Promoting the achievement of girls in GCSE science

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CONTENTS

Abstract

This study, designed to challenge the under-representation and limited attainment of girls in the physical sciences in an 11-16 comprehensive school, was suggested by research into attitude formation by Kelly et al in the early 1980s. Balanced science, in removing opportunities for girls to opt out of the physical sciences, made it essential to identify those factors which were adversely affecting girls' attitudes towards science.

Preliminary research tasks investigated stereotypical attitudes towards science activities and the school curriculum amongst students and their parents. Additional research probed students' perceptions of their ability in science and the relevance of science subjects. Students' attitudes towards science and science teaching were investigated in relation to their option and career choices. These data influenced the choice of MEG Coordinated Science (The Suffolk Development) as the GCSE balanced science course for the school.

The subsequent programme of action research included a series of small-scale investigations, involving both monitoring and evaluation, designed to develop the Suffolk scheme and satisfy the research aims. Student attitudes towards teaching methods and the Suffolk materials were amongst those areas investigated. After evaluation the findings were channelled into the action research spiral to integrate teaching methods and curriculum development thereby promoting the attitudes and achievement of the girls.

Improvements in attainment by all students, particularly the girls, were illustrated by increasing GCSE success. Although the traditional pattern of boys' superiority within the physical sciences was markedly reduced the research demonstrated that it is possible to improve the attainment of girls within GCSE science without discriminating against boys.

Student opinion and the GCSE data suggested that the girls' achievements could be partially explained by the coursework-led assessment which suited the girls' preferred methods of working. The research concluded with an investigation of the role of coursework within GCSE science assessment and considered the possible effects of the reduction of emphasis on coursework in the GCSE structure imposed for the 1994 examinations. This was identified as an area where further research is necessary.

Continuing GCSE success reinforced the view that the skills and strategies developed by the department during the research have been influential in promoting positive attitudes and creating an environment where students, particularly girls, can achieve success in science. These skills include developing teaching contexts to match student interest, managing coursework tasks to promote student involvement and attainment and encouraging students to recognise and develop their individual abilities.

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Preface

This thesis is a record of a programme of action research which centred on the teaching and assessment of GCSE science to both girls and boys in a comprehensive school over an extended period.

The research took the form of a longitudinal study which commenced in 1987 and continued until 1994. The research took place in three quite distinct stages. This was necessitated partly by the rapidly changing structure of GCSE science during the time scale of the research. However, as this was an action research programme, the aims also changed slightly from stage to stage as the findings from each research task were fed into the planning cycle. These stages in the research were not continuous and in order to describe more accurately the nature and sequence of these stages in the written record of the research programme, the thesis has been divided into three research phases.

Phase one (Chapters 1, 2 and 3) considers the disadvantaged position of girls in science at the time the action research programme was instigated. It reflects upon the history of this situation and relevant research into teaching science in secondary schools. The initial aims of the programme are related to curriculum developments within the research school and to balanced science as an innovation in science teaching. The first phase then moves through a series of preliminary investigations designed to observe and gather data, particularly into students' attitudes towards science.

In phase two (Chapters 4, 5 and 6) the programme became more specific observing the introduction of a specific balanced science course in the author's school. The effects on the teaching and assessment of GCSE science are discussed. Students' attitudes and motivation in the light of the new course were investigated. This phase concluded with an in-depth evaluation of the Suffolk science course and a discussion of the role of coursework in GCSE science assessment. The GCSE performance of girls and boys was compared critically.

Phase three (Chapters 7, 8 and 9) investigates the role of coursework in GCSE assessment in more depth considering the effect of the repeated government interventions on the assessment of GCSE science. GCSE grades are compared between students who were assessed mainly by coursework and those who were assessed using a reduced coursework component. Gender differences were again subject to investigation.

Chapter 10 recalls and discusses the main findings of the research and suggests areas for further research in this field.

Most of the references within this thesis reflect the research and theory prevalent at the time of that particular phase of the research programme and many, particularly those in phase one, may no longer reflect current opinion. These references have, however, been retained as part of the text in order to illustrate the progression and development of this longitudinal study and to illustrate how the nature of educational thinking in science changed during the period of the research.

CHAPTER ONE

Gender differences in science education: theory and practice

This chapter discusses how some of the more influential theories relating to gender differences in science were being developed during the period prior to the commencement of this research project in the late 1980s. The implications for the teaching of science in mixed secondary schools, with particular reference to the author's school and the research project, are drawn from these theories.

From the late 1970s onwards educationalists were becoming increasingly concerned about what appeared to be a major failing of the education system in this country. This was the inequality of both representation and achievement in the separate sciences between boys and girls. The concern was that this inequality was leaving the girls in a disadvantaged position. The Equal Opportunities Commission survey of the organisation and content of the school curriculum (EOC, 1985) revealed two specific areas of concern:

> ...1. within a largely co-educational system different patterns of education and different educational experiences are identifiable for girls and for boys,
> 2. the outcome of the education system is unequal and is generally less favourable for girls regardless of their ability and aptitude. (p1)

The Commission quoted a variety of sources to position the origins of this inequality within the primary sector of the education system, with subsequent, powerful reinforcements at secondary level:

> The different patterns of girls' and boys' education becomes more apparent at the time when option choices are made for public examinations. The DES annual reporting of CSE and GCE O-level statistics reveals a heavy imbalance in certain key subject areas which is even more pronounced at A-level. (p3)

The public examination entries at all levels clearly demonstrated that science was a major area of concern. The DES statistics covering the period 1970-1980 illustrated a consistent pattern in the sciences which was gender-differentiated. Boys' entries decreased from physics to chemistry to biology whereas girls' entries decreased in the reverse order. This pattern tended to be repeated in the science option groups of many co-educational schools. Table 1.1 details the option group composition in the author's and in three other schools in the same LEA over a three-year period. The numbers of boys opting for and being examined in biology were also greater than the corresponding numbers of girls in physics. Table 1.2 presents the national statistics as percentages to show how more boys were successful than girls in all (GCE) sciences. A reduction in the superior position of boys is, however, apparent during the ten year period covered by these statistics.

Table 1.1 Percentage of students opting for science in four schools in the collaborating LEA, by gender, 1986-1988. School A is the research school.

SCHOOL	A			B			C			D		
Year	1986	1987	1988	1986	1987	1988	1986	1987	1988	1986	1987	1988
BIOLOGY												
Boys	39	15	8	33	44	53	25	23	18	26	33	55
Girls	92	75	74	75	100	96	57	73	41	76	77	83
CHEMISTRY												
Boys	41	29	35	20	44	58	53	74	67	68	44	51
Girls	16	22	30	50	83	21	46	57	65	57	41	49
PHYSICS												
Boys	57	71	68	47	36	95	73	49	77	72	86	64
Girls	10	11	8	0	17	4	31	19	34	26	25	26

Source: Individual schools

Table 1.2 GCE O-level/CSE grade 1 passes in all science subjects, nationally by gender, 1978-1987.

Year	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Boys (%)	61.6	61.3	60.5	60.0	59.5	59.0	58.7	58.7	58.1	57.7
Girls (%)	38.4	38.7	39.5	40.0	40.5	41.0	41.3	41.3	41.9	42.3

Source: DES Statistics (1988)

The DES figures showed a disturbing national trend but the disparity between boys and girls was found to extend far beyond this country. The International Association for the Evaluation of Educational Achievement (IEA) conducted a survey in 1973 which tested 10 year olds, 14 year olds and pre-university secondary students in nineteen different countries. The design and conduct of the survey have been fully documented (Comber and Keeves, 1973) and the findings have stimulated a great deal of further research and discussion.

