pupils and the sixteen low performance pupils

The Relationship Between Goal Orientation, Creativity and Performance

Whilst still targeting goal orientation the next analysis added the creativity levels of each pupil to the equation. Once again those pupils who were creative but had achieved poor marks and those pupils who were not creative but had achieved high marks were identified (Figure 6.30). This analysis provided some interesting points for discussion. As in the earlier analysis, both these groups obtained an average mean score for 'acting'. However, those who were creative but achieved a low mark achieved a lower than average mean score for 'reflecting' (see Table 6.19) and an extremely low mean score for 'planning' (see Table 6.20). Whilst those who were not creative but achieved a high mark achieved a high mean score for 'planning' and an even higher mean score for 'reflecting'. As already discussed, planning and reflecting have been shown to be important skills in design and technology project work. This would suggest that, for the group of pupils with low creativity scores, their ability to plan and manage their time had helped them



	Mean scores for total Sample $n = 50$	Mean Scores for those who were creative but achieved Low Marks $n = 7$	Mean Scores for those who were not creative but achieved High Marks $n = 7$
Acting	2.489	2.714	2.429
Planning	2.444	1.571	3.143
Reflecting	2.467	2.000	3.429

Figure 6.30 Illustrates the mean scores achieved by pupils in their project work grouped by pupils who were not creative although they achieved high scores and pupils who were creative although they achieved low scores

meet both interim and final deadlines. Whilst at the same time, their ability to reflect had supported them throughout the design process. This was particularly noticeable in their evaluative comments, both ongoing and summative. With evidence of evaluative thinking being highly rewarded at the assessment stage it was hardly surprising that these pupils achieved high marks in their GCSE design and technology project work.

Performance Level	Creativity	Count	Mean	Variance	Std Dev.	Std. Err.
High performance	Low	7	3.429	0.286	0.535	.202
Low performance	High	7	2.000	0.667	0.816	.309
	Mean diff.	1.429				
	df	12				
	t - Value	3.873				
	p - Value	.0022				

The mean 'Reflecting' score for High performance pupils who were not creative was found to be higher than the score for Low performance pupils who were creative. The difference was significant at the $p = 0.0022$ level (two tailed t test; $t = 3.873$, $df = 12$). $n = 14$

Table 6.19 Shows the unpaired t - test of the mean score for the goal orientation characteristic - reflecting for pupils who were either uncreative although they performed well in their project work or were creative and performed poorly in their project work

Performance Level	Creativity	Count	Mean	Variance	Std Dev.	Std. Err.
High performance	Low	7	3.143	0.810	0.900	.340
Low performance	High	7	1.571	0.619	0.787	.297
Mean diff.		1.571				
df		12				
t - Value		3.479				
p - Value		.0046				

The mean 'Planning' score for High performance pupils who were not creative was found to be higher than the score for Low performance pupils who were creative. The difference was significant at the $p = 0.0046$ level (two tailed t test; $t = 3.479$, $df = 12$). $n = 14$

Table 6.20 Shows the unpaired t - test of the mean score for the goal orientation characteristic - planning for pupils who were either uncreative although they performed well in their project work or were creative and performed poorly in their project work

Analysis of observations made during the project work, regarding individual members of these two sub-groups, highlighted certain factors that impinge upon this research topic. Of those pupils who were not creative but had achieved high marks in their project work it was noted that throughout the project work they were each willing to put in many extra hours on their folio work both in school time and at home. They were each seen to follow the prescribed design process that had been suggested to them by their teachers and they had all addressed each specified section in a thorough, although not often creative manner.

During the researcher's visits to the schools it had been noticed that each of these targeted pupils had received greater attention from their teachers than had other members of their class. This was particularly evident during practical sessions and when folio work was being pulled together. However, the researcher could appreciate the reasons for this. The pupils were motivated. They were receptive towards their teacher's inputs and gave their teachers opportunities to demonstrate their capabilities. Both pupils and teachers were seen to build excellent relationship with one another. Positive reinforcement of each others activities was seen to enhance the situation during observation sessions.

However, a disappointing, although not unexpected fact that came out of the discussion between the researcher and this targeted group of pupils, was that even though they had the satisfaction of achieving high marks for their projects they were very sceptical about the value of the process they had adopted. They believed that the amount of extra time they had devoted to their design and technology project work had meant that they had not spent as much time on homework for other subjects. They also resented their lack of free time to be with their friends who were not studying design and technology at GCSE level. A number referred to parental concerns regarding the excessive amount of homework design and technology project work engendered. The pupils were also very disappointed with the outcomes that they had produced. Very few of the products that they had made were of use either to the pupils themselves or to the specific client for whom they had been designed.

With regard to the group who were creative but achieved poor results, as has already been mentioned, these pupils found the structured approach prescribed by their teachers to be inhibiting. Their creative thoughts wished to take them far beyond the bounds of their personal technological capabilities and the mundane nature of the tasks set did not inspire them. During the observation period the researcher also noticed that out of the seven pupils in this sub-group, five of them did not relate well to their teacher. Although it was also observed that only two of them became class nuisances as their projects failed to progress. In order to avoid working, these pupils developed various strategies to occupy their time. They were often observed helping others solve problems with their projects, going to the library in search of information, re-doing early research sheets, looking for lost work, quietly doing very little or in some instances completing homework for other subjects during their design and technology lessons.

Whilst still targeting goal orientation a further analysis of the data was carried out using two new categories of pupil taken from the original sample. In this instance it concerned those who scored very highly on the goal orientation index and yet achieved low marks in their project work. As a comparison the analysis also concerned those pupils who achieved a low score on the goal orientation index and yet managed to achieve a high mark for their project work. Unfortunately, the numbers found in these two categories were too small for statistical analysis. However, it did give the researcher a new perspective on the possible reasons why certain capable pupils were demotivated and achieved low marks and why other pupils who were expected to gain low marks, managed to be motivated enough to achieve high marks.

Only two pupils were found in the category that scored highly on the goal orientation index and yet did not obtain high marks. Both of them were boys. They had very similar profiles (Table 6.21). Each had suggested before they attempted their examination project work that they were capable of achieving good results. They had also both specified that they enjoyed the design process involved. As far as creativity was concerned they were both identified as average. For each aspect of the design process they achieved similarly low scores. However, in the case of one of the boys it was disappointing to see, both in his perceptions of his abilities prior to tackling his project work and through scrutiny of his actual output, that his capability to design was high. He had excellent drawing and conceptual skills to support his designing activity.

Profile factors	High Goal Orientation but achieved a Low Mark		Low Goal orientation but achieved a High Mark	
Project work mark achieved	32%	50%	84%	95%
Goal Orientation Score	265	266	197	191
Creativity Score	115	122	147	175
Pupil perception of their capability	4	3	3	3
Pupil perception of their enjoyment of the process	3	3	2	2
Pupil ability observed by Researcher				
Specification & analysis	2	0	4	2
Research	1	2	4	2
Initial ideas	2	2	2	2
Detailing chosen idea	2	2	3	0
Planning	0	1	3	0
Manufacture	1	2	3	2
Product	1	2	3	2
Evaluation	1	2	3	1
Drawing skills	4	2	3	3
Writing skills	2	2	4	4

Maximum Score = 4

Table 6.21 Illustrates the profile of four pupils who were found at each end of the goal orientation score with marks in their project work that did not conform to the pattern expected

Further analysis of the fortnightly observation sheets, specifically targeting these four pupils pointed towards the teacher as the possible catalyst in the situation. Both teachers in the two schools were using 'interventionist' approaches and both were despondent about the work that was being carried out by their pupils. Through observation and discussion it became apparent that they each attributed the blame for their lack of enthusiasm in the class room to external forces such as the increased pressures upon them, and the moving goal posts of the National Curriculum.

However, these external pressures existed in all schools at the time of the research study. It was therefore decided that other factors concerning the teachers must be having an effect upon the situation. Analysis of the researcher's observations led to a belief that as well as the external pressures upon teachers it was also the case that limited personal philosophy regarding the design process prevented a number of the teachers from providing the necessary support for their pupils. Their teaching tended to focus upon telling the pupils what stage of the process they should be dealing with at any particular time. Valuable teaching time was used to persuade pupils of the need to speed up their work rates as they were behind schedule. It was evident that all the teachers observed were able to tell their pupils what must be in their project folios in order to meet examination criteria. However, what was very often missing was explanations of 'why' and 'how' this should be done. These teachers either assumed that the pupils would understand these concepts without being taught them, or they did not believe that in order to design efficiently and effectively an understanding of 'why' and 'how' were essential ingredients of the design process.

The second category for the analysis concerned another two pupils who had achieved very low scores for the goal orientation index and yet had managed to achieve high marks for their projects. Once again, when looking at the pupils' profiles (see Table 6.21) they were found to be very similar to one another, although, in this instance one was a boy and one was a girl. As far as their perceptions regarding their enjoyment and ability to achieve good results was concerned, they stated that they did not enjoy the activity although they both believed they were capable of achieving good results. With regard to creativity levels, the boy had the second highest creativity score of the total sample, whilst the targeted girl achieved a high creativity score amongst the girls. In both instances their ability to draw, write and design in the context of project work, was high.

One major difference between the two pupils was observed. The boy did very little work until the final deadline was upon him whilst the girl, although not appearing to work to her full potential, did tackle her project week by week. As with the other targeted group these two pupils came from schools where the teachers had adopted an 'interventionist' approach. However, in comparison to the other targeted pair who failed to achieve high marks and had demotivated teachers, in this instance, the two teachers involved were highly motivated: not motivated towards teaching the pupils to really understand about the design process but towards enabling their pupils to pass the examination. Both teachers had worked out very carefully what was essential for a project to achieve high marks. It could therefore be seen that for these two pupils for whom goal orientation was poor, but creativity and capability to do the work was high, their needs were to have a teacher who acted as a motivator. They needed to be helped to become task orientated in order to meet examination criteria and deadlines. This, fortunately matched the teaching strategies adopted by their schools and therefore helped these pupils to be successful.

The Relationship Between High and Low Performance and the Various Factors Under Investigation

The next analysis concerned the top eleven pupils who achieved over seventy percent in their examination project work (Figure 6.31). These were compared with the group of twenty pupils who had accumulated less than forty marks for their design and technology project work (Figure 6.32). Fifty-five percent of those who had achieved a mark of over seventy were found to have above average scores for creativity, and nearly sixty-five percent of them scored highly on the goal orientation index. Whilst only forty five percent indicated in their questionnaires that they enjoyed the process of designing, eighty-two percent believed that they would be able to achieve good results from their endeavours. As far as communication skill levels were concerned they tended to have a low opinion of their writing skills but an inflated opinion of their ability to draw successfully in the context of their project work.

Identified Profile Factors	Pupil 1	Pupil 2	Pupil 3	Pupil 4	Pupil 5	Pupil 6	Pupil 7	Pupil 8	Pupil 9	Pupil 10	Pupil 11	Number of scores less than average
Creativity level	-	+	+	-	+	+	+	-	+	-	-	5
Goal Orientation	+	-	+	+	+	-	-	+	+	-	+	4
Perceived enjoyed the process	-	-	+	-	+	-	-	-	+	+	+	6
Perceived capable of achieving good results	-	+	+	+	+	+	+	+	-	+	+	2
Perceived level of drawing skills	-	+	+	-	-	+	+	+	+	+	+	3
Perceived level of writing skills	+	+	-	+	+	+	+	+	-	-	+	3
Actual level of drawing skill	-	-	+	-	-	+	+	-	-	+	+	6
Actual level of writing skill	+	+	+	+	+	+	+	+	+	+	+	0
Project work mark (maximum mark 100)	98	95	94	90	88	84	83	78	78	72	70	
Number of scores less than average	5	3	1	4	2	2	2	2	3	3	1	
	+ = above average score; - = below average score											

Figure 6.31 Shows a comparison of above and below average scores for certain identified profile factors for those pupils *(n = 11)* who achieved high project work marks

On the other hand, as one might have expected, pupils who's project work had achieved less than forty percent tended to obtain low scores for the majority of factors under investigation (Figure 6.32). There was one exception, fifty percent of this targeted sample achieved above average scores on the goal orientation index. However the implication that these pupils were therefore orientated towards achieving goals was not found to be evident in their attitude to their design and technology project work. These pupils found it very difficult to be motivated. It was also the case that whilst some of these pupils had inflated opinions of their ability to achieve good results, others accepted their inability to do well right from the beginning of their design and technology project work. Unfortunately observation of this group of pupils indicated that those who started out believing that they were capable soon became de-motivated as the project work progressed and their inadequacies became apparent.

Identified Profile Factors	Pupil 1	Pupil 2	Pupil 3	Pupil 4	Pupil 5	Pupil 6	Pupil 7	Pupil 8	Pupil 9	Pupil 10	Pupil 11	Pupil 12	Pupil 13	Pupil 14	Pupil 15	Pupil 16	Pupil 17	Pupil 18	Pupil 19	Pupil 20	Number of scores less than average
Creativity level	-	+	-	+	-	+	-	-	-	+	-	+	+	-	-	+	-	-	-	-	13
Goal Orientation	-	+	+	+	-	+	+	-	-	+	+	-	-	+	+	+	-	-	-	-	10
Perceived enjoyed the process	-	-	+	-	-	-	-	+	-	-	-	-	+	-	-	-	-	+	-	+	15
Perceived capable of achieving good results	-	+	+	+	-	-	-	+	-	-	+	+	-	-	-	-	-	-	-	-	14
Perceived level of drawing skills	-	-	+	-	-	-	-	+	-	-	+	+	-	-	-	-	-	+	-	-	14
Perceived level of writing skills	+	+	+	+	-	-	-	+	-	-	+	+	+	-	+	-	+	-	-	-	11
Actual level of drawing skill	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	17
Actual level of writing skill	-	+	-	-	-	-	-	-	-	+	-	-	-	-	+	-	+	-	-	-	16
Project work mark (maximum mark 100)	33	33	32	32	28	26	24	23	23	21	21	20	18	14	11	7	0	0	0	0	
Number of scores less than average	7	3	2	3	8	6	7	4	8	5	4	4	5	7	5	6	5	6	8	7	*n = 20*

+ = above average score; - = below average score

Figure 6.32 Shows a comparison of above and below average scores for certain identified profile factors for those pupils *(n = 20)* who achieved low project work marks

When split by gender it was interesting to note that the percentage of the total sample of girls found in the sub-group achieving over seventy percent in their project work was very high in comparison to the percentage of boys. In the sample of twenty who had been given poor marks for their project work the opposite was found to be the case (Table 6.22).

Project work mark	girls	boys
Achieved over 70%	36% (5)	17% (6)
Achieved less than 40%	29% (4)	44% (16)

Table 6.22 Indicates the gender differences between those eleven pupils who achieved over 70% for their project work mark and those twenty pupils who achieved less than 40%. (Total sample *n = 50*)

All five girls who achieved good results were very hardworking. Four of them believed that they were capable of achieving good results although only two of them enjoyed the activity they were involved in. Three of them scored highly in the creative test even though only one of them was seen to be artistic. On the negative side three of them had very poor drawing skills. In fact the girl who achieved the highest mark in the total sample of one hundred and twelve pupils, achieving a mark of ninety-eight percent, did no freehand drawing at all in her project. Her ideas were conveyed in a written dialogue and very basic working drawings were carried out by drawing round existing templates. Her marks came from her ability to present evidence which met examination criteria at each stage of the process. This included a product outcome that achieved what she had intended. However, a worrying factor that came from observation of the pupils at work, was that four out of the five girls who obtained over seventy percent in their examination received excessive amounts of help with their project work from their teachers. This was particularly noticeable at the manufacturing stage of the project when for these pupils their chosen solutions were seen to be only hazy ideas in their heads. It was evident from talking to them that they did not have the technological or craft skills needed to proceed. For these pupils, their design folios were completed once the teacher had solved all their problems and manufacturing had taken place.

With regard to the boys who gained over seventy percent for their project work, only half of them were hard working. Five out of the six in the sample believed that they were capable of achieving good results, although like the girls, only two of them enjoyed the activity. None of them were seen to be artistic whilst four of them were either creative or goal orientated. Only one boy was both creative and goal orientated whilst another was neither. For this latter boy his good mark came about through enthusiastic sound teaching strategies. These strategies worked for the majority of his class even though this set of pupils was identified as the least able amongst the eight case study schools. Of the six, two designed their solutions and then made them, four made their projects before their design work was finished and two were observed completing the manufacturing stage before any of the design work which they handed in was attempted.

Analysis of the data regarding the teaching strategies adopted in the schools showed that all the girls and the majority of the boys who gained over seventy percent in their project work were able to work within the teaching strategy adopted by their individual teachers, whether that was 'collaborative' or 'interventionist'. However, when looking at those pupils who failed to achieve high marks it was noticeable that the teaching strategies adopted were not helpful to these pupils for all the reasons discussed in earlier sections of this chapter.