One of the principal discoveries was that, on average, boys scored considerably better than girls on the tests. Neave (1974) observed;

> Amongst the student-based variables the most powerful single factor discriminating between science achievement was the sex of the student. The gap between girls and boys in science performance widened as they moved through the education system. Generally the girls were outshone by the boys. (p54)

The DES examination figures point towards a differential in achievement but the IEA findings highlight it. In addition the IEA data showed that the sex difference varied in the same manner in all the countries studied, being particularly pronounced in physics. It was, however, observed that girls in some countries achieved better than boys in other countries, suggesting that there was also some environmental factor operative in the determination of achievement levels. In all the countries the gap between the sexes was found to be approximately constant and this inevitably led to suggestions that inherent biological factors may be responsible for the differential.

Kelly (1978) carried out extensive research into the IEA data, attempting to locate and describe sex differences in science achievement, examine hypotheses on the origins and development of these differences and to suggest ways of reducing them so as to improve girls' performance in science. She centred her research in two main areas by, initially, considering the findings in conjunction with a series of explanatory hypotheses focussing on cultural, school and attitudinal issues. The second investigation reinterpreted the results in terms of Kohlberg's cognitive development theory of the acquisition of sex-role stereotypes.

Kelly proposed four general hypotheses on the origins of the sex differences in science achievement pointing out that although these were stated and investigated independently in terms of their origins and effects no mutual exclusivity or independence could be attached to them. The hypotheses were:

1. The Genetic Hypothesis - girls have less innate potential than boys for achievement in science.
2. The Culture Hypothesis - girls achieve less well than boys in science because society does not expect or encourage girls to achieve as well as boys in science.
3. The School Hypothesis - science is presented in schools in a way more suited to boys than to girls.
4. The Attitude Hypothesis - girls perform less well than boys in science because they have less favourable attitudes than boys towards science.

Gray (1981) argued for the influence of biological factors in creating the sex difference on the basis of the observed constancy of the difference. He suggested that spatial ability is an important factor in, if not a prerequisite for, achievement in science. He quoted Yeu (1975), Maccoby and Jacklin (1975) and Wilson and Vandenberg (1978) to show that in tests involving spatial awareness males regularly outperform females. He attempted to show that spatial ability was a genetic factor and was also sex-linked but the IEA survey produced no data which had any bearing on this hypothesis. It has already been noted that although the sex difference tended to be internationally consistent, actual levels of performance varied from one country to another. This would suggest that the sex difference is capable of being altered and the reasons for its existence are other than purely biological.

The coffin lid appears to have been finally nailed down on the genetic hypothesis as a result of a series of investigations carried out in Thailand. Klainin and Fensham (1987) demonstrated girls' superior achievements over boys in chemistry. This was followed by an assessment of achievement in <u>physics</u> by a series of practically-based tests (Klainin, Fensham and West, 1989) which resulted in a reversal of the sex difference.

> ...the results show for these senior secondary students in Thailand, all studying the three-year physics curriculum, that:
>
> 1. Girls perform at least as well as the boys in all outcome measures...and five other non-practical ones including attitude to science.
>
> 2. In laboratory-related outcomes...girls outperform boys after one year of physics, but that boys reduce the gap (but do not close it) after three years of physics.
>
> 3. In laboratory-related outcomes (manipulative skills and problem solving), girls in single-sex schools outperform girls and boys in co-educational schools and boys in single-sex schools after one year of physics, but after three years of physics, boys and girls in co-educational schools catch up in problem solving abilities, and boys in single-sex schools catch up in manipulative skills. (p109)

The culture hypothesis could not be directly tested from the IEA survey as this did not provide data on expectations for girls or other associated factors. Consequently, the discussion relating to this aspect of gender differences was broad-based. It did, however, appear to encourage the expression of some of the more extreme views of sex-roles and society particularly in those areas where the discussions related to the male and female roles within the home and within society in general. It was possible to isolate some interesting ideas from the general debate, many of which related to the differential development of boys and girls and to sex-role stereotyping at home and at school.

Bonora (1974) suggested:

> ...an interest in science is gradually inculcated in boys from a very early age particularly through a choice of toys. Later in the educational guidance process, boys are veered more into science tracks...the study of arts subjects is considered a positive trait for girls. (p226)

Bonora's suggestion has been documented elsewhere by other researchers, the APU national surveys in particular providing evidence to support this.

Table 1.3 illustrates this point, the survey indicated that boys appear to have had more experience of 'tinkering' activities than girls. This will be further investigated later in this thesis (Research Task 3). Research Task 4 will be used at a later point to investigate Bonora's statement.

Table 1.3 Differences in involvement in out-of-school activities, by gender for 11-year old students.

Activity	Boys %	Girls %	Discrepancy in favour of Boys	Discrepancy in favour of Girls
Make models from a kit (Airfix)	42	6	38	
Play pool, billiards or snooker	59	30	29	
Play with electric toy sets	45	16	29	
Create models using Lego etc	50	23	27	
Take things apart to see inside	38	18	20	
Go fishing or pond dipping	30	13	17	
Watch birds	30	27	3	
Sow seeds or grow plants	30	34		4
Look after small animals/pets	52	57		5
Weigh ingredients for cooking	29	60		31
Knit or sew	5	46		41

Source: Johnson and Murphy (1984) from APU data

It is essential that we remember that girls do not underachieve in all subjects. The IEA data showed that at fourteen years the boys were at a great advantage in physical and practical science, at a lesser advantage in chemistry and biology and at a disadvantage in reading, language and literature tests. In addition, these sex differences remained remarkably constant across the full range of countries tested. If there was a cultural effect, then one would expect that this would be accompanied by an observable variation in the sex differential from one culture to another.

If we are to include cultural effects in our explanation of the gender effects then it must be in an indirect fashion. The values and expectations of a society and the sex role structure within it appear to be influential in attitude formation amongst boys and girls. This will be discussed in more detail when the attitude hypothesis is explored.

The school hypothesis that science is presented in schools in a way more suited to boys than to girls opens up a wide range of factors which may have varying degrees of influence on the students. These include the school organisation, the teaching environment, teacher characteristics, teaching methods, options systems etc.

The IEA and other research has shown that at ten years of age there is a differential between boys and girls in science. Craig and Ayres (1988) observed this differential taking shape during a study of the effects of science teaching to primary students:

> Irrespective of...grouping, the majority of pupils in some classes were very keen to do more school science topics whilst in others pupils showed little interest. This suggested that influences such as teaching style might be more important. (p422)

The position twelve months later, with the children as first year secondary students was that:

> The level of interest amongst the girls, which at primary school had been higher than for boys, appeared to have dropped considerably so that the girls who had had greatest primary science experience now gave the lowest response to questions about interest in future school science topics. (p423)

They summarised their findings as follows:

> At the end of the primary school, many girls indicated a stronger wish to do more school science than the boys in their class. Just one year later the pattern had changed considerably and many girls appeared disillusioned. Girls who had done substantial amounts of primary science seemed to be amongst the most disillusioned. (p424)

It would be quite easy to dismiss this by suggesting that the teachers of science in the primary sector were free to pursue topics in whatever form suited them in order that interest and motivation on the part of the students were maximised. However, research from a variety of other sources has suggested a 'switching-off' effect during the early secondary years. For example, Kelly (1986) in carrying out a longitudinal study investigating the formation of girls' and boys' attitudes to science reported that:

> In most respects children's attitudes to science declined significantly over the two and a half year period. Their personal liking for science showed a marked drop, especially amongst girls...The children also lost interest in learning about most aspects of science. (p402)

It is important to note her further comments in relation to differences between schools:

> Differences between schools were highly significant...and were larger at the second testing than at the first. This is in contrast to the sex and class differences both of which stayed approximately constant over the period tested. (p405)

Kelly also observed (1987):

> ...in some schools girls did not enjoy their physics lessons but in other schools the topic was presented in a more girl-friendly way... (p674)

Earlier research had identified the importance of presentation of material in schools. In a report on Equal Opportunities (1983) Clwyd County Council stated:

> It would appear that girls enter secondary education with different scientific interests from boys but not deficient in scientific knowledge and clearly see themselves equally able to do science. However, it seems that there is some experience that has a decisive effect on their choosing to avoid physical sciences after year three. (p20)

Samuel, quoted in Whyld (1983) was quite specific:

> ...somewhere between the beginning of the first year and making option choices in the middle of the third year, lies the 'heart' of the problem. (p137)

We must assume that between ten and fourteen years of age the whole school experience creates differential responses between the sexes. When we return to the IEA data, however, we find that there was little indication that that different approaches benefitted one sex more than the other, the overall picture was that school experiences appeared to have similar connotations for both sexes. The focal point in the IEA research, however, was that the various factors should have some direct and measurable effect on science achievement. Attitudes were not investigated.

The many cultural and school factors considered above must have some effect on the students and it is logical to assume that these effects will be different for boys and girls. This effect appears to take its form not in some quantifiable differential in achievement but in the creation of differential attitudes towards science by students of opposite sex. Kelly's hypothesis that girls perform less well because they have less favourable attitudes towards science begins to appear more likely to lead us to a point where we are in a position to begin to attempt some interventions designed to reduce the damaging differential.

If it can be established that a positive link exists between attitude and achievement, it follows that any improvements in attitude should create similar improvements in levels of attainment. Kelly (1978) demonstrated that not only was there support for this hypothesis but also that there was good correlation between attitude and achievement:

> Girls <u>did</u> have less favourable attitudes towards science than boys and there <u>was</u> a connection between attitudes and achievement: good attitudes were associated with high achievement. Moreover attitudes and sex differences in attitudes varied from country to country which suggested that girls' attitudes were susceptible to improvement. However, boys' achievement was more highly correlated with attitude than was girls' and boys achieved better in science than did girls with equally favourable attitudes. (p38)

In addition, Kelly observed:

> It was interesting to note that when allowances were made for sex differences in attitude the sex differences for achievement were actually reduced. (p38)

From this information we see that there appears to be a definite connection between attitude and achievement in science and it should, therefore, be possible to reduce the difference by changing or influencing the girls' attitudes. The awareness of the relationship does not, however, give any indication of either the factors which combine to create it or the mechanism by which it functions. It would appear that the factors which influence attitudes can be grouped under two broad headings, i.e. culture and school, but we cannot assume that any of these directly affects achievement.

In order to begin to understand how the differential attitudes arise it is necessary to look in detail at specific areas related to school and culture which are influential in the creation of attitude variance between the sexes. The number of options here are too numerous to list but include pre-school and primary experiences, sex-role development, teachers and their teaching methods.

Kelly (1976) has identified eight major differences between girls and boys on leaving primary school:

> At this age girls tend to be more verbal, less independent, more easily discouraged, more conscientious, more interested in people, less interested in science, less experienced in science-related activities and more restricted in their perception of possible future roles than boys. (p125)

These sex stereotypes are derived from a variety of sources which are obviously extremely influential during a child's early years.

We can classify children's toys, for example, in terms of sex roles, boys' toys tending to encourage 'doing' (Lego, construction kits, models) and aggression (guns, soldiers) whereas girls' toys encourage caring (dolls, teasets, nurses) and these divisions tend to be supported by society. Recent years have seen a move towards less stereotyping amongst children's toys in certain sections of the community but Maccoby and Jacklin (1974) discovered as part of a review of research into parental behaviour that it was the children and not the parents who were selecting the stereotyped toys.

Children's literature has also promoted stereotypical differences in behaviour, preferences and the like, by, for example, depicting boys as adventurous, dominant and aggressive with girls usually being portrayed as more submissive and less imaginative. Belotti (1975) carried out an international survey of children's literature and remarked:

> ...however diligently one searches, it is impossible to find a female character who is intelligent, courageous, active and loyal. (p90)

Peterson and Lach (1990) observed:

> ... males were most likely to be portrayed as positive, active and competent, while females were likely to be portrayed as negative, passive and incompetent. (p185)

Socialisation and sex role acquisition theories can be classified into two broad categories. Social learning theories attribute the way in which a child develops to the direct and indirect influence of parents, peers and teachers through a continual series of conscious and unconscious reinforcements of sex-appropriate behaviour. The media and toys can also be included in this category. Cognitive development theories, for example Kohlberg (1966), suggest rather that a child may seek security and achieve competence in a specific sex role and will, therefore, copy those attitudes and attributes which are characteristic of that role. Both of these viewpoints would appear to be influential in attitude formation. Maccoby and Jacklin (1974) suggested that:

> ...boys seem to have more intense socialisation experiences than girls ...adults respond as if they find boys more interesting and more attention provoking than girls. (p348)

Atypical behaviour and attitudes are frequently overtly or covertly punished whereas conformity is rewarded. The reactions to atypical gender related behaviour show some strange paradoxes which themselves show a gender bias, for example, the 'tomboy' girl who plays football, gets dirty etc. tends to be less strongly discouraged than the 'cissy' boy who does not fit the traditional male role model pattern.

If science is considered to have a masculine image then science achievement (or even opting for science) may be seen as being inappropriate for girls by peers, parents etc and may be considered by the girls as being incompatible with their developing femininity.

The evidence certainly indicates that both students and parents perceive the physical sciences as more difficult than other school subjects (Ormerod, 1975). If this is combined with the fact that the majority of physical science teachers, engineers and 'scientists' are men then a powerful attitudinal pattern must build up which suggests the inappropriateness of the physical sciences for girls. In addition, many of the contexts for learning within the physical sciences tend to stress masculine activities. The image of biology with its emphasis on nature and nurture is seen to have a more female bias and contrasts strongly with the male ramifications of physics (for example bridge building, projectiles and nuclear power).

Saraga and Griffiths (1981) commented:

> The subject matter of physics appears impersonal, inanimate and far removed from the world of everyday objects and people. Biology on the other hand with its concern for living things appears more personal and alive...Choosing the biological as opposed to the physical sciences thus involves girls in fewer contradictions and they receive more encouragement and support in their choice. (p92)

The DES (1980) suggested that the sex of the science teacher was influential in this area:

> Although physics and chemistry cannot really be thought of as boys' subjects any longer, a great many of the teachers still tend to regard them as such. The fact that the majority of these teachers are male does not help the situation. If more women were employed to teach these subjects, it might help more girls to realise that chemistry and physics are just as much for girls as for boys. (p26)

This statement seems to imply that a female presence is required in the science department purely as a role model for the girls and does nothing to address the circular issue that if there are fewer girls studying physical sciences the numbers of women teachers in this area will continue to be small.

Fortunately this report concluded that:

> ...there was no clear relationship between the popularity of science among girls and the number of women teaching science. (p26)

The IEA data demonstrated quite clearly that the girls did not achieve any better in schools where female science teachers were in the majority. It was observed that in most countries girls actually achieved better in science with male teachers.

In terms of the overall achievement of girls in science this observation is interesting particularly when we consider that the majority of science departments in this country are male dominated. As a result of data collected during the Second International Science Study carried out by the IEA (which commenced in 1984), Keys (1987) reported that for students aged 10 years the percentage of women teachers in science was 56%, this decreased to 31% for students at age 14 and was only 23% for A-level students. The A-level figure could be broken down further to indicate the percentage of women teachers in each of the three science disciplines. Unsurprisingly, a gender bias is demonstrated with 34% of biology teachers, 20% of chemistry teachers and only 14% of physics teachers being women.