The Relationship Between Teacher Motivation, Pupil Motivation and Pupil Performance

An analysis of the observations made regarding teacher motivation in the eight case study schools provided interesting food for thought (Table 6.23). As in the case of pupil motivation, the categorisation of teachers as motivated or demotivated was established as an ongoing process throughout the observation period.

Judgements were made using the following criteria:

* teacher interaction with the whole class;
* teacher interaction with individual pupils;
* time keeping;
* teaching style;
* observed enthusiasm for the subject based on interaction with pupils;
* observed enthusiasm for the subject based on interaction with researcher;
* observed enthusiasm for project work based on interaction with pupils;
* observed enthusiasm for the project work based on interaction with researcher.

In three of the schools teachers were seen to be motivated. In the other five schools observation of the teachers in action throughout the design and technology examination project work indicated that they were despondent about a variety of factors which they believed impinged upon their teaching. These factors, such as new NC requirements, changes in GCSE syllabuses, and accountability, have already been discussed in more detail in an earlier section of this chapter.

In schools where design and technology teachers were enthusiastic there was an air of optimism surrounding the classroom/workshops. This was despite the fact that they too believed that external pressures affected the work they were carrying out with their pupils. However, the 'optimistic' schools seemed to treat these pressures as a challenge rather than as an excuse for poor results. It was also noticeable, in each of the 'optimistic' schools targeted for this research study, that the teacher was part of an enthusiastic team of design and technology staff lead by a motivated Head of Department. In the five schools where teachers lacked enthusiasm for their work it was found that in three instances the noted despondency prevailed across the whole design and technology department including the Head of Department.

To establish whether the collected data supported the researcher's belief that teacher motivation had an effect upon pupil motivation and performance, the examination results achieved by the sample of fifty pupils were split into three separate levels, high, average and poor (Table 6.23). Mean scores for other factors such as goal orientation and creativity were checked. It was established that mean scores for these factors for the total sample corresponded to mean scores for the targeted pupils found in schools with both motivated and despondent teachers (Table 6.24). However, analysis of the data concerning performance showed that there was a significant difference between the number of pupils who achieved poor marks in schools where teachers were observed to be despondent in comparison to schools where teachers were seen to be motivated. Poor marks were achieved by only sixteen percent of the pupils in schools where teachers were motivated compared to fifty-five percent of pupils in schools where teachers were despondent. In fact in one school, where a team of three teachers,who all appeared to be despondent throughout the observation period, taught the class from which the sample of pupils was taken, eighty-three percent of the sample were found to have achieved less than forty percent in their examination project work. It was also disappointing, although not unexpected, to see that no pupil achieved over seventy percent for their project work in two of the schools with teachers were observed to have been despondent. In the other three schools only one pupil was found to be in that category in each school.

	School Code	Teaching Strategy	GCSE Examination Project work Mark High	Average	Low
Motivated	007	Interventionist	43% (3)	43% (3)	14% (1)
	032	Collaborative	17% (1)	50% (3)	33% (2)
	049	Interventionist	67% (4)	33% (2)	00
	Total for motivated teachers		**42% (8)**	**42% (8)**	**16% (3)**
Despondent	021	Interventionist	17% (1)	33% (2)	50% (3)
	031	Collaborative	00	33% (2)	67% (4)
	035	Interventionist	00	17% (1)	83% (5)
	036	Collaborative	17% (1)	33% (2)	50% (3)
	047	Interventionist	14% (1)	57% (4)	29% (2)
	Total for despondent teachers		**10% (3)**	**35% (11)**	**55% (17)**
	df			2	
	Chi - Square			10.257	
	p - Value			.0059	

The number of pupils who achieved low marks in school whose teachers were considered to be despondant was found to be high. The difference was significant at the $p = 0.0059$ level (*chi* - square = 10.257, $df = 2$).

Table 6.23 Shows the number and percentage from each school *(n = 8)* sample who achieved marks for their project work in the three categories of high, average and low

	No. Schools	No. Pupils	Goal Orientation	Creativity	Mark
Mean Score motivated teacher	3	19	2.158	2.3	61.6
Mean Score despondent teacher	5	31	2.226	2.3	36.6
Total Sample	8	50	2.200	2.3	46.1

Table 6.24 compares motivated and despondent staff*(n = 8)*, with regard to the performance, goal orientation and creativity of the pupils *(n = 50)*

However, analysis of the data concerning performance showed that there was a significant difference between the number of pupils who achieved poor marks in schools where teachers were observed to be despondent in comparison to schools where teachers were seen to be motivated. Poor marks were achieved by only sixteen percent of the pupils in schools where teachers were motivated compared to fifty-five percent of pupils in schools where teachers were despondent. In fact in one school, where a team of three teachers,who all appeared to be despondent throughout the observation period, taught the class from which the sample of pupils was taken, eighty-three percent of the sample were found to have achieved less than forty percent in their examination project work. It was also disappointing, although not unexpected, to see that no pupil achieved over seventy percent for their project work in two of the schools with teachers who were observed to have been despondent. In the other three schools only one pupil was found to be in that category in each school.

The effect of teacher's motivation upon the outcome achieved by the pupils was further analysed in two ways. Firstly, it was found that the mean score for pupils taught by motivated teachers was noticeably higher than the mean score for those pupils taught by despondent teachers (see Table 6.25).

Teacher Motivation	Mean Score
Motivated Teacher	2.895
Despondent Teacher	1.806

Table 6.25 Illustrated the effect of teacher motivation upon the mean score of pupils in their GCSE project work

Secondly, the sample of pupils was re-dividing into three new categories (Table 6.26 and Figure 6.33). The three groups were: those pupils who were motivated and enthusiastic about their project work; those pupils who were motivated to perform but were unenthusiastic about the activity they had been involved in; and those pupils who were neither motivated by the activity nor by the possible examination outcome.

	Pupil Motivation	Total Sample	Motivated Teacher	Despondent Teacher
A	Motivated & enthusiastic	3.200 (10)	3.400 (5)	3.000 (5)
B	Motivated towards result but unenthusiastic about activity	3.182 (11)	3.571 (7)	2.500 (4)
C	Demotivated	1.517 (29)	1.857 (7)	1.409 (22)
	Total Number of Pupils	(50)	(19)	(31)
	Chi Square	228.667	2.667	204.667
	p - Value for the significance of difference between A, B & C.	<.0001	.5272	<.0001
				n = 50

Table 6.26 Illustrates the mean score for pupil *(n = 50)* performance grouped by teacher motivation and pupil motivation

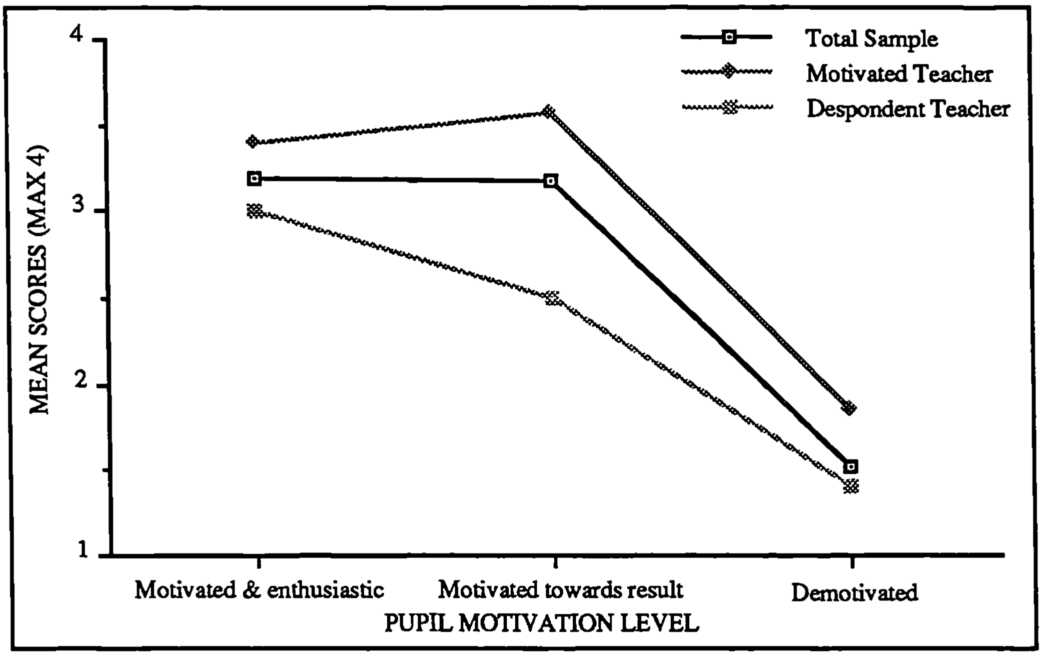


Figure 6.33 Illustrates the mean scores for pupil *(n = 50)* performance grouped by teacher motivation and pupil motivation

Throughout the observation period pupils were monitored in order to establish whether they were motivated during the time when they were carrying out their design and technology examination project work. The categorisation of pupils as motivated or demotivated was an ongoing process. Judgements were made using a number of criteria:

* observed enthusiasm for their project;
* observed pupil interaction with their teacher;
* observed pupil interaction with their peers;
* attendance;
* time keeping;
* ability of pupil to stay 'on task' during lessons;
* teacher comments on pupil's levels of motivation;
* pupil comments on their levels of motivation;
* ongoing scrutiny of design and practical outcomes.

Analysis of the data showed that twenty-six percent of the pupil sample taught by motivated teachers were enthusiastic about their project work, whilst only sixteen percent of the pupils taught by despondent teachers were found to be in the same category. The mean score for performance achieved by the group of pupils taught by motivated teachers was seen to be higher than the mean for the total sample, whilst the mean score for the group of pupils taught by despondent teachers was seen to be lower.

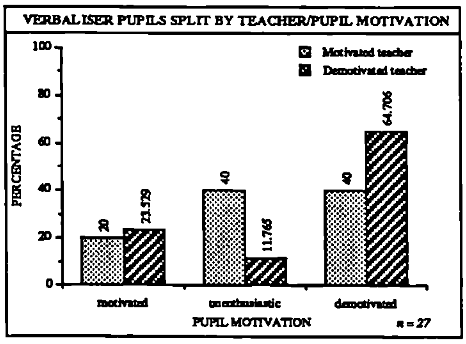
Analysis of the data provided an interesting comparison between the two groups of pupils who were unenthusiastic about the activity but were motivated by anticipated performance outcomes. Those pupils who were taught by motivated teachers achieved a very high mean score of 3.571. The score was found to be even higher than the mean score achieved by pupils who were both enthusiastic and motivated and were taught by motivated teachers. On the other hand the same group of pupils taught by despondent teachers only managed to achieve a mean score of 2.500 (see Table 6.26).

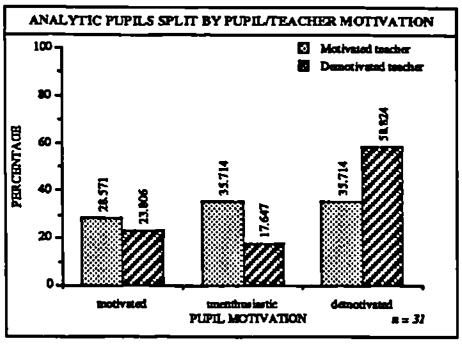
As anticipated, when comparing the data concerning teachers' motivation and the number of pupils who were demotivated by their design and technology experience, it was established that seventy-one percent of the sample of pupils being taught by teachers who were despondent belonged to this group. The data also supported the researcher's belief that fewer pupils would be found to be demotivated in schools where enthusiastic, motivated teachers were teaching the design and technology lessons (see Table 6.26).

A pupil's cognitive style had been shown in earlier data analysis at the start of Phase Two, to have a noticeable effect upon a pupils' time management capabilities and upon the mark that they ultimately achieved for their design and technology examination project work. The researcher therefore considered it pertinent to study the relationship between a pupil's cognitive style, their level of motivation and their design and technology teacher's level of motivation. This was carried out in order to ascertain whether depending upon a pupil's cognitive style their motivation level was affected more or less by their teacher's motivational level.

As in the previous analysis the sample of pupils were broken down into: those who were motivated; those who were unenthusiastic but completed their work successfully; those who were demotivated. The teachers were once again separated into those who were motivated and those who were demotivated. Unfortunately the combination of a six celled matrix and the size of the sample meant that some of the resulting cells for each of the four cognitive style dimensions were too small to use in statistical analysis. However, column graphs based upon percentages were produced for each cognitive style in order to illustrate the interesting variations which were identified between pupils taught by motivated and demotivated teachers (Figure 6.34).

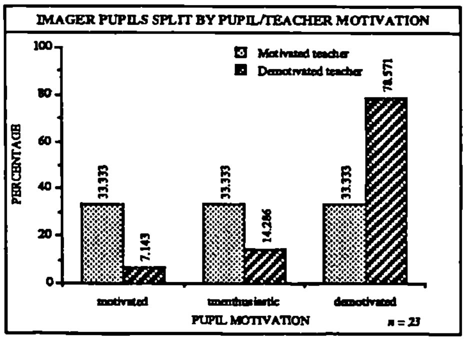
The evidence indicated that pupils who were wholists or were imagers were more than twice as likely to be demotivated if their teacher was demotivated than if their teacher was motivated. Only seven percent of the imager pupils taught by demotivated teachers were motivated whilst seventy-nine percent were demotivated. In comparison, imager pupils who were taught by motivated teachers were found to be equally spread between the three pupil motivational categories.

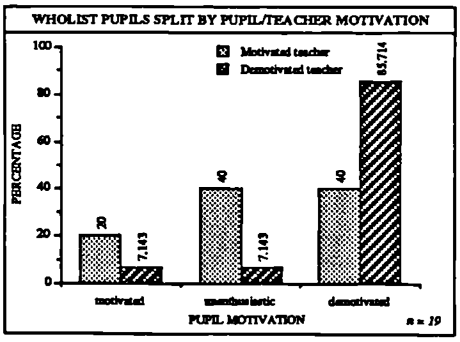




	motivated pupils	unenthusiastic pupils	demotivated pupils
motivated teachers	2	4	4
demotivated teachers	4	2	11

	motivated pupils	unenthusiastic pupils	demotivated pupils
motivated teachers	4	5	5
demotivated teachers	4	3	10





	motivated pupils	unenthusiastic pupils	demotivated pupils
motivated teachers	3	3	3
demotivated teachers	1	2	11

	motivated pupils	unenthusiastic pupils	demotivated pupils
motivated teachers	1	2	2
demotivated teachers	1	1	12

Figure 6.34 Illustrates the effect of a pupil's cognitive style and their teacher's motivation upon a pupil's motivation

As far as pupils who were wholist were concerned an even larger percentage of pupils who were taught by demotivated teachers were demotivated. Eighty-six percent of wholist pupils taught by demotivated teachers were found to be in this category.

The difference in percentage between the number of motivated and demotivated pupils taught by demotivated teachers was not as great for pupils who were verbalisers or analytic. Although, in both of these cognitive style groupings there were over twice as many demotivated pupils as motivated pupils being taught by demotivated teachers.

Chapter Seven

Phase Two Conclusion and Integrated Discussion

Conclusion to Phase Two

Introduction

Phase Two achieved its objectives. The wide variety of research tools used during this phase furnished the researcher with further exploratory and explanatory information. The analysis of the data, both statistical and descriptive, provided additional answers to questions that had been identified at the beginning of the study and during Phase One. Inevitably, as the study progressed, the matrix of key factors which were found to influence pupil motivation at Key Stage 4 has become larger and more complex. However, during Phase Two the thorough analysis of data, concerning each identified factor separately and in conjunction with one another, had enabled the researcher to gain a clearer picture of the implications upon pupil motivation of each of the factors.

An important feature of the study throughout every phase has been the effect that assessment had had upon the attitude of the pupils and their teachers. During Phase Two, the observation period in schools enabled the researcher to collect a wealth of data regarding this vital area and its effects upon motivation. In design and technology, motivation has been seen to affect performance and performance affect motivation. The importance at Key Stage 4 of the examination result to pupils and teachers alike dictated that the nature of assessment and its criteria influenced what was learnt, how it was taught and how much pupils and teachers enjoyed their experiences.

During Phase Two, creativity, goal orientation and cognitive style were all shown to be indicators of a pupil's level of motivation and their ability to achieve successful outcomes when measured by examination results. The gender of a pupil was also seen to have a bearing upon the situation. Observations made during Phase Two highlighted evidence to support concerns identified during the Literature Review and Phase One of the project regarding the lack of technological skills, knowledge and understanding found amongst many pupils at Key Stage 4. Analysis of the data collected in Phase Two indicated ways in which pupils and teachers had developed strategies that had overcome the lack of skills possessed by the pupils. However, the researcher would suggest that although these strategies may have achieved their end with regard to examination results, in doing so they had undermined the very nature of the activity and caused demotivation amongst a large proportion of the pupil sample.

Evidence Relating to the Specific Questions Raised in the Research Project

Phase Two set out to explore whether a pupil's motivation during design and technology project work at Key Stage 4 was affected by a selected list of internally and externally dependent factors.

The internal factors that were tested during Phase Two were:

* creative ability;
* goal orientation;
* cognitive style;
* design ability;
* manufacturing capability;
* gender.

The external factors that were tested in Phase Two were:

* the design process specified by GCSE Examination Boards;
* the relationship between the knowledge base taught and the design process used;
* the balance of time given to the various aspects of the design process;
* the delivery programmes devised by the schools;
* the teaching strategies adopted by the individual teachers during project work;
* the relationship between the teacher and their pupils;
* the teachers' knowledge of designing and the skills required to carry out that process;
* the teachers' motivation.

The Effect of Internal Factors upon Motivation When Engaged in Design and Technology Project Work at Key Stage 4

Creative Ability

As a result of the analysis of relevant literature and conclusions reached during Phase One of the project, a connection between a pupil's creativity level and the strategies pupils adopted whilst engaged in design and technology project work at Key Stage 4 had been established. Research carried out during Phase Two confirmed this association. Data collected during this phase also enabled the researcher to establish the link between levels of creativity and pupil motivation.

Observation of the pupils throughout their examination project work supported the researcher's opinion that pupils could be separated into those who were creative and those who were not very creative, and that within each of these categories there were two sub-groups. During Phase Two, it was discovered that the group classified as inherently creative was small. Within this group there was evidence that there were pupils who were able to design within the constraints of the GCSE examination model, and there were those pupils who were inhibited by such a structured approach. This latter group of pupils were seen to become demotivated at an early stage of their project work. Within the second category, those who were not creative, the majority of pupils, were found to be unreceptive to working within the design process model offered to them. Evidence collected throughout Phase Two indicated that this group became increasingly demotivated as the project work progressed. The other, much smaller sub-group of non-creative pupils were seen to be willing to accept the design methodology taught to them at the early stage of the project. However, as time progressed they too became increasingly dissatisfied with the process they had been asked to adopt. This group tended to maintain their motivation, not through their enjoyment of the process, but by concentrating their efforts upon achieving good examination results instead.

Goal Orientation

Analysis of data from Phase Two supported Atman's (1986) research findings which indicated that high scores for the behavioural, goal orientation characteristics of reflecting, planning and acting were needed in order to accomplish goals. The results of the analysis of the relevant Phase Two data also supported the belief that these characteristics were essential ingredients for the successful completion of design and technology project work.

From the data it was interesting to find that a pupil's ability to 'act' remained fairly constant whether they were motivated in their project work or not. Those pupils who achieved high marks for their project work were found to be significantly more capable of planning and reflecting than those pupils who achieved low marks. The pupils gaining low marks, the majority of whom were seen to be demotivated, struggled with both planning and reflecting. The results suggested that they found planning particularly problematic. Poor planning and time management gave one explanation for the failure of these pupils to complete their project work by the examination deadline, which in turn provided a possible reason for the demotivation witnessed amongst this group of pupils.

The literature search had supplied evidence to support the researcher's opinion that reflective thinking was an essential tool used in developing sound design solutions. Phase Two added further support to this theory. The data analysis indicated that pupils who had poor skills of reflection tended not to succeed in their design work. It was also evident that this was another group of pupils who experienced motivational problems with their project work.

Cognitive Style

The importance of understanding a pupil's cognitive style in the context of design and technology and teaching and learning strategies was found to be considerable. Through analysis of the data it was identified that a pupils' cognitive style had a marked influence upon how a pupil was able to cope successfully with the design process model adopted by the teacher, particularly at Key Stage 4.

Cognitive style, as assessed by Riding's CSA test (Riding, 1991), has been shown to be concerned with the way in which individuals process information in wholes or in parts, and whether that information was represented during thinking either verbally or in images. As has already been pointed out during the literature review, designing should be a holistic experience with imaging central to the development of sound ideas. However, the data collected during Phase Two indicated that the very pupils whom one would have expected to be motivated and successful were not. Those pupils who were imagers and wholists were the ones who became demotivated and achieved the poorest results. The analysis of the evidence suggested a number of explanations for this result. With regard to imaging, only a small proportion of the pupils in this category were able to represent their mental images in a free and yet competently drawn form. Nor, on the whole, were they found to be successful in providing the easily assessed written evidence which could have gained them valuable marks. As far as the belief that design needed to be a holistic experience was concerned, analysis of the design process adopted during the GCSE technology examinations indicated that the holistic nature of the process was fragmented by teachers into manageable units of work which tended to play into the hands of those who were analytic rather than those who were wholists.

The importance of cognitive style upon mean marks achieved in the project work was highlighted when cognitive style was analysed using mean marks and gender as a sorting mechanism. Analysis of the total sample indicated that the best marks in the GCSE technology examination project work were achieved by those who were analytic/verbalisers and that girls achieved significantly higher marks than boys. However, in the context of cognitive style and high mean marks, girls with the highest marks tended to be imagers and analytic whilst boys with the highest marks tended to be verbalisers and wholists (see Figure 7.1). This could suggest that the imager/verbaliser domain may not be as influential as the analytic/wholist domain in determining project work results. Although, it needs to be pointed out that the size of the sample of girls was too small for the data to be statistically analysed.

	Wholist/Analytic	Verbaliser/Imager
Total Sample - Predominent cognitive style achieving high mean score	Analytic	Verbaliser
Boys - Predominent cognitive style achieving high mean score	Wholist	Verbaliser
Girls - Predominent cognitive style achieving high mean score	Analytic	Imager

Figure 7.1 Illustrates the predominant cognitive styles of boys, girls and the total sample when split by high mean scores for each group

With regard to the effect of a teachers' level of motivation upon a pupils' level of motivation it was found that the predominant cognitive style of the pupil had a considerable bearing upon the issue. The data suggested that pupils who were wholists and imagers were more than twice as likely to be demotivated if their teacher was demotivated than if their teacher was motivated. There was not such a marked difference for those pupils who were verbalisers or analytic, although pupils who were verbalisers and analytic and were being taught by demotivated teachers were found to be more than twice as likely to be demotivated as motivated.

Design Ability

The effect of a pupil's ability to design upon their level of motivation had been specifically targeted during Phase One of the project. During Phase Two, the design process was 'un-picked' further and the relationship between drawing skills, writing skills and conceptual design skills was analysed.

The new data collected added support and clarification to the Phase One findings. The evidence suggested that pupils who could draw but refrained from annotating their drawings either because their writing skills were poor or because they were unable to think what to write were at a disadvantage compared to those pupils who could explain their thoughts and ideas in words and failed to produce many, if any, drawn images. The need to produce written evidence at each stage of the process caused many pupils to become demotivated.

Those pupils who believed in their own ability to design were generally more motivated to complete their projects than those pupils who believed that they were poor at designing. This was despite the fact that this latter group believed they were good at the manufacturing stage of the process.

However, through observation during Phase Two, there were found to be notable exceptions to this case. For instance, a number of pupils who were assessed as creative and believed that they could design, were observed to be capable of designing and yet were found to be demotivated. In this instance, the data suggested that the demotivation was caused by the restrictive design process model imposed upon them during their GCSE examination project work.

At the opposite end of the motivational spectrum there was a group of pupils who believed that they were poor at designing, mainly due to their lack of ability to draw, and yet they were enthusiastic throughout their project work. The reasons why this group of pupils remained motivated were numerous and mainly concerned with external factors which will be referred to in the section dedicated to external factors. In the context of the design process the reasons for this group's continued motivation were focussed in two areas. Firstly, the cognitive style of these pupils tended to be analytic and therefore they were able to work within the fragmented design process that their teachers' adopted. Secondly, the majority of them were verbalisers and therefore they were able to overcome their inadequate drawing skills by showing their ability to think through their solutions using written explanations rather than drawn images.

Manufacturing Capability

During each phase of this study the researcher has been disappointed by the poor quality of manufactured artifacts produced by pupils during their GCSE technology examination project work. An up-date of the Literature Review illustrated support for this concern from a growing number of educationalists, industrialist and teachers after the introduction of the National Curriculum (e.g.DES,1992; Smithers & Robinson,1992; Barlex, 1993; Rogers & Clare, 1994). During Phase Two the lack of progress made during the manufacturing process was seen to have a marked effect upon the levels of pupil frustration, upon their motivation and upon their capability to complete their design and technology examination project work satisfactorily.

Analysis of the collected data, in the context of manufacturing capability, would suggest that the frustration and demotivation tended to be caused by one or more of the following:

* a lack of basic skills taught during Years 7 - 9;
* a lack of detailing of the chosen idea during the design stage;
* a lack of planning for manufacture prior to the start of the manufacturing stage;
* the delays caused by waiting for materials to be bought, either by the school or the pupils themselves;
* unsuitable materials being used for the task;
* a pupil's inaccuracy due to a lack of practical skills and knowledge of the properties of the materials they were working with;
* a lack of patience (this was particularly noticeable amongst the boys and the less able girls);
* a teacher's inability to satisfactorily solve on-going design and manufacturing problems before it was too late;
* the realisation by the pupil that what they were making was not going to function as they hoped it would.

Gender

To add further to the complex picture regarding motivation this research study has highlighted a number of intricate gender[1] differences between boys and girls at Key Stage 4 when they were engaged in design and technology project work.

In line with other research findings (e.g. APU,1991) gender differences in attitude and ability during designing were identified during both Phase One and Phase Two. Many of the girls were seen to enjoy the reflective activities involved in the process. They had patience and enjoyed the presentational skills that were necessary in order to achieve satisfactory design folios that met the GCSE requirements. In sharp contrast, the boys tended to see the design folio only as a means to an end. They were more interested in the manufacturing stage of the project and were frustrated by the need to produce evidence of all their thinking, only wishing to record what would be, not what might have been.

The connection between completion rates and motivation has been well documented throughout this thesis. Data from both phases indicated that significantly more girls than boys finished their projects.

When looking at the relationship between completion rates and lack of enjoyment it was found that a significantly large proportion of girls managed to finish their projects on time even though they did not enjoy designing, whilst a significant number of boys did not.

In the context of cognitive style, perceived capability and gender, it was interesting to see that a significantly large number of boy imagers believed that they were incapable of achieving good results whilst designing. Whilst girl imagers and both girl and boy verbalisers were evenly split with approximately half in each sample, suggesting that they could design successfully and half believing that they could not.

The high marks being achieved by girls studying design and technology were good to see. However, a worrying factor was identified during the observation period in Phase Two: four out of the five girls who obtained over seventy percent in their examination received excessive amounts of help with their project work from their teachers. By contrast, boys who achieved over seventy percent tended to work on their own with limited input, other than encouragement from their teachers.

An important aspect of motivation highlighted by the researcher in the early stages of the study was the fact that pupils of both sexes who had chosen their own projects were more

The researcher would like to remind the reader that in this study 'gender' has been taken to indicate biological gender. This is in contrast to behavioural or learning gender style where gender is seen as a continuum rather then as a binary divide (Durey, 1995).

motivated than pupils who were set a task. The researcher believed that the reason for this was because pupils who chose their own project felt that they owned that project. This important theory has since been identified by other researchers (e.g. Kimbell, 1994; Hennessey & McCormick, 1994) as being an important feature of Key Stage 4 work in design and technology.

Having established that ownership of the project was an important motivational issue, it was disappointing to see that at the manufacturing stage of the project many of the pupils, observed during Phase Two, lost ownership of their project. Ill defined, but often in the context of the pupils existing technological or constructional understanding, adventurous ideas meant that many pupils, both boys and girls, were working in areas which were beyond their technological capability. This resulted in them having to rely heavily upon their teacher during the manufacturing stage of the process. It was during this stage that in the context of 'ownership' a gender difference was identified. Capable girls tended to cope with this lack of ownership. They did not expect to know all the constructional or technical details of the manufacturing processes. They looked towards their teacher to be shown how to turn their ideas into reality and they had patience when they were unable to make headway. They viewed the project either as a learning experience or, were able to accept it as a necessary part of their GCSE examination in which they wished to do well.

In contrast, able boys tended to became frustrated and impatient with their inability to make progress. They found it difficult to cope with their lack of control when they were unable to solve manufacturing or technical problems for themselves. Those who were highly motivated did make progress by attending extra sessions when, like the able girls, the teacher could give them more individual attention. The others turned to their peers for advice, simplified their ideas until they no longer became a challenge, or made and re-made pieces of their project, altering their designs to fit their mistakes.

As far as less able boys and girls were concerned, there was little difference between the genders. They all became frustrated, disillusioned and demotivated by their lack of progress. Some became truants, either from school in general or design and technology in particular. Those who continued to attend became resigned to the situation early in their project, making less and less effort as time slipped by.

The Effect of External Factors Upon Pupil Motivation When Engaged in Design and Technology Project Work at Key Stage 4

The Design Process Specified by GCSE Examination Boards

The data collected from observations, interviews and questionnaires during both Phase One and Phase Two enabled the researcher to build up clear evidence to support her opinion that the process that Key Stage 4 pupils were asked to adopt during their GCSE project work hampered the development of genuine design skills, inhibited creativity and had a demotivating effect upon many pupils.

Quite rightfully, syllabus designers would have us believe that their assessment criteria allowed for the development of well designed products that could also achieve excellent examination results. However, there appeared to be a mismatch between theory and practice. In a school situation, where for pupils, parents and teachers alike the examination result was of great importance, the process adopted certainly imposed a *"procrustean regime" (Layton, 1991)* upon the majority of pupil's design activities. Pupils could end up with satisfactory marks for their GCSE examination but a disappointingly large portion of them became demotivated and sceptical about the activity in which they had been involved and were dissatisfied with the practical outcomes they had produced.

The data collected during both Phase One and Two indicated that it was not necessarily the pupils' own choice to design in the manner witnessed in schools at Key Stage 4. In the majority of cases it was the teacher who, through their analysis of the appropriate examination assessment criteria, determined the best way for their pupils to tackle their project work in order that they may achieve maximum marks.

It was observed that the demands of the examination boards were translated by the majority of teachers into a simple linear design process model. Pupils were expected to produce drawn and written evidence showing that they had addressed each of the examination boards' specified stages of designing, whether it was appropriate to the design of the artifact or not.

The rigid process was often seen to be unhelpful in developing creative, innovative thinking. Many pupils were aware that they were producing work in order to meet assessment criteria, not to enable them to produce better designs. The use of retrospective design work *"...to fill in gaps in the folio"* did little to help pupils understand the real purpose of the process.

A few graphically able pupils were content to spend many hours on their documentation. However, for the vast majority of pupils this demand for paper work had a demotivating effect, These pupils saw the design process stretching interminably ahead of them. The manufacturing stage which they looked forward to seemed an impossible target to reach. This caused a noticeable slowing down of work rates that only exacerbated the situation.

The Relationship Between the Knowledge Base Taught and the Design Process Used

As explained in the last section, evidence collected during both Phase One and Two indicated that the majority of Key Stage 4 pupils held a disappointingly poor understanding of the design process. When this was combined with a lack of understanding of materials and processes it caused many of them to work beyond their technological capability, both at the design and manufacturing stage of the process. During the manufacturing stage, when their lack of understanding became visibly evident in a three dimensional form, teachers were seen to develop strategies that enabled them to design solutions to pupils' problems in their heads, as the need arose. The necessity for pupils to have an understanding of the way forward and therefore continuing ownership of their developing outcome was given a low priority. As mentioned previously, however well intentioned this course of action may have been, the evidence from this study would suggest that it had a considerable demotivating effect upon many of the pupils, particularly the boys.

The Balance of Time Allocated by Teachers to the Various Aspects of the Design Process

Although each school followed examination guidelines regarding hourage for the project work, the actual amount of time given to the process varied greatly from school to school and from pupil to pupil. The balance of time given to the various stages of the design process was found to be influenced by such factors as the delivery programmes adopted by the school, the amount of extra time pupils spent on the task over and above the allocated lesson time, and the importance that individual teachers placed upon each stage of the process.

Phase Two enabled some conclusions to be drawn about the time allocated to the various aspects of the process. In many schools, inappropriate research was allocated too much time. In schools adopting an 'interventionist' approach, detailing the chosen idea was not given enough time. It was also evident that in schools adopting a 'collaborative' teaching style, too much time was wasted by pupils throughout the whole of the design stage of the process.

At the specification stage not enough explanation was given as it its purpose within the process. Nor at the final stage of the project did the teachers explain how to carry out an evaluation of the product using the specification as a starting point. Quite often, no timetabled sessions were given to the valuable learning situation encompassed in evaluating the outcome of the process. Evaluations were often done for homework or the night before the project was to be handed in.

The Delivery Programmes Devised by the Schools

Delivery programmes were devised by each school to enable pupils to cover all the examination syllabus requirements. They took into account a number of school related issues that were individual to each school. Although the different delivery programmes adopted during Phase Two gave the same number of taught hours to the examination project, in some schools these hours were in a block of a few weeks, whilst in others they were spread out over several months. The latter model benefited pupils in that it gave them a longer time frame in which to think through their thoughts and ideas. Evidence from the study would suggest that these differences, when combined with the teaching strategies adopted by the schools, did have an effect upon the pupil's ability to design successfully and manage their project work. It also affected their motivation to do so.