Following directly along these lines it is important to consider the relative merits of single sex and co-educational teaching in the sciences. The majority of the research in this field has been confined to a consideration of single sex schools. Dale (1974) has suggested that girls in single sex schools were more likely to choose physics than girls in co-educational establishments. Ormerod (1975) investigated this suggestion confirming the wider subject choice in single sex schools and the subject polarisation found in mixed schools. The latter enabled him to derive a 'gender spectrum' of common school subjects, this being reproduced as Figure 1.4. The question of gender effects which arise from educating students in single-sex schools is reconsidered in Chapter 10 along with a discussion of other factors which have more recently been found to exert some influence in this area.

It was also found that co-educated boys demonstrated a greater preference for 'male' sciences than boys in single sex schools. Ormerod suggested:

> ...each sex , when educated with the other, is at puberty driven by developmental changes to use subject preference and, where possible, subject choice as a means of asserting its sex role. (p102)

Figure 1.4 Gender Spectrum of school subjects.

Numbers are percentage of GCE O-level entries
from boys (1972).

	MALE	
70		Chemistry
79		Physics
55		Geography
	NEUTRAL POINT	
36		Music
37		Biology
48		2nd Foreign language
50		Latin
43		Art
46		French
43		English
37		Religious Education
	FEMALE	

Source: Ormerod (1975) in Kelly (1981), p101

Ormerod also found a lower correlation between girls' subject preference and option choice across all subjects in mixed schools than there was for boys. This led him to suggest that the prevailing option choice systems were more suited to boys' patterns of preferences than girls'. Keys and Ormerod (1976) further investigated this tendency noting that:

> ...we found a significant proportion of girls who 'liked' physics (and in one sample chemistry as well) who were dropping it, together with a significant proportion of girls who 'disliked' biology and yet were taking it. (p102)

Harding (1983) discovered, during a comparison of students' performance in conventional and Nuffield type examinations in physics, that, in general, boys were more successful than girls in mixed schools and that girls in girls' schools were more successful than girls of equal ability in mixed schools. Table 1.5 outlines this difference in the 'conventional' physics examination.

Table 1.5 Percentage passes in 'conventional' physics examination, by gender and school type.

SCHOOL TYPE	BOYS	GIRLS
SINGLE SEX:		
Direct grant, independent	62.3	78.6
Grammar	67.9	75.5
Comprehensive	50.5	57.1
MIXED:		
Grammar	72.0	60.0
Comprehensive	59.3	46.0

Source: Harding (1983), p26

Harding argued that:

> ...it is not the type of school per se that creates a difference but the expectation of girls found in the school. (p27)

She discussed how a differential in expectation could arise by comparing the different traditions inherent in the girls' grammar and comprehensive schools. It has been recorded how girls tend to perceive themselves as being less able than the boys. Stanworth (1981), for example, noted that able girls tended to underrate themselves compared to boys of the same intellectual level. Students in the author's school have also reflected this trend (see Chapter 7).

Eggleston, Galton and Jones (1975) collected data by observing science lessons as part of a project designed to examine the effectiveness of different teaching styles. They subsequently identified three distinct styles in science teaching. These were:

1. The Problem Solvers: where the initiative was maintained by the teacher who, by questioning, challenged the students to observe,speculate and solve problems;
2. The Informers: who presented a non-questioning approach except where the questions demanded recall or the application of facts and principles;
3. The Enquirers: who used student initiated and student maintained behaviour to design experiments, infer solutions, formulate and test hypotheses.

During the GIST project (Girls into Science and Technology, Whyte, 1986) the researchers discussed with the students their preferences in terms of teachers and teaching styles. It was discovered by the team (and illustrated with direct quotes by Kelly, 1981) that in general the girls disliked and were frequently uneasy with styles 1 and 2. Style 3, the Enquirers, however, allowed the girls to participate fully in lessons but in a less overt and public manner. Many of the girls had identified this problem when they were in a predominantly male teaching group and were, therefore, present as the minority group.

Galton suggested (1981) that:

> One possible explanation for the popularity of biology for girls, in contrast to the physical sciences, is that girls dislike the direct-questioning problem-solving approach adopted by the majority of teachers of physics and chemistry and prefer either the more open enquiry style which allows them to 'get on with it' among themselves or to be given the facts and told to write them down with a minimum of discussion between the teacher and the class. (p187)

Other aspects of classroom organisation (or lack of it) have been identified as appearing to adversely affect girls' attitudes towards science, these include poor discipline, unfamiliar subject matter, being in a minority in the group and mixed sex groupings. All discriminate against girls' attitudes and, therefore, their achievement. The traditional secondary school system allowed no way for these feelings to be expressed until the third year when the options system was utilised by the girls as a means of rejecting the unpopular physical sciences.

It became apparent at this stage of the research that some major initiatives were needed to make our education system work equally well for students of both sexes. The EOC (1985) suggested that the system worked against girls:

> The education system is allowing too many able girls to leave school unqualified to work in anything other than a circumscribed range of unskilled, low-status and low-paid occupations. (p7)

There were two obvious solutions in relation to the options systems in operation in our secondary schools. The first of these was a system of counselling designed to fully inform the girls of career choices and requirements in an attempt to prevent the opting out of physical science. The second alternative was to discard the options system entirely and not allow the girls to opt out, but then the subsequent science courses for public examinations would need careful selection.

The DES had suggested a solution to this problem in 1987 when the proposals for what was to become the National Curriculum were presented for discussion by stating:

> A national curriculum backed by clear assessment arrangements will help to raise standards of attainment by...ensuring that all pupils, regardless of sex, ethnic origin and geographical location, have access to broadly the same good and relevant curriculum... (p3)

This was a rather naive view and suggests that, although the DES appeared to be aware of the problems pupils were experiencing, they had given little thought to addressing the roots of these problems. Ditchfield and Scott (1987) expressed the following opinion:

> To provide girls and boys with equal opportunities does not necessarily mean providing them with identical educational experiences - we must take into account the different experiences and interests which they bring to their

> lessons. First and foremost our students are individuals with their own assortment of weaknesses and strengths, aptitudes and interests. (p11)

The research has demonstrated quite conclusively that one of the major reasons for girls' underachievement in science rests with poor or negative attitudes towards science on the part of the girls. Before the issue of the National Curriculum is addressed it is essential that the mechanisms by which these attitudes arise and influence students are understood.

In order to investigate these mechanisms it is necessary to instigate some dialogue with the students, boys and girls, and then to attempt to affect these attitudes. The way in which this was visualised by the majority of people involved in researching this issue was by a series of interventions in the classroom situation, hence the widespread use of action research as a methodology for attitude investigation. It appeared that the smaller the focus of the action research project, the greater the chance of some positive feedback, this being evident from an investigation of the titles of much of the research carried out in the late 1980s. This, however, meant that in order to get an overview of the attitudes, their formation and their operation, it was necessary to combine all these smaller elements which appear to have some influence on the central issue.

The GIST survey attempted to incorporate several smaller investigations within the whole project in order to give some direction and cohesiveness to the research programme. Its purpose was both to initiate and support a range of school-based efforts designed to operate on two levels by improving girls' attitudes to physical science and to encourage more girls to select physical sciences for options courses. The action research involved simultaneous intervention and evaluation in order that new ideas or developments could immediately be pursued and any non-productive areas of research could be abandoned. It was stressed by the team (1981) that:

> This is not a neat experimental situation, but it does approximate to life in a school. (p2)

Another observation made by many researchers is the way in which boys and girls interact within the school environment to the detriment of the girls. These interactions take many forms and may be physical, verbal or psychological and occur throughout the school. This is not an issue specific to science but it is worth pursuing in the general context of gender differences as it appears to have a marked influence on the girls' perceptions of themselves as members of the school.