The Teaching Strategies Adopted by the Individual Teachers During Project Work

As discussed earlier, observation during Phase Two identified that teachers utilised either an 'interventionist' or 'collaborative' mode of teaching during GCSE technology examination project work.

Neither strategy was successful in motivating pupils throughout the examination project work. Although it was evident that the two strategies gave rise to demotivation for very different reasons. In those schools adopting an 'interventionist' approach, the speed of the process caused the pupils to move very quickly from stage to stage. For the majority of these pupils, an inadequate amount of time caused frustration. This developed quickly into despondency as they became aware that they were not producing satisfactory outcomes at any stage of their project work. By the hand-in deadline, a disappointingly large number of these pupils were demotivated and failed to finish their projects.

In theory, in schools where teachers exhibited what has been defined as the 'collaborative' model, the design stage should have been successful. This approach enabled pupils to retain ownership of their ideas and produce well developed solutions ready for manufacture. It also allocated ample time for the completion of practical work in time for assessment. However, in reality, a considerable number of pupils in schools adopting a 'collaborative' approach did not succeed in finishing their projects or reaching the manufacturing stage of the process. For these pupils, the problems associated with this model came about through boredom. From a fairly early stage these pupils, particularly the boys and the less able girls, saw the design process stretching interminably ahead of them. The need for interim goals in long term projects was rarely addressed. The manufacturing stage which pupils looked forward to became an impossible target for many of them to reach.

The Relationship Between the Teacher and Their Pupils

Much research has been carried out into the importance of the relationship between teachers and pupils. Design and Technology is fortunate in that it provides excellent scope for teachers to develop positive relationships with their pupils. The design studio and workshop afford different opportunities by comparison to those offered in other subjects and classroom situations.

Observations in Phase Two also indicated that a teacher's level of motivation had a strong bearing upon the relationship that existed between a pupil and a teacher, and upon the motivational level of that pupil. Throughout both Phase One and Phase Two good teacher/pupil relationships were seen to motivate the least able pupils in the context of their design and technology project work. However, the opposite was also found to be the case. Poor teacher/pupil relationships caused a number of able as well as less able pupils to become demotivated.

It was also observed that, in the eyes of the pupil, the nature of the activity involved meant that the credibility of the teacher of design and technology was easily measured. An artifact that had been made with the help of the teacher and did not perform as the pupil expected was found to have a marked effect upon how that pupil viewed the teacher and the subject.

The Teachers' Knowledge of Designing and the Skills Required to Carry Out Project Work

Observation during Phase One and Two supported the widely held belief that the role of a design and technology teacher at Key Stage 4 was not just as a facilitator but also as a provider of knowledge, skills, guidance, direction and understanding. Many of the teachers observed during this research project were able to fulfil this role successfully in the area of practical skills both craft and technological. However, the majority of teachers displayed a lack of confidence in their understanding of the design process. This was witnessed in the way in which they presented the process to their pupils.

It was disappointing to see that the majority of teachers used surface rather than deep approaches to learning when teaching their pupils during the GCSE Technology examination project work. The majority of the teachers observed did not, or could not, provide their pupils with the learning opportunities that would enable them to 'use' rather than just 'do' the design process.

The Teachers' Motivation

A considerable number of the design and technology teachers observed during both Phase One and Phase Two were despondent about teaching. The reasons for this were as complex and numerous as the reasons for pupil demotivation. The Literature Review had signalled certain problematic areas both specific to design and technology and in a wider educational framework. Phase Two had supported these as being relevant in the context of teacher motivation in design and technology. These issues could be summed thus: the developing philosophy of design and technology over the past twenty years; the introduction of the National Curriculum; accountability; financial constraints; the speed of the changes in direction since the introduction of the National Curriculum.

Teachers understand that we live in a dynamic world where change is a necessary part of the continuum. However, discussions with the teachers involved in Phase One and Two indicated that for many this awareness of the need for change had not prevented their enthusiasm from being affected by the number of initiatives and the speed at which they had occurred. They all suggested that the continuous state of change gave them little opportunity for consolidation or continuity. Some of them felt de-skilled by the breadth of the 'new' technology curriculum that they were expected to teach. Many of them did not feel proud of the work that their pupils were producing. They believed that their pupils used to achieve far higher standards in the past. They indicated that they were disappointed that their present pupils did not enjoy their design and technology lessons as their pupils had done in the past. They found it difficult to accept that an emphasis must be placed on the process across a wide variety of context and materials rather than on an outcome, of which teachers, pupils and their parents could be proud. Nor were they convinced that the new emphasis was superior or more appropriate for the majority of the pupils that they taught.

The data collected during both Phase One and Two indicated that demotivated teachers tended to produce demotivated pupils. It also showed that pupils taught by demotivated teachers tended to achieve significantly poorer results in their GCSE project work than did the pupils taught by motivated teachers.

It was disappointing, although hardly surprising, to find that the despondency of teachers had an effect upon their teaching and upon the pupils that they taught. Motivated teachers were seen to motivate many of their pupils, even those who were of average or below average ability. However, in the classes taught by despondent teachers there was a tendency for even capable pupils to become demotivated.

The data collected would also support the researcher's and Biggs & Moore's (1993) belief that those teachers who are not enthusiastic about teaching or about their subject were unable to motivate pupils to become deep learners who would develop an empathy with, and an understanding of the subject, that would last them beyond Key Stage 4 and their Technology examination.

Implications For Teachers of Design and Technology

The second aim of Phase Two had been to predict teaching and learning strategies that could help to improve the situation regarding the demotivation of Key Stage 4 pupils engaged in design and technology activities. In order to address this aim it was important to first of all draw together information from each separate phase of the study. This enabled the researcher to make sense of the various identified factors affecting motivation amongst Key Stage 4 pupils.

Literature Review

Several factors which had the potential to affect a Key Stage 4 pupils' motivation had first been revealed through the Literature Review. These were grouped at the end of the Literature Review into two categories: those that were pupil dependent ; those that were teacher dependent (Figure 7.2). An analysis of the Literature Review also enabled the researcher to identify a number of educational issues which related directly to the selected factors.

	Key factors which relate to demotivation amongst Key Stage 4 pupils studying Design and Technology	Issues which relate to the key factors
Pupil dependent	⊙ Intellectual ability ⊙ Creative ability ⊙ Goal orientation ⊙ Cognitive Style	⊙ Educational changes ⊙ Historical perspective of Design and Technology Education
Teacher dependent	⊙ Pupil's design capability ⊙ Pupil's manufacturing capability ⊙ The process used in designing and making ⊙ Relationship of the knowledge base to the process ⊙ Balance of time given to aspects of the process ⊙ Teaching strategies	⊙ NC Technology / Design and Technology ⊙ Examination requirements ⊙ Accountability

Figure 7.2 Lists the key factors that relate to demotivation amongst Key Stage 4 pupils. It also indicates the educational issues that relate directly to those key factors. (As identified in the summary of the Literature Review (Figure 1.9))

Initial Survey

The Initial Survey was not concerned with adding to the researchers understanding of the factors concerning motivational issues. The aim of the Initial survey was to select eight representative schools from which data could be collected in order to verify and clarify the identified factors and provide insight into other possible elements that may cause pupil de-motivation amongst Key Stage 4 pupils in studying design and technology.

Phase One

Analysis of the data collected throughout Phase One enabled the researcher to add breadth and depth to her understanding of the existing factors concerning motivation. The early questionnaire used in Phase One also highlighted the need to investigate the intricate relationship between modelling and conceptual skills utilised during various aspects of the design process. These were considered to be another possible area that caused motivational problems amongst Key Stage 4 pupils. The interviews carried out during the latter half of Phase One clarified that relationship and added to the researchers understanding of demotivation amongst the targeted sample of pupils (Figure 7.3).

	Motivating Features	Demotivating Features
Process	• Being given choice during project selection • Being given a context within which to work. • Making the product - as long as it is a success • Completing the project in time for assessment • Working towards an examination result	• Projects that are too big or too complex • Designing and in particular researching and evaluating • Products made which are unfit for their purpose • Poor time planning - teacher and/or pupil
Skills	• Early sketching of ideas • Having the skills to produce a finished functioning product	• Drawing skills in general • Writing skills in general • Drawing and conceptual skills needed when detailing an idea • Orthographic drawing skills • Careful lettering skills • Written evaluations both conceptual and writing skills • Inaccuracy during the process • Poor manufacturing skills • The relationship between conceptual skills and the knowledge/skill base throughout the project
Attitudes	• Pupils who dislike project work but are not bored by the process usually complete their projects.	• Pupils who dislike project work and are bored by the process tend to produce incomplete project work

Figure 7.3 Lists the key motivating and demotivating features of the skills, processes and attitudes of the pupil sample during Phase One of the research project

Phase Two

The Key Factors identified at the start of Phase Two were an amalgamation of the broad factors identified during the analysis and synthesis of the Literature Review and the more specific factors concerning processes, skills and attitudes that had been identified and researched during Phase One. Throughout Phase Two the researcher sought to explicate further the complex picture of key factors relating to demotivation (Figure 7.4). On-going analysis added new factors and clarified existing ones. The classification of the factors was changed. The terms 'external' and 'internal' were used rather than the earlier groupings of 'pupil dependent' and 'teacher dependent'. 'External' was seen to be more appropriate as the factors identified in this group were affected by a wider framework than simply the teacher. Whilst the researcher saw the terms 'pupil dependent' and 'internal' as interchangeable within the context of this research project. The importance of the relationship between the refined list of key factors and the broader educational issues that had been identified during the Literature Review were also thoroughly investigated throughout Phase Two.

	Key factors which relate to demotivation amongst Key Stage 4 pupils studying Design and Technology	Issues which relate to the key factors
Internal factors	❂ Creative ability ❂ Goal orientation ❂ Cognitive style ❂ Design ability ❂ Manufacturing capability ❂ Gender	❂ Educational changes ❂ Historical perspective of Design and Technology Education ❂ NC Technology / Design and Technology ❂ Examination requirements ❂ Accountability
External factors	❂ The design process specified by GCSE Examination Boards ❂ The relationship between the knowledge base taught and the design process used ❂ The balance of time given to the various aspects of the design process ❂ The delivery programmes devised by the schools ❂ The teaching strategy adopted by the individual teacher during project work ❂ The relationship between the teacher and their pupils ❂ The teachers' knowledge of designing and the skills required to carry out that process ❂ The teachers' motivation	

Figure 7.4 Illustrates the Key Factors that relate to demotivation amongst Key Stage 4 pupils studying design and technology. It also indicates the wider educational issues that were first identified during the Literature Review

Throughout each phase, the importance of the teacher in the context of pupil motivation in design and technology was highlighted time and again. Analysis of all the relevant data identified a number of key points that were pertinent. The points concerned: the teachers' own understanding, knowledge, skills and attitudes; the pupils understanding, knowledge, skills and attributes. As an on-going activity throughout Phase Two, these points were complied into a list that indicated problem areas regarding pupil motivation for the teacher.

The teacher must:

* have a thorough understanding of designing beyond the requirements of the GCSE examination criteria;
* teach adequate basic skills during years 7 - 9 in order to give pupils confidence during years 10 and 11 when they are confronted by new processes and manufacturing techniques;
* remember that a pupil's belief in their own ability has been shown to be of greater importance than their anticipated enjoyment of the process;
* encourage pupils to use appropriate forms of modelling, both 2D and 3D during the design process in order that both teachers and pupils can understand fully the principles and the form of the ideas being suggested;
* enable pupils to plan their manufacturing processes before making commences in order that outcomes are produced that not only satisfy examination criteria but also enable outcomes to be produced of which the pupils can be proud;
* be aware that pupils need to be taught how to design not just be set deadlines;
* be aware of the effect of a pupil's differing goal orientation, levels of creativity and learning styles upon how they react to the teaching strategies adopted;
* be aware that many boys are disadvantaged by the examination criteria, design strategies and teaching strategies adopted by teachers;
* encourage girls to be more responsible for their own projects throughout the design and manufacturing process;
* be aware that the duration of the project should neither be too long nor too short; set realistic interim goals throughout the project;
* use group presentations as a method of checking progress and stimulating future developments;
* be aware that the teaching strategy adopted will have differing effects upon different pupils within one cohort;
* be enthusiastic both about designing and about each individual pupil's project but at the same time allow pupil's to retain ownership of their idea throughout the process.

Figure 7.5 Illustrates the key points of advice regarding motivation of pupils for teachers of design and technology at Key Stage 4

Although the researcher would suggest that all the points in the list were important and needed to be addressed if teachers were to encourage pupils to be motivated, she would wish to highlight six as being of paramount importance.

The teacher must:

* teach adequate basic skills during years 7 - 9 in order to give pupils confidence during years 10 and 11 when they are confronted by new processes and manufacturing techniques;
* have a thorough understanding of designing beyond the requirements of the GCSE examination criteria;
* set realistic interim goals throughout the project;
* be aware of the effect of a pupil's differing goal orientation, levels of creativity and learning styles upon how they react to the teaching strategies adopted;
* be enthusiastic both about designing and about each individual pupil's project but at the same time allow pupil's to retain ownership of their ideas throughout the process;
* be motivated.

Discussion of the Six Points From the List of Advice for Teachers

Teach Adequate Basic Skills During Years 7 - 9 in Order to Give Pupils Confidence During Years 10 and 11 When They are Confronted by New Processes and Manufacturing Techniques

The research carried out during both Phase One and Two would support the opinion of many, that for the majority of design and technology teachers the pendulum swung too far in the early 1990's. Too much freedom of choice was given to inexperienced, immature pupils at the time of the Initial Survey, Phase One and Phase Two.

Identifying their own " *...needs and opportunities*" as advocated in the first NC documentation meant that skills were provided by teachers on a 'need-to-know' basis throughout each Key Stage. Class teaching become inappropriate. Pupils at the start of their studies in design and technology had a very varied, individual experience. This meant that many of them reached Year 10 & 11 without having acquired the basic skills that are agreed to be essential by teachers, HMI, educationalists and industrialists. The review of the National Curriculum recognised the inadequacies for many teachers of the very flexible framework provided in the first Orders. A far more structured approach was suggested in the most recent NC documentation pertinent to design and technology.

The findings of this study support teachers in rethinking the design tasks that they set in Years 7 - 9. Structured programmes of skill acquisition of both a practical and a conceptual nature that are built into targeted design opportunities will enable all pupils to develop the same expertise, rather than the ad-hoc methods witnessed recently. However, the researcher would like to issue a word of warning. It is important that the pendulum does not swing too far back. Teachers should not forsake the process model that is now firmly and rightfully embedded at the heart of design and technology activity. Pupils do need to be given tasks that become progressively more complex and provide them with the opportunity to take risks and become increasing responsible for managing their own activity. This approach is essential if pupils are to be ready to cope competently with the challenges of the open-ended design and technology tasks which are rightfully carried out during Years 10 and 11.

Have a Thorough Understanding of Designing Beyond the Requirements of the GCSE Examination Criteria

Observation throughout this research project identified that the skills of designing have not been adequately addressed by the majority of teachers. Teachers were observed instructing their pupils on what they must do within their design folio. Pupils were observed mechanistically following that prescribed pathway. The questions that the teacher should have raised and answered for the pupils concerning the 'how?' and 'why?' of designing were left unsaid. The data collected during the observation period would suggest that a possible reason for this may be that the majority of the teachers sampled during each Phase of the study did not themselves understand the complex philosophy underpining the process of designing.

An analysis of this situation led the researcher to surmise that the teachers, like their pupils, had had little opportunity to be involved in the activity of designing at a level that would give them the capability to support their teaching of design activity. If the researcher is correct then this would help to explain why so many teachers were unable to provide a deep, meaningful experience for their pupils and why they were unenthusiastic about teaching pupils to design.

Set Realistic Interim Goals Throughout the Project

During Phase Two it was noted that some teachers did set interim deadlines. However, the researcher would suggest that rather than setting deadlines which pupils fail to meet teachers should set realistic interim goals which pupils can achieve. Presentations to the rest of the group at various stages of the process can be a strong incentive for pupils to reach a certain stage by a given time. They can also be an excellent means of clarifying for both pupils' and teachers' an understanding of the solution being developed. This is particularly the case if three-dimensional models are used as a means of portraying thoughts and ideas at various stages of the process.

Be Aware of the Effect of a Pupil's Differing Goal Orientation, Cognitive Learning Style and Levels of Creativity Upon How They React to the Teaching Strategies Adopted

There has been little evidence of any research concerning internal factors such as a pupil's goal orientation, cognitive learning style and creativity in the context of motivation in the field of design and technology. It was therefore hardly surprising to find that the effect of these internal factors was not understood or even acknowledged by teachers during any phase of the study.

The researcher would suggest that testing pupils for goal orientation and cognitive style would enable teachers to be aware of the differing needs of the pupils in their classes. It would also enable them to provide appropriate advice and alternative strategies for individual pupils. Such strategies could help pupils to reach their full potential and overcome the lack of motivation witnessed in so many of the pupils targeted in this study.

As far as creativity was concerned, evidence collected from teachers during Phase Two indicated that teachers expected creative pupils to be well motivated and achieve high marks for the design elements of their project work. They believed that pupils who were not creative would struggle with these same aspects of the task. Phase Two data would suggest that their latter assumption was generally correct, however the former premise was not always found to be the case. Many creative pupils were demotivated by the mundane, restrictive framework set by the examination boards and adhered to by teachers. Whilst pupils who were less creative were demotivated by the length of time they had to devote to designing during their project work.

From the evidence collected the researcher would see it as important that teachers address their lack of encouragement of creativity in the work produced by pupils at Key Stage 4. Strategies need to be designed that will foster creativity. However, care needs to be taken to pay as much attention to building up creative attitudes as imparting creative techniques if the strategies are to be successful.

Be Enthusiastic Both About Designing and About Each Individual Pupil's Project but at the Same Time Allow Pupil's to Retain Ownership of Their Ideas Throughout the Process

Evidence from Phase Two indicated that the majority of teachers were themselves unenthusiastic about the process of designing. Through observation, discussion and analysis the researcher was able to build up a picture of some of the causes for this lack of enthusiasm. These tended to focus on an absence of teacher confidence in their ability to teach about designing and an inability to cope with the unknown.

Teachers focussed their concerns regarding the process of designing on the unpredictable nature of the process and its outcomes. They commented upon:

* their lack of control over their pupils' choice of projects, the direction those projects could take and the standards that their pupils would be able to achieve;
* their accountability when the results of the examinations were announced;
* the anticipation of pupil disappointment with the outcomes achieved.

The method that the majority of teachers used to overcome these fears was to try to take control of the design of each individual pupils' product. Within this research project this meant teachers being responsible for as many as seventy-five individual examination projects, an unenviable task even for the most successful designer. This model often meant that pupil s were no longer responsible for their own ideas and solutions. This lack of ownership was seen as demotivating by many pupils who had looked forward to work in years 10 and 11 specifically because they had understood that they would be able to make choices and decisions for themselves.

However, the mismatch between what pupils could achieve and what pupils believed that they would achieve was great. In this materialistic age when pupils are surrounded by complex technological products, their disappointment at the simplistic, poorly made solutions they were able to produce during their design and technology project work was understandable. Teachers were seen to have the unenviable task of turning the sophistication achieved in pupils' early ideas into solutions that were achievable given the pupils' ability and the material and process resources available within the school environment. Unfortunately, pupils did not always have the understanding, or the maturity of thought to visualise the consequences of their design decisions. They expected that their teacher would be able to solve any problems, as they generally had done in the simpler, teacher orientated tasks carried out in Years 7 - 9.

Be Motivated

Enthusiasm, confidence, an enquiring mind and the ability to cope with the unknown would seem to be key attributes needed for the motivated design and technology teacher. Being an expert in every aspect of design and technology is an impossible task. However, this has not always been the case. In the past when teachers taught single material, craft orientated courses they tended to be experts in all that they taught. They usually had great depth but limited breadth in their knowledge base. Many teachers of design and technology still find it difficult to come to terms with their new role. Being the fount of all knowledge is not a quality that can be expected of a teacher of design and technology. What is needed are teachers who: have a sound, in-depth knowledge base within a targeted area of design and technology; are able to design and make products at a level beyond that expected of their pupils; have the ability to work as a team with their pupils, and others, in order to source and use any new skills and knowledge as the need arises.

Establishing which factors have caused pupils to be demotivated and suggesting ways and means of overcoming the situation has been the main task of this research project. It would be unrealistic for the researcher to present any suggestions regarding the reasons why teachers are demotivated beyond those identified in the Literature Review and summarised in Figure 7.4. However, the researcher would wish at this point to state that whatever the reasons for a teacher's demotivation, the considerable effect that this demotivation has upon a pupil's motivational levels and their ability to achieve satisfactory outcomes, particularly at Key Stage 4, have been firmly established during this research project. It is therefore important for teachers to be apprised of this fact.

In order to verify further the correlation between despondent teachers and demotivated pupils a small case study was set up as an extension to Phase Two. This extra study also set out to test whether motivated teachers addressed a higher proportion of the 'Points for Teachers' successfully than did despondent teachers. The method, results and analysis concerning this extension are reported in Chapter Eight.

Further Reflections Specifically Upon High/Low Achievers and Motivation

Analysis of the extremes of any continuum can be the means of identifying the cause and effect of a situation. It was therefore considered important in the context of this research study to revisit the data concerning those pupils who were identified as high achievers and those pupils who were identified as low achievers in relation to motivation.

Within the classification of high/low achievers in design and technology and motivation it was important to understand that this could refer to pupils who were high/low achievers in design and technology alone or it could mean that they were high/low achievers across the whole diet of subjects that they were taking during Years 10 &11.

The analysis of the data indicated that all high achievers in design and technology tended to be successful across the majority of the subjects that they took at GCSE level. Low achievers could be separated into those who were low achievers across all their subjects and those who were low achievers only in design and technology.

High Achievers

When looking at the skills of high achievers, the evidence compiled gave further support to the theory that written skills were more important than drawing skills in achieving high project work marks. All high achievers were able to provide written communications of the highest standard, although only half of them were successful in communicating drawn images.

A significant point regarding attitude was that all of the high achievers had believed that they were capable of achieving good results before they started the task. Nor were any of them deterred from achieving that goal, whichever teaching strategy their teacher adopted, or whether their teacher was motivated or not. High achievers were found to score highly on the goal orientation index with their ability to reflect being particularly strong. In the area of cognitive style they were found to be mainly analytic although there were an equal number of verbalisers and imagers who gained high marks in their project work.

As far as creativity was concerned, half the group achieved above average scores in the creativity test whilst the other half did not. It was in the area of creativity that a difference within the group of high achievers was pin pointed. Those who were not creative tended to work hard throughout the project achieving their high mark through effort rather than design ability. Their motivation tended to come from their wish to achieve a good examination result rather than their enjoyment of the task.

On the other hand, those in the group who were creative and achieved high marks were not consistent in their work pattern. In fact, from an early stage in the process, most of them became disillusioned, demotivated and failed to provide work on a regular basis. The main cause for this was identified during observation and discussion with these pupils. The problem was the restrictive design process model that they were forced to adopt. However, even this sub-group of pupils were able to overcome their demotivation as the deadline approached. Their design ability, intelligence and goal orientation helped them to recognise the need for the production of a folio of work that would meet all the assessment criteria if they were to pass the examination. This they produced in a very limited time frame, with the minimum of effort, as the hand-in deadline was upon them. Unfortunately, for these highly creative pupils, their motivation also came through their wish to achieve a good examination result rather than their enjoyment of the task.

Low Achievers

The low achievers in this research project were all identified as demotivated. This demotivation occurred because of the lack of pupil success in the project work. For some the demotivation came at the start of the project, whilst for others it came as time progressed and their project work did not achieve the outcomes they had anticipated. Analysis of the data identified a combination of the following points as being reasons for the lack of success: poor design skills; poor communication skills; ill thought-out solutions; over ambitious solutions; poor manufacturing skills; incompatible teaching strategies; poor relationships with their teacher; absenteeism.

Analysis of the data indicated that nine of the twenty low achievers were low achievers only in design and technology whilst the other eleven were low achievers across the full range of their subjects at GCSE level. Of the latter group, three became truants from school on a regular basis, whilst another three had spasmodic attendance. These absences from school severely affected the pupils' ability to meet deadlines or understand what their project should entail in terms of thought or output. The five remaining pupils attended regularly but found the design work expected of them beyond their intellectual capability. The point at which these pupils became demotivated was dependent upon a combination of factors. In two instances, the enthusiasm of the teacher kept the less able pupils motivated for the majority of the design stage of the project, although the work that they produced was not of a high standard. In the case of the four other less able pupils, despondent teachers never managed to encourage them to participate whole-heartedly in their design activities. For these pupils demotivation set in from an early stage. This was despite their replies to the questionnaire at the end of Year 10, when three of them had indicated that they enjoyed the activity and believed that they would be able to achieve good results. The type of task selected by these less able pupils was seen to influence their motivation. In a number of instances, teachers were unable to adapt pupils' chosen designs enough to 'design-out' over ambitious solutions that were beyond the less able pupils' manufacturing capability.

As explained, absenteeism was common in this group of pupils. The reasons for missing school were sometimes valid personal reasons, although, more often than not they were school or design and technology orientated. When questioned about their absences these pupils usually cited boredom as the reason for their non-attendance. However, when asked for more specific answers the responses tended to centre around the pupils' lack of success in school in general or design and technology in particular.

The more complex group of low achievers were the nine pupils who were intellectually capable and were producing successful results in their other subjects. One of these pupils was amongst the four in the total sample who were not entered for the examination. For him, the demotivation came about for three reasons. He did not wish to take the subject in the first place; he missed a lesson; whilst away his design work was lost for several weeks; he did not enjoying the manufacturing stage of project work. When it came to the assessment deadline he just did not hand in any work.

Five pupils, all from the same school, also belonged to this category of academically able low achievers in design and technology. However, they belonged to a class who all achieved poorer marks than was expected of them. This school had adopted a rigid 'interventionist' approach, in which three teachers taught different aspects of the process to the same group. The teacher responsible for the design activity was a food technologist who was unable to prevent over ambitious design decisions being made. The teacher responsible for the manufacturing stage was seen to take little responsibility for any of the projects as he had not been involved in the design stage, whilst the Information Technology teacher insisted that pupils carried out the word processed aspects of their project during his timetabled sessions, whether the pupils were at an appropriate stage of their process or not.

An interesting point to note regarding four of these pupils was that they had all scored highly on the goal orientation index and the creativity test. This would suggest that in this instance, the external factors had been too powerful an influence over the internal factors, ending up with five, demotivated, intelligent pupils.

Three other academically able low achievers, all from different schools, also failed to be motivated. This was even though their questionnaire replies, their goal orientation test and their creativity scores indicated that they had a chance of being successful in their examination project work. In one case the pupil and the teacher were in constant dispute over discipline matters during every lesson that the researcher observed. This case was particularly disappointing as this pupil's designing was of a very high standard and exhibited a high level of creativity.

In the other two cases, the pupils from different schools began their project work already demotivated. They both believed that the subject was " *...a waste of time.*" One because of unrewarding experiences in Years 7 - 9, the other because he did not believe that design and technology would help him to achieve his ambition to go to University to study Medicine. They were both intellectually capable but neither of them believed they could draw. Nor did they see the point of trying to overcome their lack of skill in this area. They both suggested that they were unable to design. They were not interested in being taught how to tackle the work expected of them, although both pupils said that they enjoyed making things at home. Not surprisingly, neither of them finished their projects on time nor was the standard of the work they produced worthy of good marks.

Advice on how to Enhance Low Achievers Motivation

The list of key points of advice for teachers illustrated in Figure 7.5 were considered to be appropriate for all pupils, including those classified as low achievers. However, the researcher was aware that those pupils who had the potential to be low achievers and demotivated were particularly at risk and that extra strategies need to be put into place if demotivation was to be avoided.

When collating the additional advice for teachers, the researcher became aware that one set of strategies would not suffice for the wide variation of motivational problems associated with all the low achievers. The solution was to divide the advice into two separate lists. In the previous section, low achievers had been successfully classified for the discussion, as those who were low achievers in all their subjects and those who were low achievers in only design and technology. However, after careful consideration the researcher realised that classifying the low achievers in these groups did not overcome the problem identified when all the low achievers were in a single group. The diversity of motivational problems of the 'low achievers across all subjects' group would be the same as leaving all low achievers together (see Figure 7.6).

Low achievers in design and technology	Low achievers across all subjects
demotivated able pupils	demotivated able pupils
	demotivated less able pupils

Figure 7.6 Illustrates the classification of low achievers grouped by those who were low achievers across all their subjects and those who were low achievers in only design and technology

The researcher's solution was to divide the low achievers into those who were academically able and those who were less able (Figure 7.7) as it was seen that the needs of these two groups could be more easily covered by two separate lists of advice.

demotivated able pupils	demotivated less able pupils
Low Achievers in design and technology	Low achievers across all subjects
Low achievers across all subjects	

Figure 7.7 Illustrates the classification of low achievers grouped by ability

Academically Able Low Achievers

The problems associated with encouraging academically able pupils who are very demotivated across the full spectrum of their subjects is a difficult one to address. These pupils tend to opt out of the majority, if not all, of school activity by the time they reach Key Stage 4. The influence of the most enthusiastic, energetic, successful teacher will not be felt by the pupil who never attends. The researcher would suggest that dealing with the advice to teachers of this type of pupil is beyond the remit of a this research project. However, the demotivated able pupil who is a low achiever but does attend can be an interesting challenge for any enthusiastic teacher of design and technology. It makes little difference whether that pupil is demotivated in just design and technology or across all their subjects. Design and technology taught by a lively, enthusiastic teacher can enthuse the most demotivated, academically able pupil, if time and energy are on their side.

This research project has concentrated on Key Stage 4. However, it needs to be pointed out that if pupils are only demotivated in design and technology then an area that needs to be scrutinised is the pupil's past experience during Key Stage 3. Although the researcher is aware that in a number of cases control over that stage of a pupil's education may have been in the hands of another teacher or even a different school.

However, whatever the starting point in order to motivate these pupils they need to:

* be excited by the subject and have fun;
* be challenged by the subject;
* enjoy the activity they are involved in;
* see the relevance of what they are being asked to do;
* believe that they are capable of achieving, although aware that it will stretch them;
* believe that they will achieve more than just an examination result at the end;
* have something to take home that they will be proud of;
* possess the basic techniques and skills that will be their tool box whilst designing and making;
* believe that their teacher is guiding and supporting them;
* believe that their teacher is interested and enthusiastic about them and their work.

As far as the teacher is concerned, the list of key points for teachers illustrated in Figure 7.5 are all appropriate, although that list was written to cover all pupils and was not targeted at this particular group under discussion. The researcher has therefore written some additional points that she believes will help to encourage motivation amongst academically able pupils.

The teacher of these pupils needs to:

* provide mentally stimulating, rigorous activities - these pupils need to be shown the challenge that can be involved in design projects;
* encourage and support pupils when they experience disappointment and frustration;
* be aware that within the group learning and work rates will vary considerably;
* get to know the pupils, their strengths and their weaknesses;
* build upon a pupil's interests and experiences;
* understand that it is quality not quantity that is important - excessive quantity comes in two forms:
    * over-enthusiasm;
        * it is a teachers' responsibility to protect pupils from their own over-enthusiasm;
        * teachers must not push pupils to do too much for their projects as they may well have other subjects that are far more important to their futures;
    * irrelevant work;
        * for example in research rather as in an essay any research that is not shown to be of use to the specific task being addressed should be discouraged;
        * there should be evidence of research leading to design decisions;
        * using ball park terms and figures until the need arises for more detail;

    * collecting in depth research into such things as materials at the appropriate time rather than pages and pages of information regarding materials before any materials need to be chosen;
* make the process fun;
* give them a transparent, honest design process model to work within - one that will:
    * accept intellectual scrutiny;
    * be un-supportive of retrospective designing;
    * specify that hoops must only be jumped through if they are appropriate;
* try to involve pupils in designing for 'real' clients with genuine needs, not just themselves or imaginary situations;
* see the process as holistic. To do this teachers need to break down the artificial barriers they have constructed in the form of stages of the process - these pupils will have the intellect to understand;
* plan for progression over the Key Stage, not just more of the same;
* provide a well organised, well resourced, lively, stimulating environment;
* teach pupils to design in order to understand the how and why, not just be given a competency based model indicating what must be in a folio - e.g:
    * explain that a specification is dynamic and should be developed over the whole of the design stage;
    * explain that the development of the final solution needs each part to be detailed but that a feel for the product as a whole must not be lost;
    * separate the evaluation of the process from the evaluation of the product and explain how and why;
    * show pupils how a well designed specification can assist their evaluation;
* show pupils that at times their scientific knowledge and mathematical modelling are necessary skills within their design and technology work, but only where it is genuinely needed and not as another hoop to jump through;
* present sound arguments that support design and technology being a foundation subject that is relevant for all - to do this teachers need to believe in the subject themselves;
* teach them and support them and do not expect them to blossom on their own.

Less Able Low Achievers

Much has been written over recent years to support teachers in their task of enabling pupils with extreme learning difficulties to reach their full potential during design and technology activities. It is well recognised that many of these pupils may have severe difficulties in manipulating even the simplest of tools, equipment and materials that are normally found in design and technology studios and workshops. However, in the context of this research project it is not these pupils that this section of the thesis seeks to adress: it is those pupils who are entered for a range of examinations at GCSE level but are not expected to achieve grades above an F or G.