The first influences on the students in this area will be in the primary sector and even at this early stage evidence has been found to indicate that the girls are being placed in a disadvantaged position. Clarricoates (1978) observed the gearing of lessons towards boys' interests in four different primary schools and Sears and Feldman (1974) had noted more, and more varied, interactions between boys and their primary teachers than were afforded to the girls.

Meyer and Thompson (1963) and Wienekamp et al (1987) have provided evidence that students perceive teacher approval for boys' behaviour, reporting, for example, more interactions between teachers and boys. The evidence points towards male-dominated interactions between teacher and students so that the girls quickly assume that they are perceived by the teachers as being less important than the boys. Stanworth (1983) found that all students (on an A-level Humanities course) believed that the teachers found the boys more conscientious and capable. Spear (1984) has shown that science teachers show a bias in favour of boys when marking work.

In lessons it has been observed that the boys try to dominate the class discussions and will actively attempt to discourage the girls from taking part by making comments, tapping pens, moving chairs and so on when girls attempt to participate. In practical science lessons the boys will try to dominate the proceedings by making a rush for the apparatus before the girls, often with only a vague idea of the experimental procedure. Tobin (1988) observed male dominance in both responses to questions and in the selection of science apparatus, he also noted male off-task disruptive behaviour.

Taber (1992) observed more student-teacher interactions with boys than with girls in physics lessons. If the students were allowed to call out in the

the lessons, the boys were seen to dominate the student-teacher exchanges. He also noted that the boys behaviour was such that it actually invited disciplinary interaction.

Kruse (1992) has observed that teachers appear to regard boys and girls as different and, therefore, expected differential behaviour and attainment. She noted that in addition to the schools spending more time on the boys the boys themselves were more demanding of attention. According to her research the girls were at a considerable disadvantage, she concluded:

> Boys receive more attention, talk more, are more respected and are found more interesting as persons than girls. (p85)

The boys will also intimidate the girls by dominating the physical space during lessons. Harding (1983) remarked on the way the boys selected their seats in order to monopolise the teacher. The physical presence of the boys is also used in an intimidating fashion during practical science lessons. Hacker (1991) has also observed similar gender differences amongst students in their behaviour in science lessons. These behaviour differences extend beyond the classroom, for example, Wolpe (1977) and Harman (1978) have indicated how the school playground tends to be dominated by the boys engaged in vigorous games, the girls tending to collect around the periphery.

If we are to change the attitudes of the girls towards science then we must attempt to alter their perceptions of their subordinate role in the secondary school. It is unlikely that this could be achieved without some fundamental changes in society and education.

This research aimed to investigate the attitudes of the students, particularly the girls, towards their school science and then use this information to make the science courses more attractive. In this way I hoped to be able to increase the achievement of the girls in science and to prevent any restriction of career opportunities through 'turning off'.

CHAPTER TWO

The development of the research project

The initial aims of the research are outlined in conjunction with a discussion of the plans for restructuring the science department in the research school. The threads of the movement towards balanced science are traced and the author's aims reassessed in the light of these moves. The main features of the first phase of this research project are presented. The principles of action research and the various models which describe the progress of a programme of action research are discussed in relation to the aims of this project.

The Research Project

This research project arose through a desire to challenge the traditional pattern of gender bias in school science. The original aims of the study were, within the context of a particular school, to:

1. ascertain the attitudes of girls and boys towards individual science subjects;
2. identify those factors which appeared to contribute to the unpopularity of physics amongst the girls;
3. devise and evaluate teaching strategies to help reduce the unpopularity of physics courses or modules;
4. assess teachers' and parents' attitudes to the new teaching strategies within balanced science courses.

Determining the attitudes was a relatively straightforward exercise, however, the identification of the reasons for the creation of these attitudes proved more complex. The development of a programme of action research designed to make some progress in counteracting the negative attitudes was considered. In order to fine tune such a programme it proved necessary to investigate more deeply the attitudes and their formation.

At this stage the research had also to encompass a change of focus due to the introduction of balanced science courses within the framework of the National Curriculum. The investigation into those student perceptions and opinions which helped to shape attitudes became more closely linked with the subject-based investigations into the unpopularity of certain subject areas.

The third aim, to devise and evaluate better teaching strategies began to assume greater importance as the students began to indicate increasingly strongly that the dissatisfaction with science was directed towards both the contexts and the methods of science teaching. In the past this had been expressed quite simply by the polarisation of the physical and biological sciences with respect to gender (see Table 1.4).

The aims now began to move towards investigating the attitudes of the students towards specific topics within the balanced science format. It was necessary to study student option choices in the work on gender issues and to investigate the opinions and attitudes expressed by the current school population when planning for teaching in balanced science. It was vital that the planning focussed on both teaching strategies and materials.

Another amendment of the aims was directed towards reducing the numbers of students who were becoming disenfranchised within the balanced science structure by virtue of their limited abilities in science and/or language skills.

The aims thus became transferred into a study which, although situated in one school and referring to one balanced science course, had implications for science teaching in general, whether taught through an integrated, a coordinated or a separate science approach.

These revised aims were, therefore, to:

1. identify those aspects of the science syllabus which students from years 9, 10 and 11 within the research school perceive as being either unattractive or irrelevant;
2. closely monitor the performance of students in science, particularly the girls;
3. devise strategies designed to improve the performance of students in science, particularly the girls;
4. evaluate those assessment strategies developed within the GCSE framework with a view to understanding their role in improving student development and motivation.

At the time that the research programme was initiated the science department was reorganising itself in order to enhance the provision of science for lower school students and to rationalise the upper school courses leading to external examinations. The realisation of the aims in the research programme would have profound implications for the revitalisation programme already underway within the department. It was decided that the two programmes could run in parallel with information being transferred as appropriate.

The school is a mixed 11-16 comprehensive, one of 20 comprehensives in a Metropolitan Borough in the North of England. It has a student population of approximately 800 and serves the local community, which is currently suffering some financial deprivation as the steel and mining industries are in serious decline. The school's catchment has been mainly from council housing but recent building programmes have increased the numbers of private houses in the area.

Prior to its redesignation as a comprehensive the school was the local Secondary Modern. It is in competition with two other comprehensives, both of which are 11-18, and one of which was the local grammar school prior to comprehensivisation. This history is reflected in the student population. Students are tested (using AH2 tests) during their first year at school and these have indicated a population which has been skewed towards the less able. This is reflected in GCSE performance.

Table 2.1 GCSE examination results, research school, summer 1990

Subject	Percentage of students at each pass grade							
	A	B	C	D	E	F	G	N
English	3	7	15	16	26	27	3	197
English Literature	1	8	17	14	31	22	1	171
Geography	4	2	6	7	16	25	10	112
History	6	10	12	10	14	8	18	50
French	3	5	14	8	16	22	24	37
German	10	17	16	21	27	6	2	63
Mathematics	2	6	12	9	20	24	6	187
BIOLOGY	0	0	9	11	20	34	20	56
CHEMISTRY	0	0	10	2	2	27	29	41
PHYSICS	2	9	9	19	19	16	14	43
MODULAR SCIENCE	0	0	9	16	21	35	2	43

Source: Department records

Tables 2.1 and 2.2 reproduce the GCSE examination results from 1990 and 1991 respectively, as published in the School Prospectus and demonstrate the underachievement in the science subjects. The school, however, began to change its image, its results and its standing within the local community and consequently 1991-92 saw an increase in the Year 7 intake.