As with the group of academically able low achievers, the list of key points for teachers illustrated in Figure 7.5 are also all appropriate for the pupils referred to in this discussion. However, a number of the points need clarification and there are several extra ones that the researcher would wish to add specifically for this group of pupils.

The points raised for pupils who were academically able but were low achievers are just as relevant for the pupils who are less able low achievers. For this group of pupils to be motivated they need to:

* be excited by the subject and have fun;
* be challenged by the subject;
* enjoy the activity they are involved in;
* see the relevance of what they are being asked to do;
* believe that they are capable of achieving although aware that it will stretch them;
* believe that they will get more than just an examination result at the end;
* have something to take home that they will be proud of;
* possess the basic techniques and skills that will be their tool box whilst designing and making;
* believe that their teacher is guiding and supporting them;
* believe that their teacher is interested and enthusiastic about them and their work.

As far as the teachers are concerned they need to:

* be aware that within the group of pupils defined as less able low achievers there will be a considerable variation in the learning and the work rates achievable, although, the teacher must not assume that these pupils cannot or should not be stretched;
* get to know the pupils, their strengths and their weaknesses;
* build on previous experiences;
* provide opportunities for success;
* incorporate pupil interests and experiences;
* highlight the progress of the individual;
* help them overcome disappointment and frustrations;
* explain the relevance of tasks and processes in easily understood terms;
* provide flexible frameworks within which to design;
* get their pupils involved in making as early as possible;
* sometimes be prepared with a solution but always make improvements to ideas in conjunction with the pupil;
* making testing and evaluating fun as these are areas that have proved problematic;

* provide a range of stimuli:
    * use actual examples of products rather than photographs to explain products, materials and manufacturing processes;
    * use examples of design work to illustrate concepts within the design process;
* provide a well organised, well resourced, lively, stimulating environment;
* provide alternative methods of communicating:
    * use work sheets to develop specifications;
    * use photographs - digital cameras and computer print outs to record parts of design activity (e.g. early three dimensional models) - this overcomes the necessity to 'finish' a film;
    * use templates, jigs and devises to help pupils draw and make;
    * use group discussions and report back sessions to stimulate thinking and overcome mental blocks e.g:
        * at the early stage of developing a design specification - thinking of what must be considered;
        * deciding what research needs to be collected;
        * looking at early solutions in the form of models;
        * discussing what materials would be suitable;
        * discussing how to test, the materials, the solution etc;
        * evaluating the outcome;
* encourage pupils to use quick forms of three dimensional modelling:
    * at the early design idea stage to stimulate evaluative thinking;
    * to help in detailing chosen solutions;
        * these models help the pupil in the imaging of their ideas;
        * they provide the teacher with a real idea of what the pupil is intending;
        * they provide teachers and pupils with a discussion point to help them develop the form and the function;
* give targeted choice of projects not complete freedom of choice.

The researcher is aware that there are not many revolutionary points amongst the advice that is offered. Instead, the researcher has tried to establish a framework in which a teacher of design and technology could influence the motivational tendencies of their pupils and provide them with a quality learning experience. An analysis of the various lists should also inform the reader of the researcher's firm belief that the teacher's own keenly developed understanding of the design process is of paramount importance. The need for teachers who are enthusiastic both about their teaching and about the subject of design and technology is also evident from the suggestions made.

The results of the research project would support the notion that although the internal factors highlighted throughout the study have a vital role to play in determining a pupil's level of motivation in design and technology at Key Stage 4, the external factors can have an overriding influence upon many of the pupils. In particular the motivational level of the teacher was seen in each phase of the study to affect how they approached their teaching and the interaction that occurred between them and their pupils. In order to add support to these findings a small case study was set up as an extension to Phase Two (see Chapter 8). It was anticipated that the additional data collected would reinforce the researchers findings concerning the link between motivated pupils and motivated teachers and the corresponding link between demotivated pupils and demotivated teachers. It was also intended that further evidence would be collected to augment the suggestion that de-motivated teachers successfully address fewer of the 'Key points for teachers' indicated in Figure 7.5 than did motivated teachers.

Chapter Eight

Phase Two Extension

Introduction

The results of Phase Two provided evidence which supported the view that achievement and motivation in design and technology at Key Stage 4 were inextricably linked. Important factors that could affect a pupil's enjoyment and performance during their project work had first been identified through an analysis of the literature reviewed during an early stage of the project. Research carried out during Phase One and Two lead to a clarification of the researcher's understanding of the complex integrated nature of these internally and externally interdependent key factors. It identified the importance to pupil motivation of strategies adopted by both pupils and their teachers. It indicated that gender, creativity, cognitive style and general goal orientation were indicators of a pupil's ability to perform in design and technology project work. The collected data also highlighted the fact that the lynch pin in sustaining, enhancing or decreasing motivation was very often the teacher and that their influence upon the identified key factors could not be ignored.

As explained at the end of the discussion regarding Phase Two, the on-going analysis of the collected data had enabled the researcher to evolve a list of key points that she believed were crucial for teachers to understand and implement if they were to help their pupils overcome motivational problems and develop sound practice in their design and technology project work. This was seen to be particularly important at Key Stage 4 when pupils needed to produce well designed products as well as achieve examination results of which they, their parents and their teachers could be proud.

However the analysis of the data from schools indicated that a teacher's understanding of the key points was not always enough to ensure motivated pupils. The teacher's own level of motivation appeared also to be a fundamental ingredient that could not be removed from the equation.

In order to extend support for this conclusion a small scale extension to Phase Two was designed and implemented.

Aims of the Phase Two Extension

* To see if the support for the findings of Phase Two which indicated that a link existed between motivated pupils and motivated teachers and a corresponding link existed between demotivated pupils and demotivated teachers could be extended and, in particular,
* To gain further support for the findings of Phase Two which indicated that de-motivated teachers successfully addressed fewer of the 'Key points for teachers' indicated in Figure 6.35 than did motivated teachers.

Method

Methods of Examining the Issues

The issues to be examined during this phase had first been raised during the introduction and the literature review, developed during Phase One and further developed and clarified during Phase Two. The issues referred to in the aims for this phase were examined through the following means:

* an attitude test
* interviews
* cross reference to Phase Two 'Key Points for Teachers' (Figure 7·5)

Data Collection Methods

Data was collected for this extension to Phase Two using two instruments. An attitude measuring test was given to a new sample of Key Stage 4 pupils and a semi-structured interview was carried out with their design and technology teachers.

The choice of four specific teachers determined the sample of schools to be used in this extension to the research project. The teachers were chosen as a non-probability, purposive sample (Cohen and Manion, 1980) by three of the researcher's University colleagues. They were asked to identify two design and technology teachers whom they considered to be motivated and two design and technology teachers whom they considered to be demotivated. The colleagues were able to make informed choices from their knowledge of, and contact with, the design and technology teachers in schools used in the University's ITT programme. There was total agreement between the colleagues regarding the selection of the sample and their categorisation. In each instance the teacher selected was the Head of the Technology Department in the school.

The four schools chosen had each taken part in the Initial Survey of the research project. This meant that the researcher already had permission, from the Head Teacher, to approach the Head of Technology in order to collect data for her research project. It is important to note that none of the selected schools had formed part of the sample used for data collection during either Phase One or Phase Two. This avoided the possibility of receiving biased information from Heads of Technology who were familiar with the research questions asked during Phase One or Two and therefore with the data which had so far been collected and also, of course, of circularity of argument.

In the first instance the researcher contacted the chosen teachers by telephone. They were each asked if they were willing for themselves and their current Year 11 pupils to participate in the on-going research project. It was explained to them that in the first instance this would involve their pupils in completing a short self-reporting attitude test

(Cohen & Manion, 1985; Robson, 1990). The measuring instrument would seek to establish how motivated their pupils believed they had been during their design and technology examination project work. The teachers approached all agreed to allow their pupils to take part. This gave a pupil sample size of sixty-six (fourteen girls and fifty-two boys). A convenient time for the researcher to administer the test to the sample was agreed with each teacher. The timing of this visit was set to coincide with the completion of the design and technology examination project work in the later part of the spring term.

The design of the attitude test was based upon a review of the literature (Cohen and Manion, 1985; Atman, 1986; Bell, 1987; Robson, 1990) and on the experiences gained designing scales during earlier phases of the research project. It was trialed in a Phase Two school, by a group of pupils who had not taken part in any earlier stage of the research project and were therefore not sensitized to the study.

Please could you complete this questionnaire to help me in my research. The information that you provide will be strictly confidential and will only be used for statistical analysis in my research.

Please tick ☑ the most appropriate answer in the boxes provided

Male ☐ Female ☐

	Strongly agree	Agree	Disagree	Strongly disagree	Don't know
I have enjoyed doing my GCSE design & technology project this year.	☐	☐	☐	☐	☐
I think I will achieve a better mark for my GCSE design & technology project than I expected.	☐	☐	☐	☐	☐
I have worked harder for my GCSE design & technology project than any of my earlier design &technology projects.	☐	☐	☐	☐	☐
On the whole I am proud of my design folder for my GCSE design & technology project.	☐	☐	☐	☐	☐
I have hated doing my GCSE design & technology project	☐	☐	☐	☐	☐
My design & technology teacher is very enthusiastic about my project work.	☐	☐	☐	☐	☐
On the whole I am proud of the practical making part of my GCSE design & technology project.	☐	☐	☐	☐	☐
I do not think I will finish my GCSE design &technology project in time for assessment.	☐	☐	☐	☐	☐
My teacher has tried to encourage me throughout my GCSE design & technology project.	☐	☐	☐	☐	☐
I used to like design & technology but I do not now.	☐	☐	☐	☐	☐
I have never been really interested in design & technology	☐	☐	☐	☐	☐
I have been motivated to complete my GCSE design & technology project	☐	☐	☐	☐	☐
I only do my design & technology GCSE project because it is for the examination	☐	☐	☐	☐	☐
I worked hard during the early stages of my GCSE design & technology project	☐	☐	☐	☐	☐
I will be proud to take the practical outcome of my GCSE design & technology project home	☐	☐	☐	☐	☐
I work hard at my design & technology project because I enjoy doing it as well as because it is for my GCSE examination.	☐	☐	☐	☐	☐
I am disappointed with my design & GCSE technology project	☐	☐	☐	☐	☐
I haven't enjoyed many of my GCSE subjects during Year 11.	☐	☐	☐	☐	☐

	Yes	No	Don't know
Have you been entered for the GCSE design & technology examination?	☐	☐	☐

Thank you for your co-operation - All the best in your GCSE Examinations Stephanie Atkinson

Figure 8.1 Illustrates an example of the attitude questionnaire given to the sixty-six pupils in two schools during Phase Two extension

The test was presented on a single side of A4 paper and was designed to take a maximum of ten minutes of the pupils' time (see Figure 8.1 for an example of the test). At the top of the sheet there was an explanation of how the pupils should complete the test. There was also a sentence supporting the confidentiality of the information given (Cohen and Manion, 1980). It was recognised that it was not possible to assess attitude by means of a single 'location marker' (Cohen and Manion, 1980) in the form of a question or statement (Robson, 1990). A range of statements were therefore compiled. These enabled the researcher to tease out the issues and allowed her to build up a fuller picture of the attitude being tested. This method also provided a useful means of triangulating the data collected from one statement with the data collected for another. In this instance nineteen separate attitudinal statements concerning design and technology project work were used. A two dimensional grid classification was designed for pupils' replies. This was based on a system developed by Likert (1932). The pupils were asked to tick one of five boxes which indicated how much they agreed or disagreed with the statements presented. In order to encourage the pupils to answer truthfully care was taken to vary the response required with the use of both positive and negative statements. The test ended with a message thanking them for their co-operation and wishing them all the best in their GCSE Examinations.

The test was taken to the schools by the researcher. It was completed and returned whilst the researcher was present. This removed the problems associated with the non-return of some tests and questionnaires (Cohen and Manion, 1985; Bell, 1987). During the visit the researcher also took the opportunity to ask the teachers whether they were willing to be interviewed about their pupils and the teaching of Key Stage 4 design and technology on another convenient occasion. All four teachers indicated that they were quite happy to participate if they were selected to do so.

The attitude test was pre-coded onto an acetate grid. This enabled quick entry of the collected data into a new data base using FileMaker Pro. Calculations of the average scores for each statement, each pupil and each school were then carried out.

The next stage of data collection was a semi-structured interview with two teachers responsible for two of the four pupil cohorts that had formed the pupil sample. The selection of teachers was made using the average scores achieved by the pupils in the attitudinal test. In one instance it was the teacher whose pupils had achieved the highest average motivational score who was chosen, whilst in the other instance it was the teacher whose pupils had achieved the lowest average motivational score (see Table 8.1).

In both cases the interviews were held in a quiet room where the teacher and researcher were undisturbed (Cohen & Manion, 1985). The interview was carried out by the researcher using a tape recorder and an interview guide (see Appendix 1.6). The guide outlined the topics to be covered and questions to be asked. The questions were based around the 'Key points for teachers' that had been developed by the researcher during Phase Two of the project. Care was taken to ask questions in a manner which did not suggest that there was right or wrong answer to any of the questions. The researcher also took pains to ensure that both teachers believed that their opinions were valued however positive or negative their replies to the questions appeared to be.

	No. of Pupils	Average Score
School 1	**11**	**27.636**
School 2	19	30.316
School 3	14	31.429
School 4	**22**	**34.545**
		Maximum Score 55

Table 8.1 Shows the average class score on the attitude test carried out by the sixty-six pupils in the Phase Two extension

Once the interviews were completed the analysis of the data was carried out by listening to the tapes and referring to the 'Key points for teachers' list. A score of 1 was recorded when the analysis of the teacher's replies indicated a positive commitment to a specific point on the list. A score of 0.5 was recorded when the analysis indicated the teacher's partial commitment to a specific point. Whilst a score of 0 was recorded if the teacher's replies indicated no commitment to a specific point in question. Once a score had been given for each of the key points listed then a total score for the teacher was able to be calculated. Teachers' and pupils' scores were compared.

Results and Discussion

It was recognised that the new sample was far too small for the data collected to be considered representative of motivated and de-motivated design and technology teachers in general terms (Cohen & Manion, 1985). However, results of the analysis of the attitudinal test supported the findings of Phase Two in which the influence of teacher motivation upon pupil motivation had been highlighted. Analysis of the pupils responses to all fourteen selected attitudinal statements were found to be more positive in the two schools in which the teachers were identified as motivated when compared to the two schools in which the teachers had been identified as demotivated (see Table 8.2).

	Average Score All pupils/Motivated Teachers	*Average Score All pupils/De-motivated Teachers*	*Mean Difference*		*t* = Value	*p* = Value
I have enjoyed doing my GCSE design & technology project this year.	1.944	1.633	0.311	DF 64	*t* = 1.471	*p* = .1462
I think I will achieve a better mark for my GCSE design & technology project than I expected.	1.333	0.933	0.400	DF 64	*t* = 1.871	*p* = .0659
On the whole I am proud of my design folder for my GCSE design & technology project.	1.750	1.467	0.283	DF 64	*t* = 1.568	*p* = .1219
I disagree with the statement: I have hated doing my GCSE design & technology project	2.111	1.767	0.344	DF 64	*t* = 1.504	*p* = .1375
My design & technology teacher is very enthusiastic about my project work.	2.056	1.567	0.489	DF 64	*t* = 1.874	*p* = .0655
On the whole I am proud of the practical making part of my GCSE design & technology project.	1.944	1.800	0.144	DF 64	*t* = 0.772	*p* = .4431
My teacher has tried to encourage me throughout my GCSE design & technology project.	2.333	2.067	0.267	DF 64	*t* = 1.334	*p* = .1870
I disagree with the statement: I used to like design & technology but I do not now.	2.111	1.733	0.378	DF 64	*t* = 1.560	*p* = .1237
I have been motivated to complete my GCSE design & technology project	1.972	1.533	0.439	DF 64	*t* = 2.291	*p* = .0253
I only do my design & technology GCSE project because it is for the examination	1.528	1.633	- 0.106	DF 64	*t* = - 0.493	*p* = .6234
I will be proud to take the practical outcome of my GCSE design & technology project home	1.778	1.600	0.178	DF 64	*t* = 0.734	*p* = .4656
I work hard at my design & technology project because I enjoy doing it as well as because it is for my GCSE examination.	1.944	1.667	0.278	DF 64	*t* = 1.412	*p* = .1629
I disagree with the statement: I am disappointed with my design & GCSE technology project.	1.861	1.667	0.194	DF 64	*t* = 0.983	*p* = .3293
I haven't enjoyed many of my GCSE subjects during Year 11.	1.750	1.767	- 0.017	DF 64	*t* = - 0.075	*p* = .9407

Table 8.2 Illustrates the results of the pupils' *(n = 66)* attitude test grouped by motivated and demotivated teachers

Assuming that one was no more likely to be positive than the other if the findings were wrong, then the overall pattern of results in which more positive pupils were associated with their teachers' more positive attitude would happen by chance alone with a probability of only $p = 0.00006$ using the Binomial Test (see Table 8.3).

	Average Score All pupils Motivated Teachers	*Average Score All pupils De-motivated Teachers*
I have enjoyed doing my GCSE design & technology project this year.	+	-
I think I will achieve a better mark for my GCSE design & technology project than I expected.	+	-
On the whole I am proud of my design folder for my GCSE design & technology project.	+	-
I disagree with the statement: I have hated doing my GCSE design & technology project	+	-
My design & technology teacher is very enthusiastic about my project work.	+	-
On the whole I am proud of the practical making part of my GCSE design & technology project.	+	-
My teacher has tried to encourage me throughout my GCSE design & technology project.	+	-
I disagree with the statement: I used to like design & technology but I do not now.	+	-
I have been motivated to complete my GCSE design & technology project	+	-
I only do my design & technology GCSE project because it is for the examination	+	-
I will be proud to take the practical outcome of my GCSE design & technology project home	+	-
I work hard at my design & technology project because I enjoy doing it as well as because it is for my GCSE examination.	+	-
I disagree with the statement: I am disappointed with my design & GCSE technology project.	+	-
	+	-
	Binomial test p = 0.00006	

Table 8.3 Illustrates the results of pupils' *(n = 66)* attitude test grouped by motivated and demotivated teachers. A binomial test was carried out on the data. It indicated that assuming that one was no more likely to be positive than the other findings were wrong, then the overall pattern of results in which more positive pupils were associated with their teachers' more positive attitude would happen by chance alone with a probability of only p = *0.00006*

When the average score for each statement was entered into a graph it was found that the data for pupils with motivated teachers and the data for pupils with de-motivated teachers followed a similar pattern (see Figure 8.2) although one graph was generally scored more positively than the other. The two instances where this was not the case arose because statements number ten and fourteen were written in a negative rather than positive form. Agreement with the two statements by pupils with motivated teachers was expected to be low. In statement ten the pupils were asked whether they agreed with the comment " I only do my design and technology GCSE project because it is for the examination". Whilst statement fourteen followed a similar pattern in that it asked pupils whether they agreed with the comment "I haven't enjoyed many of my GCSE subjects during Year 11".

As one would have expected results to a statement concerning enjoyment of GCSEs in general were similar for all pupils in the total sample (n = 66). However, in a comparison between the results to an attitudinal statement regarding enjoyment of design and technology a mirror image between the two groups was recorded. As one would have expected those pupils who were taught by motivated teachers were found to be considerably more positive in their response to that statement in comparison to those pupils who were taught by de-motivated teachers (see Figure 8.3).

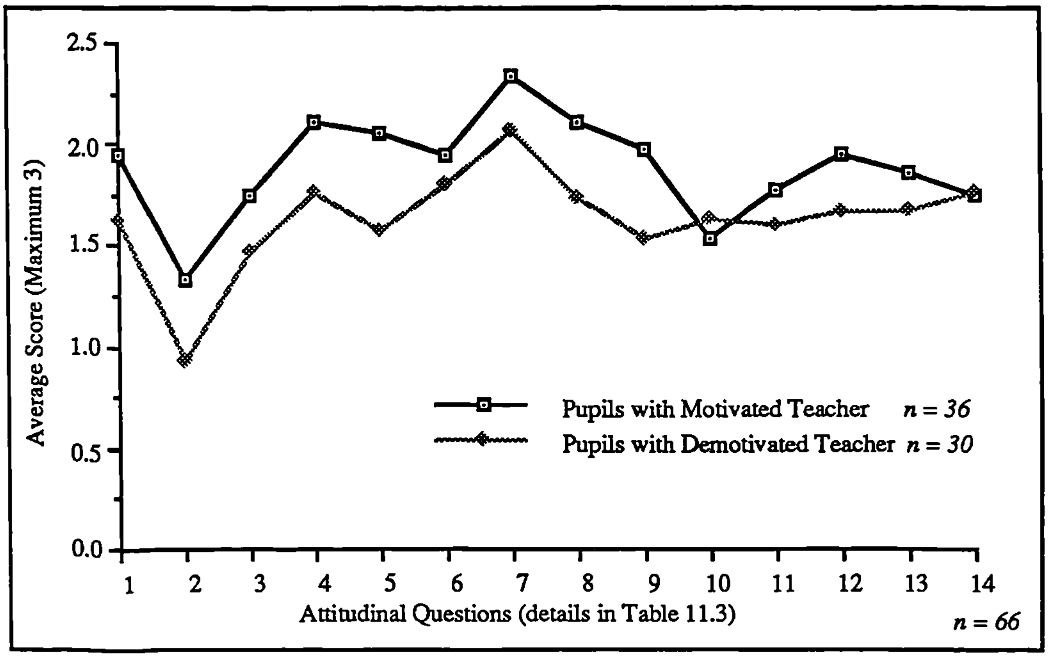


Figure 8.2 Illustrates the effect of teacher motivation upon pupils' average scores in an attitudinal questionnaire regarding design and technology project work. The graph shows data grouped by motivated and demotivated teachers. The detail of the questions asked can be found in Table 8.3

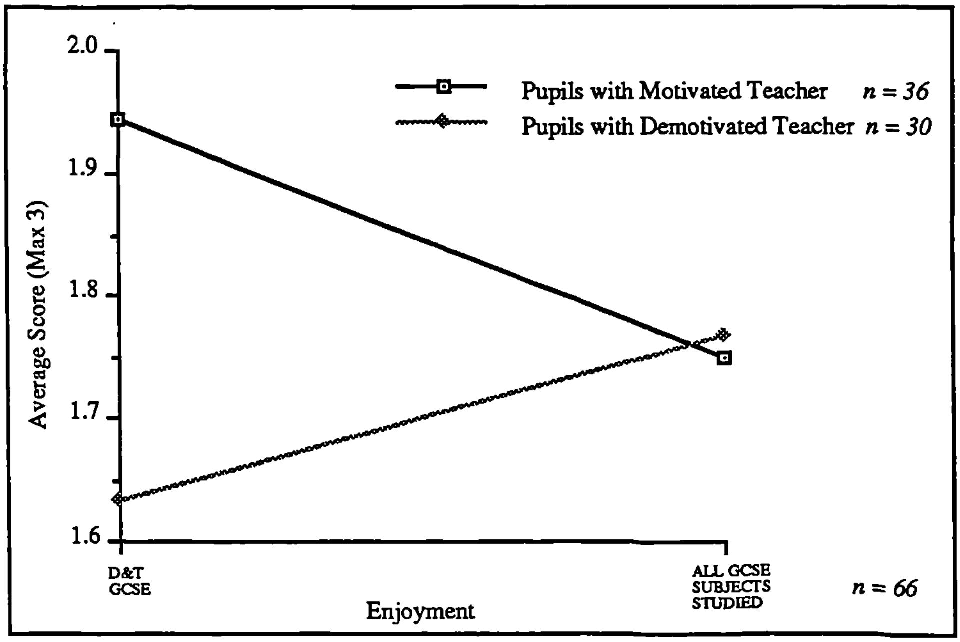


Figure 8.3 Illustrates the effect of teacher motivation upon pupils' average scores when comparing enjoyment of design and technology (question 1 in Table 8.3) and enjoyment of GCSE subjects in general (question 14 in Table 8.3)

In a comparison between the school which had achieved the highest average score in the attitude test and the school which had achieved the lowest average score (see Table 8.4) it was noted that there was a significant difference between the pupils scores (see Table 8.5). The collected data indicated that sixty-four percent of the pupils in the school with a motivated design and technology teacher achieved a score above 31.515, that being the average score for the total sample. Whilst only eighteen percent of the pupils in the school with the de-motivated teacher achieved an above average score (see Figure 8.4).

		Pupils with score above 31.515		Pupils with score below 31.515	
De-motivated teacher	**School 1**	**2**	**18%**	**9**	**82%**
	School 2	10	53%	9	47%
Motivated Teacher	School 3	8	57%	6	43%
	School 4	**14**	**64%**	**8**	**36%**

Table 8.4 Illustrates the percentage of pupils in each school *(n = 4)* who scored above and below the average score for the total sample in the attitude questionnaire. The average score was 31.515 with a possible maximum score of 55

Schools 1 & 4	
df	1
Chi - Square	6.066
p Value	0.0138
Fishers exact *p* value	0.0255

Table 8.5 Illustrates the significant difference between School 1 and School 4. in the percentage of pupils who gained above average scores and below average scores in the attitude questionnaire, using the data to be found in Table 8.4

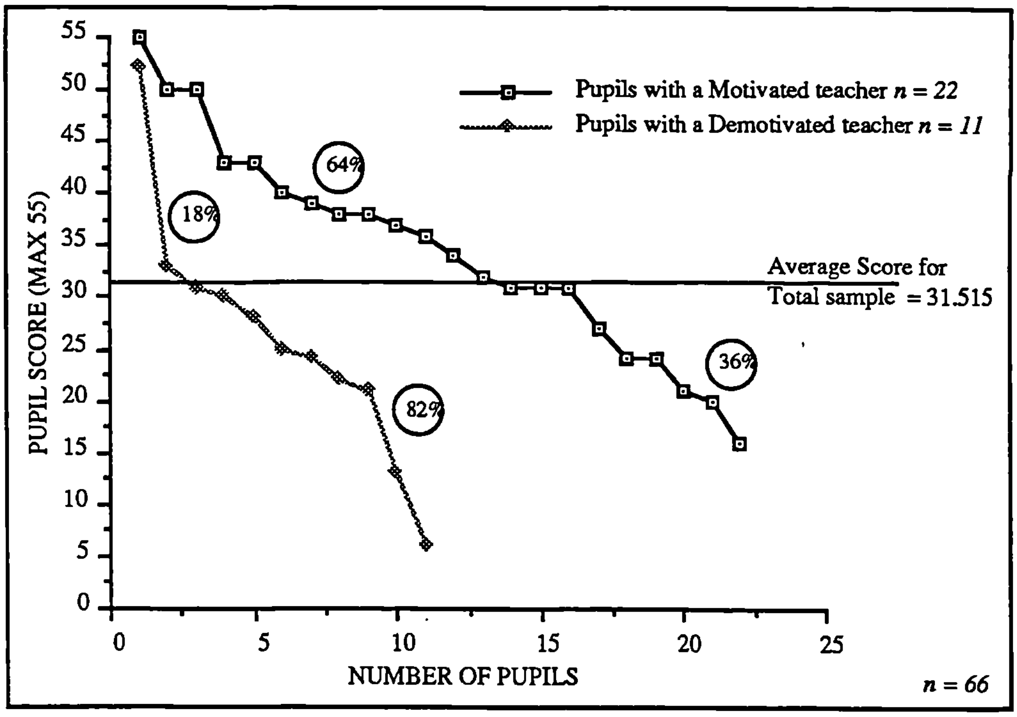


Figure 8.4 Illustrates pupils' score differences on the attitude questionnaire grouped by those who were taught by motivated teachers and those who were taught by demotivated teachers. The graph also shows the number and percentage of pupils who achieved above average and below average scores in these two categories

In setting out to add support to the findings of Phase Two concerning the 'Key points for teachers' stated in Figure 7.5 (page 280), data from the two teachers interviews was analysed. A score was given which indicated the teacher's level of commitment to each key point. This was derived from the analysis of the taped interviews. 0 indicated no commitment to a 'key point', 0.5 a partial commitment and 1 a positive commitment.

Each key point was dealt with separately. Upon totalling the scores it was found that the motivated teacher had achieved a score of 10.5, seventy-five percent of a possible score of 14, whilst the de-motivated teacher only achieved a score of 6.5 or forty-six percent of the possible score (see Table 8.6 and Figure 8.5).

	Key Points for Teachers (for details of points see Table 10.1)													
Teacher	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Motivated	1	1	0	1	1	1	0.5	0	1	1	1	0	1	1
Demotivated	1	1	0	0.5	0.5	0.5	0	1	0.5	1	0	0	0.5	0.5
1 = positive commitment; 0.5 = partial commitment; 0 = no commitment.														

Table 8.6 Illustrates the observed commitment of the motivated and demotivated teacher to the 'Key Points for Teachers'. Details of the key points are to be found in Table 10.1. Data for this table was taken from the analysis of the interviews carried out with the two chosen teachers

It was interesting to observe that there were similarities between the responses of the two teachers in their replies to thirty six percent of the fourteen Key Points. For instance on a positive note the taped interviews led the researcher to believe that both teachers understood the design process beyond the requirements of the GCSE examination criteria, they both taught basic skills to their pupils at Key Stage 3 and they both tried to address the problems associated with time management of long coursework projects. Disappointing similarities were found in two instances. Neither of the teachers were aware that a pupil's belief in their own ability could be of greater importance to their sustained motivation than their anticipated enjoyment of the process. Nor had either of them thought of using group discussions or presentations as a means of checking progress and stimulating future developments, even though the motivated teacher set interim deadlines using the process driven assessment criteria as cut off points at strategic times throughout the examination project work.

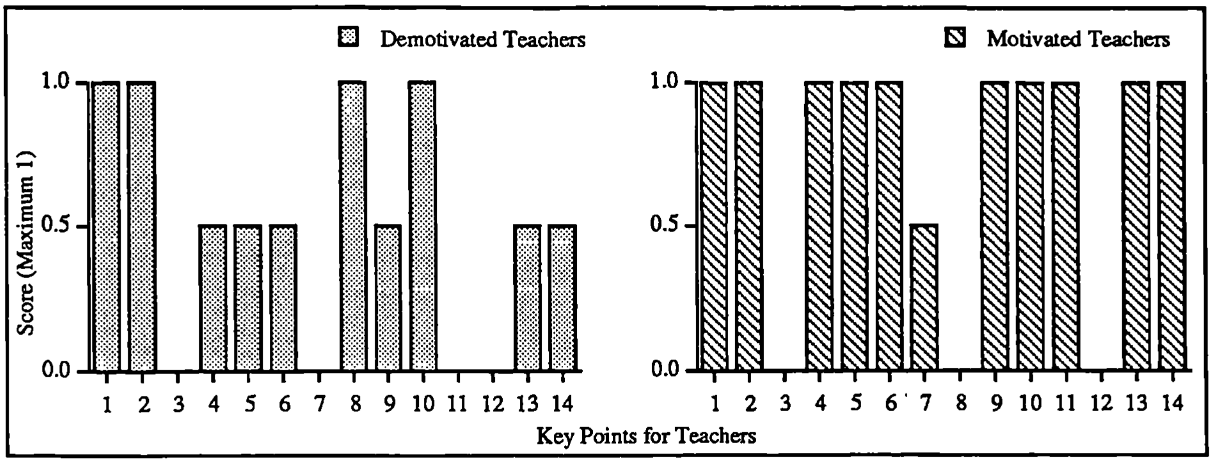


Figure 8.5 Illustrates in two bar charts the differences between the motivated and demotivated teacher's responses to the 'Key Points for Teachers'.

The motivated teacher believed that pupils needed to be taught to design not just be set deadlines. He encouraged his pupils to use various forms of modelling throughout the process, and utilised three dimensional modelling where he believed it was appropriate. He encouraged his pupils to plan their manufacturing process in order to satisfy examination criteria and also because he wished them to produce outcomes of which they could be proud. He displayed an understanding of the differing requirements of boys and girls and believed that girls needed to be encouraged to be more responsible for their own activities at all stages of the process. He was also aware that the teaching strategies that he adopted were likely to have differing effects upon different pupils within any one cohort. The motivated teacher was also seen to be very enthusiastic about his pupil's work, about his teaching in general and about the school in which he was employed. This was the case even though he believed that he, like the majority of his colleagues, was under considerable pressure from the changes that were occurring around him in education in general and technology in particular.

Similarly the de-motivated teacher also believed that pupils should be taught to design, use appropriate forms of modelling and plan their manufacturing stage before making began. He too believed boys and girls had differing requirements and was aware that boys could be disadvantaged by the GCSE examination assessment criteria. However, the interview highlighted an important difference between the two teachers approach to their pupils and the way in which they taught them. Analysis of the data suggested that the demotivated teacher tended to see his pupils' ability, their progress and their outcomes in a negative light. He explained that he needed to be in control, with solutions to each pupil's process and product at his finger tips. Pupil ownership of their project, as defined in Phase Two, was not part of his ethos. He believed that as long as he was in command, a pupil's differing goal orientation, levels of creativity and learning styles would have little effect upon what they would achieve and how much they would enjoy it. Unfortunately the data from the interview also indicated that he found it difficult to be enthusiastic about his pupils' work, about his teaching in general and about the school in which he taught.