Table 2.2 GCSE examination results, research school, summer 1991

Subject	Percentage of students at each pass grade A	B	C	D	E	F	G	N
English	2	3	21	16	31	22	2	131
English Literature	3	4	16	17	19	24	2	138
Geography	0	7	11	20	23	10	11	101
History	3	6	15	12	12	27	15	33
French	11	11	7	15	11	26	15	54
German	0	0	20	30	20	30	0	10
Mathematics	2	10	15	20	28	17	6	115
BIOLOGY	0	5	5	10	18	28	26	39
CHEMISTRY	0	2	7	9	9	38	20	45
PHYSICS	0	0	19	19	13	38	6	16
MODULAR SCIENCE	0	14	16	17	9	9	13	116

Source: Department records

Years 7 and 8 operate largely on a mixed-ability basis with some setting in core subjects in Year 8. Year 9 students are, however, setted on the basis of ability. The option groups in years 10 and 11 can lose this arrangement and return to mixed ability groupings as the school operates a free option system, although both years are split into two bands on the basis of ability and the bands are taught separately. The science, English and mathematics GCSE groups are, however, setted in both bands.

When I was appointed to the school as Head of Science in 1984, the upper school was structured on a three-tier streaming system. The department offered the three traditional sciences at 'O'-level and a range of CSE subjects which covered all the separate sciences and also included such options as physics-with-chemistry, chemistry-with-biology and general science. The first stage of the rationalisation process involved the introduction of an integrated science course, developed by the department, for the students in Years 7 and 8. The second stage accompanied the contraction of the number of upper school streams to two, and involved a reduction of the external examination courses to five (GCSE biology, human biology, chemistry, physics and modular science). The Year 9 students, however, had not been included in these major initiatives. Their courses followed the traditional pre-option fare by being intended to function, to all intents and purposes, as:-

1. an introduction into the separate sciences to allow them to make a selection of courses at the end of the year;
2. an opportunity for the teachers to assess the students' performance in the separate sciences in order to advise them regarding option choices.

It seemed that this was the stage of the students' school career which contributed most to the 'turning off' effect. This was because of a whole range of factors which included the nature of the Year 9 courses (conceptually difficult, and inappropriate teaching contexts), and the students' developing gender roles.

The first of these factors was the responsibility of the department and the issue was being addressed by a complete revision of the concepts, contexts and strategies for teaching. Unfortunately as the new courses were about to be unveiled the National Curriculum and the national drive towards balanced science was introduced.

Balanced Science

Balanced science was not a new concept and had been taught under various guises in the early 1970s, Nuffield Secondary Science and SCISP (Schools Council Integrated Science Project) being two notable examples. The major event which initiated the great debate in education which heralded the changes leading up to the National Curriculum has been identified by many educationalists as the speech by James Callaghan at Ruskin College in 1976. This was followed by a series of important publications culminating in the consultative paper 'A Framework for the School Curriculum' (DES, 1980). These publications are discussed sequentially later in this chapter. An important part of Callaghan's speech suggested that the Government had doubts about the effectiveness of schools and intended to act to remedy the situation:

> To the teachers I would say that you must satisfy the parents and industry that what you are doing meets their requirements and the needs of their children. For if the public is not convinced then the profession will be laying up trouble for itself in the future.
> (The Times Educational Supplement, 22.10.76)

In 1977 the DES consultative document 'Education in Schools' proposed a 'core' curriculum for all students up to the age of 16 which should include English, mathematics and science. The earlier HMI publication, 'Curriculum 11-16' (1976) not only specified science as 'an essential component of the education of all pupils' (p28) but also, having considered some of the existing methods of achieving this, suggested that the 'way ahead seems to be towards unified science courses throughout the age range 11-16' (p29). Moves towards reviewing the science curriculum in schools commenced in 1988 with the introduction of a joint HMI, DES, ASE (Association for Science Education), Schools Council working party which would later become the SSCR (Secondary Science Curriculum Review).

'Balanced science' was introduced into our vocabulary by HMI after the survey 'Aspects of Secondary Education in England' (1979) found large numbers of students studying either no science at all or only one science subject for external examination courses. The case for balanced science was strongly argued through a double option approach which would permit a number of strategies for delivering biology, chemistry and physics to be realised. Suggestions that a reduction in content would lead to a diminution of standards were rejected, it being stated that students would still be taught to the best of their abilities and that preparation for A-level courses would not be affected.

A highly influential publication at this time was the consultative document 'Alternatives for Science Education' (ASE, 1979) which considered science education practice in three broad contexts. The first two of these were a historical review and a discussion of existing practice which led to the third area, a series of vital proposals or alternatives for future development in science education. These were intended to promote discussion which would, in turn, lead to the formulation of future policy in science education.

The historical review considered science education in educational, social and theoretical contexts. The first of these noted how science education appeared to have remained outside the comprehensivisation programme. The second, social, review considered the balance between opposing views of the nature of change in education. The theoretical context deplored the vision of science as a discrete, cerebral activity:

> The majority of young people fail to de-mystify the subject and do not see science for what it is - one of the most important *cultural* activities devised by men. (p24)

The resulting proposals were intended:

> ...to present a range of possible curriculum alternatives for the consideration of science teachers, advisers and curriculum planners. (p37)

It was recommended that discussion should aim to preserve a balance between the contribution of science education to both personal and technological development. The document highlighted the ease with which it was possible to diagnose the ills of science education and the equal difficulty in prescribing effective remedies. The committee's concluding views and recommendations, which are still highly relevant, are reproduced in Appendix 1.

Similar themes were continued in 1980 and 1981 with a range of reports and surveys proposing methods of structuring school science. A consultation document 'A Framework for the School Curriculum' (DES, 1980) proposed that science should occupy 10-20% of curriculum time. Further HMI discussion relating to science in 'A View of the Curriculum' (1980) allowed for the freedom of choice by the individual school in relation to the method of delivering science, but stated that the presentation should be sufficiently broad to allow all students to benefit. The report 'The School Curriculum' (DES, 1981), published as a result of consultations arising from their 1980 document ('A Framework for the School Curriculum') continued the theme of breadth and balance and recognised the career restrictions imposed on girls who opted out of sciences at the end of Year 9. In the same year 'The Practical Curriculum' (Schools Council, 1981) and 'Education Through Science' (ASE, 1981) were published. Both of these outlined methods of implementing curricular change, the latter being a policy statement which was published following the discussions stimulated by the earlier 'Alternatives for Science Education' (ASE, 1979). The ASE policy statement considered ways and means of achieving the redefined aims for science education. It stressed the need to define carefully the dual role of science (content, processes and skills) in providing education 13-16 and enabling entry to post-16 studies. The document also explored viable alternatives to the traditional science curriculum pattern of biology, chemistry and physics. Its recommendations led to the introduction of many of the more successful innovations in science education throughout the remainder of the 1980s. The published summary of recommendations and proposals is reproduced in its entirety in Appendix 2.

Between 1981 and 1983 the first phase of the work of the SSCR which involved planning and consultation, was taking place. 'Science Education in Schools' (DES, 1982) confirmed science as a core subject for all students. The opinions of many professional scientists, however, indicated that the balanced science approach was not universally favoured, 'Science Education 11-18' (Royal Society, 1982) recommended that science be delivered in a coordinated framework which would allow the separate sciences to retain their identities.

In 1983 the SSCR, moving into its second phase of curriculum development (1983-1986) published 'Science Education 11-16: Proposals for Action and Consultation' suggested that moves should be taken towards creating a consensus in favour of a broader and more balanced approach to delivering science in the secondary curriculum. The time allocations of 10% for Years 7 and 8, 15% for Year 9 and 20% for Years 10 and 11 were endorsed. HMI in 'Curriculum 11-16: Towards a Statement of Entitlement' (1983) further developed these themes.

The DES document 'Science 5-16: a Statement of Policy' (1985) was quite explicit in terms of curriculum time, stating that the allocation for science should not exceed 20% for any student. In terms of content the issues of breadth and balance remained to the fore with the statement of entitlement for each student incorporating aspects of biology, chemistry and physics; the alternative methods of delivery and their relative merits were to be investigated and reported by SSCR. In addition, it was stressed that (p22):

> The science which is provided for lower-attaining pupils in years 4 and 5 should not be different in kind from that provided for average and more able pupils: it should, however, be differentiated in its treatment and should contain elements which will enable the pupils to achieve success which they can rightly feel to be worthwhile.

This document was also unique in that it was the first statement on policy in this country which applied to a single curriculum area.

In 1987 the consultative document 'The National Curriculum 5-16' was published by the DES. Science was placed in the core of the proposed curriculum. The advisory group on science in the National Curriculum supported the suggestions that science should occupy 20% of curriculum time and be taught by a coordinated approach leading to a double GCSE award. In July 1988, the Education Reform Act established a National Curriculum.

As far as the research project and the development of the Year 9 courses were concerned, the timing was unfortunate. The project itself had intended to focus on the teaching of the sciences to girls, the curricular innovations were intended to enhance the uptake of and interest in the separate sciences. The National Curriculum proposals meant that <u>all</u> students would now be compelled to study the three sciences.

It soon became apparent that the research could prove to be even more crucial, certainly as far as the girls were concerned, as it would attempt to investigate the factors which were leading to the girls turning their backs on the physical sciences at the end of Year 9. The teaching of aspects of biology, chemistry and physics to all students would be likely to occasion a certain amount of dissatisfaction, perhaps even hostility, on the part of those students who would now be forced to participate in those lessons from which they would previously have opted out. In physics lessons, for example, the majority of the girls would be present as 'conscripts rather than volunteers' (Ditchfield and Scott, 1986, p16).

I decided to introduce a programme of action research with students from years 9, 10 and 11. This programme would aim to highlight aspects of science and science teaching which the students themselves identified as contributing to the 'turning-off' process. This would be followed by a series of small-scale interventions designed to counteract these negative effects.

In order to ensure that the students in the school were not merely being used as guinea pigs it was decided to adopt an existing balanced science course to deliver the National Curriculum and then to use this course as a framework within which student attitudes could be investigated. After consideration of the alternative courses available, their provisions, assessment methods and so on, the school decided to adopt the course examined through the MEG Coordinated Science syllabus, known as the Suffolk Development. Another favourable aspect of this course, usually known as Suffolk Science was that it was a three year course. This meant that as the Year 9 work was a part of the GCSE assessment we would, as part of the one action research programme, be able to address the problem of our Year 9 science courses in addition to the gender and attitudes issues.

Action Research

Action research was first described in a systematic way by Corey (1953) who identified two major sources of influence for this type of approach. These were Collier (Commissioner for Indian Affairs 1933-45) and Lewin (1946).

A central feature of Lewin's research was the participation of the cohort in both the decision making and the evaluation aspects of the research programme. In the school situation this ideal is not always attainable; the students will usually participate in the evaluation and may suggest possible developmental action, but are unlikely to be directly influential in the decision making process when policy changes are to be made. Lewin's theories were, however, neither developed nor intended to be used in a purely educational framework.

Halsey (1972), in Cohen and Manion (1980) defined action research as:

> ...a small-scale intervention in the functioning of the real world and a close examination of the effects of such intervention. (p208)

Stenhouse, who was the Director of the Schools Council Humanities Project from 1967-72, was also influential in developing the importance of the teacher as both observer and evaluator of his/her own practice. This role of the teacher as researcher should, he envisaged, be effective in the improvement of education. Cohen and Manion quote Stenhouse (1979) to point out that action research, although concerned primarily with educational practice should also contribute to educational theory and thus become available to all teachers rather than just the researcher(s).

Lewin described action research as a series of steps. He considered each step to contain four basic stages of planning, acting, observing and reflecting. This visualisation was utilised and developed by Kemmis (1981), Elliott (1981) and Ebbutt (1983) in the formulation of their more structured representations of the action research process.

Kemmis described a cyclical pattern of progression with the four 'moments' of action research (planning, action, observation and reflection), being carried out in a collaborative fashion and together constituting the cycles of the spiral. Kemmis produced a schematic form of his spiral model which is reproduced in Figure 2.3, (Kemmis, 1981, p8). His representation clearly demonstrates the four 'moments' of the programme as outlined earlier.

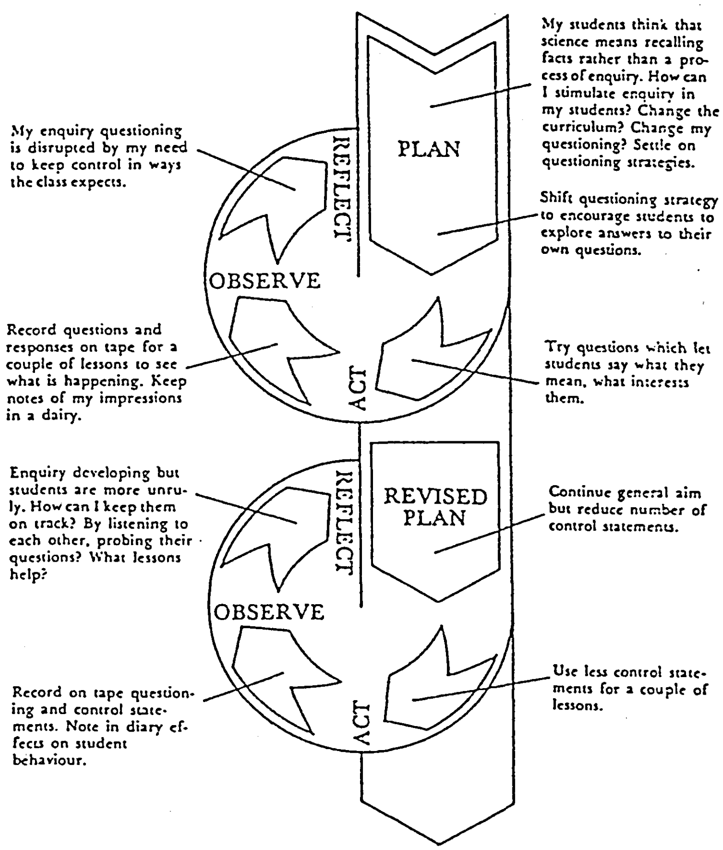
Elliott accepted the basic outline of Kemmis' sequential programme but argued (1981) that the visualisation of the preparatory 'reconnaissance' stage was limited and prescriptive by being restricted to non-analytical fact finding. He produced a similar progression to Kemmis but one which was much more elaborate. A slightly modified form of Elliott's model is presented in Figure 2.4.

Ebbutt (1983) disagreed with Elliott's interpretation of the Kemmis model and, as quoted in Hopkins (1985, p32), visualised action research as being:

> ...about the systematic study of attempts to improve educational practice by groups of participants by means of their own practical actions and by means of their own reflection upon the effects of those actions.

Ebbutt was not entirely convinced of the usefulness of Kemmis' spiral model and suggested (Hopkins, p35) that a better way to visualise action research was, as represented in slightly modified form in Figure 2.5:

Figure 2.3 Kemmis' schematic form of the spiral model of action research.