Conclusion

Phase Two extension achieved what it set out to achieve. It provided a small case study from which data was gleaned that enabled the researcher to provide extra support for the conclusions that had been drawn out of Phase Two of the research project. The research tools used were appropriate and gave the anticipated exploratory and explanatory information. The size of the sample of pupils interviewed was large enough for statistical analysis to be carried out successfully on the collected data. The size of the teacher sample was far to small for any statistical analysis. However, it had not been the intention of the researcher to collect data for the purpose of statistical analysis at this stage of the project. Rather, the information gathered from the two teachers was used to provide a more informed picture of a motivated and despondent design and technology teacher. The combination of data from the pupils and the two teachers enabled the researcher to provide further support for the findings of Phase Two which indicated that a link existed between motivated pupils and motivated teachers and a corresponding link existed between demotivated pupils and demotivated teachers. Having established during Phase Two that certain external factors influenced by teachers were vital in maintaining pupil motivation whilst they were engaged in design and technology project work, the results of Phase Two Extension supported the researcher's belief that motivated teachers were more likely to address these points satisfactorily than were teachers who were despondent.

The researcher was aware from other professional encounters, and from her detailed observations during Phase One and Two of the study, that the reasons for a teacher's demotivation were likely to be as complex and multifaceted as had been found to be the case when the reasons for a pupil's demotivation had been researched. However, the identification of reasons for a teacher's level of motivation have not been the aim of this research project. Although, the key educational issues that had been identified during the LiteratureReview were confirmed during both Phase One and Phase Two as having an effect upon teachers and their motivation. These issues could be summed up as: the developing philosophy of design and technology over the past twenty years; the introduction of the National Curriculum; accountability; financial constraints; the speed of the changes in direction since the introduction of the National Curriculum.

The salient feature of this Phase Two extension has been the support that it has provided for the conclusions drawn during Phase Two. In particular it has added reinforcement to the theory that identified internal key factors do affect a pupil's ability to perform and be motivated but that these factors could be enhanced or negated by a teacher's own level of enthusiasm and their ability to bring that enthusiasm into their teaching.

A Final Look

As explained in the introduction to this thesis, the importance of design and technology education and its failure to involve a larger proportion of young people at a time of considerable technological change in society, has been the concern of educationalists and others in the UK throughout the second half of this century (e.g. Snow, 1964; Black & Harrison, 1985; DES, 1988; Smithers & Robinson, 1992).

Design and Technology is a relatively new and therefore developing area of the school curriculum. Most recently, it has grown out of work undertaken in CDT, Home Economics, Art and Design, Business Education and Information Technology. During the short period of this research project, this subject area has witnessed a further series of curriculum developments that have lead to a number of fundamental changes in emphasis and direction. Although the majority of teachers involved in delivery have supported the need for change, it would be fair to suggest that changes would have happened at a slower pace if it had not been for the introduction of the National Curriculum. In particular, it was the timetable for implementation specified subject by subject and key stage by key stage (NCC, 1989) which dictated when the new curriculum must become part of every pupil's entitlement and hence when the changes must take place.

Capability in design and technology involves a complex integration of processes, concepts, knowledge and skills (APU, 1987). Since the introduction of design activities within this area of the school curriculum, it has been considered important that pupils should be engaged in purposeful, comprehensive activities (APU, 1991), that require them to apply their skills and knowledge in developing solutions of a practical nature (DES,1990; NCC,1993). Project work, using a design process model, has been recognised as an appropriate method through which teachers can deliver the content of this area of study.

For a long time it has been recognised that there is a logical procedural strategy required when designing (Lawson, 1990; APU, 1991; McCormick et all, 1993; Shield, 1995). However, not all of those using, or teaching others to use, the design process have understood that with each new task the procedure should vary in emphasis and in the amount of time needed for each stage. In fact, even given the same task, each designer's process should be determined by the individual nature of the developing solution.

Within a school context, GCSE examination syllabuses have tended to interpret the process in a rather narrow, unhelpful and restrictive manner. Assessment criteria have been written in such a way as to suggest that pupils are not engaged in designing unless they undergo and demonstrate each of the stipulated stages of the process (NEAB, 1993; SEG., 1993). As a consequence there has been a tendency for pupils to learn that designing is concerned with jumping through hoops in a pre-determined order, whether it is appropriate to the task or not.

The relevant literature (DES, 1993; DES, ; Barlex, 1994) has signalled that teachers working within national curriculum guidelines have found it increasingly difficult to balance the requirement for pupils to work within a broad based range of materials within expanded contexts, with the need to ensure that pupils produce outcomes of quality by possessing sound design and manufacturing skills.

The use of project work as a teaching and learning strategy has been well researched in the UK (e.g. Down, 1986; Wray, 1988; Stables, 1993) and abroad (e.g. Tenenbaum, 1951) in a variety of educational contexts. It's motivational advantages over the more traditional forms of classroom activity have been widely reported. However, there has been a growing recognition that project work in design and technology (e.g. Denton, 1992; Grieve, 1993; Barlex, 1994) can cause some pupils considerable motivational problems. Research into reasons why this should be the case have been minimal as scholars have tended to concentrate on the advantages rather than the disadvantages of such an activity.

Given the accepted importance of design and technology education, it would seem vital that the curriculum offered to these pupils should motivate them to participate fully. Within this context the research project set out to clarify the potential causes of demotivation identified during the literature review. It also sought to examine and quantify new causes of demotivation that were highlighted during each phase of the study. The final stage of the research project was to recommend strategies for teachers of design and technology that could help to improve the situation regarding demotivation.

Based on reasonable speculation, the literature review revealed and suggested several key factors that could possibly relate to pupil demotivation. The inter-relationship between the potential factors was seen to be complex. Although analysis of the different elements did enable them to be classified into two groups which were seen to be helpful. These were factors that were pupil dependent and those that were teacher dependent. Data collected and analysed during Phase One enabled the researcher to refine these classifications. It became apparent that the factors that had been grouped as teacher dependent were not all instigated by the teacher alone. Key educational issues that had been highlighted during the literature review were seen to have a marked affect upon the teachers and their teaching strategies. This, in turn, affected their pupils and the ways in which they tackled project work. It therefore seemed more appropriate to re-classify the teacher dependant factors as 'external factors', whilst those that had been labelled pupil dependent were re-classified as 'internal factors'.

Various permutations of the data collected regarding the internal and external factors throughout both Phase One and Phase Two were used in order to come to some conclusions regarding the causes of demotivation amongst the Key Stage 4 pupils whilst they were engaged in their design and technology project work. This included an analysis specifically targeting high and low achievers as it was felt by the researcher that reflecting upon the extremes of any continuum could be the means of identifying the cause and effect of a situation.

In general terms the effect of performance upon motivation and motivation upon performance was seen as a significant feature throughout the study, one that had a considerable influence upon both teachers and pupils. It was found to be particularly relevant at Key Stage 4, when the importance of examination results dictated that the nature of assessment and its criteria influenced what was learnt, how it was taught and how much pupils and teachers enjoyed their experiences.

Internal attributes such as creativity, goal orientation and cognitive style were seen to have an effect upon motivation and performance. High scores for creativity and goal orientation both tended to be valid indicators of good examination results and high levels of motivation. Low scores in goal orientation usually indicated poor performance and demotivated pupils. Correspondingly, low scores in creativity although quite often indicative of low levels of motivation were not always reflected in poor project work marks. In the context of cognitive style, pupils who were found to be analytic verbalisers achieved the highest marks and were highly motivated whilst those whom one would have expected to achieve high marks (as explained in earlier chapters), wholists imagers, were found to achieve significantly low marks and were all demotivated.

The importance of goal orientation as a reliable indicator of levels of both motivation and performance was emphasised when a combined analysis of all three internal attributes was carried out. It was found that the majority of pupils with high goal orientation scores overcame their lack of creativity and the fact that they were wholist imagers. They remained motivated and achieved high marks. Correspondingly, pupils with low goal orientation scores tended to be demotivated and achieve low marks even if they were highly creative and were analytic verbalisers.

When scrutinising the teaching approaches adopted by design and technology teachers it became apparent that they did not provide alternative learning strategies for pupils disadvantaged by their levels of creativity, goal orientation or cognitive style. However, this was hardly surprising, as little research has been carried out or published within the field of internal attributes and their effects upon motivation and performance in design and technology project work.

Recently there has been considerable research interest across all curriculum areas concerning the issue of gender difference both in terms of performance and motivation.

This has been particularly pertinent in the context of design and technology where it has been recognised as important to redress the balance away from the male domination witnessed in this subject area in the past. However, in line with other statistical analysis of examination results (Riding, 1993; SCAA, 1997), the evidence from this study would suggest that in the majority of their subjects at Key Stage 4 it is boys who are disadvantaged in terms of performance and motivation at this present time.

An explanation for this unexpected gender result within design and technology was uncovered during this research study. It stemmed from the lack of design and practical skills displayed by the majority of pupils of both genders during their project work at Key Stage 4. The strategy adopted by teachers to overcome this problem was for them to take away the decision making element of project work from the pupil at the manufacturing stage of the project. Pupils no longer felt that their work was their own. This had a detrimental effect on the boys for whom ownership of their project would appear to be of greater consequence than was found to be the case for girls in a similar situation.

However important all the internal factors on their own, or in combination with one another, may appear to be in determining a pupils level of motivation, the significance of the external factors upon pupil motivation cannot be over emphasised. The data collected indicated that the external key factors all affected how the design and technology teachers taught and that the pupils were affected by whom and what they were taught.

As was stated earlier, the external factors were not necessarily all teacher led, although they were all design and technology orientated. One such demotivating external factor was the effect that the National Curriculum had upon teachers and their pupils. The breadth of experience which the teachers had had to provide during Key Stage 3 prevented them from teaching a suitable basic skills programme to their pupils that would have supported their examination project work. This led to the lack of skills, which have been seen to cause dissatisfaction, leading to demotivation amongst many pupils.

At Key Stage 4, the effect of the design process upon pupil motivation was considered to be highly influential. These influences came from two sources: the teachers' understanding of the process; the examination boards use of the process within their syllabuses. Examination board syllabuses were also shown to influence the delivery programmes and teaching strategies adopted. Content demands and assessment criteria were seen to affect what was taught, how it was taught and how long teachers gave to each aspect of the syllabus. The major project assessment criteria were not in themselves responsible for the teaching of inappropriate design strategies. However, the importance of the examination results meant that teachers adhered rigidly to a process that would provide evidence that would gain marks for their pupils, rather than concern themselves with teaching pupils to choose the most appropriate process for each specific task.

However, as has already been discussed, the blame for demotivation due to the adoption of inappropriate design processes does not rest solely with the examination boards. The influence of the teacher's own understanding of designing was shown to be significant. Evidence from observation of the teaching methods used indicated time and again that teachers did not themselves understand the process beyond a need to meet assessment criteria specified by the examination board. Their teaching methods were based on rote learning techniques rather than using strategies that would have developed pupils' real understanding and enjoyment of the process. This was unfortunate as the majority of teachers hampered the development of genuine design skills, inhibited creativity, incited boredom and demotivation amongst many of their pupils.

The teachers' pre-occupation with trying to achieve good examination results was understandable. External pressures upon teachers and schools in general have become significant, not least in the areas of performance indicators, accountability and financial constraint. The effect of the identified general educational issues and those more closely concerned with design and technology have been widely felt. The introduction of the first National Curriculum Technology Orders and the start of this research project coincided. During this time teachers have found themselves in a constant state of change. This was seen to be particularly difficult for teachers who have been in the profession for a number of years and for whom teaching design and technology had until then been a stable aspect of their teaching activities. Evidence from the study would suggest that for many teachers, even those who were once motivated, the combination and speed of the changes eroded their enthusiasm. Not surprisingly, the data analysis indicated that the motivational level of a teacher had a marked affect upon their pupils. Motivated teachers were seen to motivate many of their pupils, even those who were not necessarily expected to achieve good results. The effect of such factors as poor goal orientation, a lack of creativity, unhelpful cognitive style in the context of design and technology project work, average or below average ability either in design and technology alone or across the full range of subjects at Key Stage 4, were all seen to have less effect if the teacher was enthusiastic and motivated. In classes taught by despondent teachers there was a tendency for even capable pupils with the potential to be well motivated to become demotivated and fail to achieve outcomes of which they could be proud. These pupils were found to be leaving Key Stage 4 with a very disadvantageous and unrepresentative view of design and technology. A message which they would inevitably carry with them into their future life beyond school.

The final aim of the research project had been to recommend strategies for teachers that could help to overcome the demotivation witnessed amongst the pupils studying design and technology at Key Stage 4. Throughout Phase Two experiences and situations that were seen to affect motivation were noted. These were organised into a general list providing suggestions that it was hoped would benefit the teaching of design and technology and encourage pupils to participate with enthusiasm. It included points that were concerned with: the teachers' own expertise; the teachers' own attitudes; strategies that could improve their teaching; the skills and processes used by the pupils that needed greater attention than had been witnessed during the research project; aspects concerning the pupils attitudes that needed a teachers' encouragement; pupils' attributes that had been identified as affecting motivation.

Two other lists of suggestions for teachers were also compiled. These were targeted at addressing the specific problems of the disappointingly large group of low achievers identified during the research project. The two lists were targeted at two sub-sets of pupils within this classification, those pupils who were academically able low achievers and those pupils who were less able low achievers. The lists contained further, more detailed suggestions concerning both the teachers' skills and attitudes and the pupils' skills and attitudes.

The various lists were written with the intention of helping teachers motivate their pupils. However it was recognised by the researcher that not all the guidance was required by all teachers to the same degree. Phase Two extension had supported the researcher's view that the majority of motivated teachers encouraged their pupils throughout their teaching using the type of suggestions raised in the researcher's 'points for teachers'. Although, even in the case of motivated teachers there were aspects of their teaching which had been shown to discourage even the most motivated of pupils. Therefore consideration of the points for teachers were still believed to be appropriate. Phase Two extension also provided further evidence to indicate that it was demotivated teachers who particularly required the suggestions if they were to encourage and improve the level of motivation amongst their pupils. This provided the researcher with a further problem. Demotivated teachers needed to want to raise the motivational level of their pupils. Having spent four years researching the questions associated with demotivated pupils the researcher was well aware that there was no simple solution to demotivated teachers. Throughout the research project, in the context of pupil demotivation, a number of issues concerning teacher demotivation had been raised. The questions associated with providing answers to teacher demotivation were seen as numerous and complex, although it was not an aim of this research project to solve them.

However, if pupils are to overcome their demotivation in design and technology, then the demotivation of teachers cannot be ignored. It is therefore hoped that for those demotivated teachers who read this thesis, and future publications that the researcher intends to write, that the unravelling of some of the causes of pupil demotivation may help them to clarify their own position and re-kindle their enthusiasm. It is hoped that the hints, suggestions and strategies offered may enable all teachers to improve the enjoyment, motivation and success of all their pupils in design and technology and that in doing so they can improve their own enjoyment of the subject.

Evidence throughout this research project has supported the theory expounded by motivational psychologists regarding the relationship that exists between motivation and success. Success has been shown to motivate whilst a lack of success has been shown to lead to demotivation. However, in the context of design and technology at Key Stage 4, one has to be very careful in defining what is meant by success.

* Is it success as judged internally or externally ?
* By whom and for whom is it judged a success?
* Is it success concerned with outcome or with the process used to achieve that outcome?

The research carried out would indicate that within design and technology a successful outcome can be interpreted in two separate ways. It can mean a well designed, well made product or it can signify a successful examination result. It has also been found that a successful well made product does not necessarily lead to a successful examination result. Conversely, a successful examination result does not necessarily mean that a successful product has been produced.

The internal and external importance of the examination result can be understood, although its influence upon motivation cannot be ignored. The mismatch between the process provided by teachers in an attempt to achieve successful examination results and the process needed to achieve successful product outcomes have caused the majority of teachers and hence pupils considerable problems. A lack of both internal pupil belief and external teacher belief in the adopted process and the poor products that have been realised as a consequence of that process have been seen to have an overriding influence upon the motivation of pupils at Key Stage 4.

Postscript

The evidence of the research into reasons for pupil demotivation has shown how complex the picture of interactions between internal and external key factors are. Creativity, personal goals, and ways of thinking and working have all been shown to affect pupil motivation. At the same time the over-riding importance of teacher motivation has a central role to play in promoting pupil motivation. Design and technology is a relatively new area of the curriculum. In the early days craft teachers were able to provide a clear, simple message of what they and their subject represented. As the subject has become more complex so has its message. Surprisingly, no critical mass of thinkers or practitioners has been able to articulate their views in a manner that has provided a single clear philosophy and pedagogical understanding of design and technology. Several have tried but all have failed. The National Curriculum has set out to explain to teachers what pupils should be taught and the expected standards that they should reach. With each successive document a subtly different emphasis and direction has been provided. The notion of design and technology in schools remains vague. Without the provision of a clear philosophy upon which to base their understanding, teachers will remain sceptical about the changes that they are being forced to implement. It is no wonder that many of them have lost the enthusiasm and love they had for their subject and their teaching. Nor is it difficult to understand why so many of their pupils are demotivated during their design and technology lessons.

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