Source: Kemmis (1981), p11

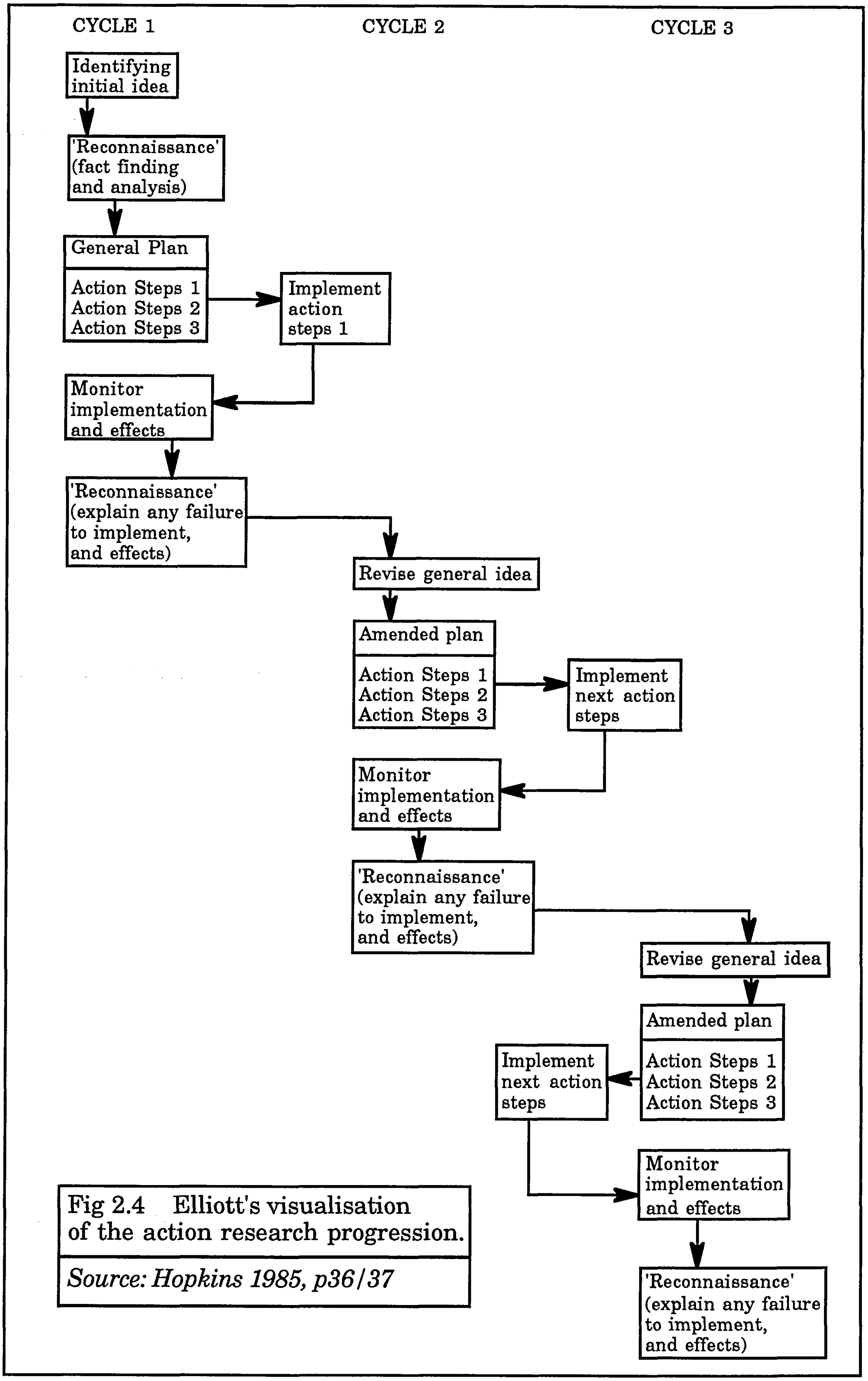
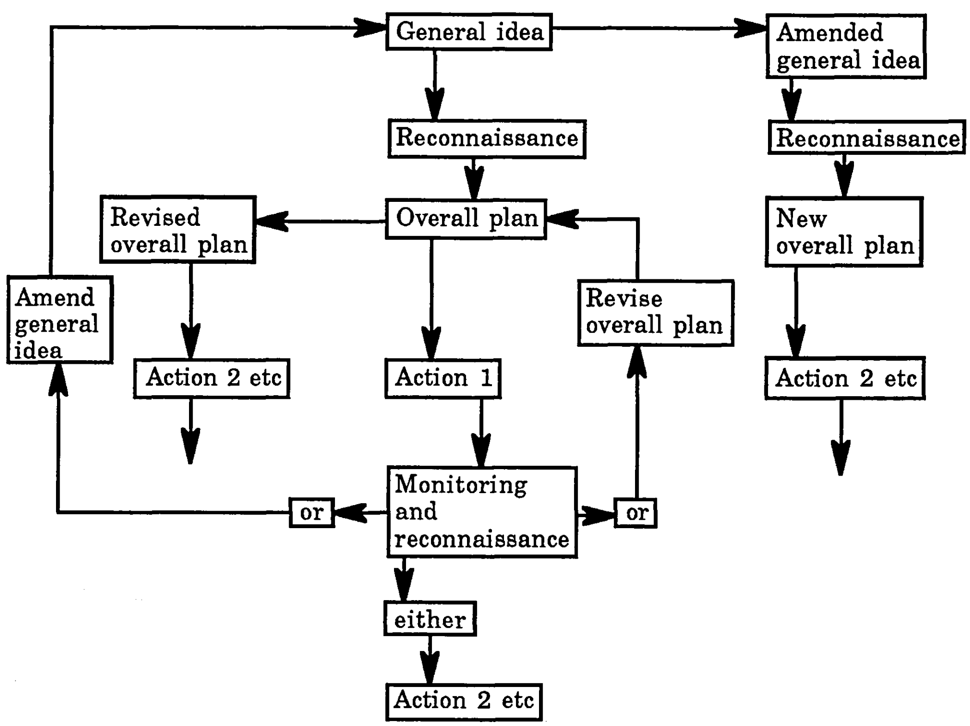


Fig 2.4 Elliott's visualisation of the action research progression.

Source: Hopkins 1985, p36/37

...to think of it as comprising of a series of successive cycles, each incorporating the possibility for the feedback of information within and between cycles. Such a description is not nearly so neat as conceiving of the process as a spiral, neither does it lend itself quite so tidily to a diagrammatic representation. In my view the idealised process of educational action research can be more appropriately represented like... (see Fig 2.5)

Figure 2.5 Ebbutt's model of the action research process.



Source: Hopkins (1985), p38

Whichever of these models one holds as being the best representation of action research it is apparent that the central route through a programme of action research is not linear and must develop over an extended period of time because of the cyclical nature of the progression through the programme. In addition, it is unlikely that the stages in the cycles are clearly defined, the reflective phase of one cycle will frequently merge with the target identification and planning for the next. The cycles themselves may be short-term projects designed to quickly gather information and then return to the field with fresh initiatives or may be fully integrated within the overall action plan. Both of these alternatives will allow feedback to the main stem of the research. The former need not be a sequential approach and may in some ways prove to be more flexible by permitting the researcher to investigate further the salient points of the projects as revealed during the evaluation stages.

It was specified at the outset of this research that the work should not in any way interfere with either the teachers' teaching or the students' learning and that all the outcomes would be channelled into attempting to make the science courses in the school more suitable for our students. It was intended that ultimately we would, by virtue of developing improved techniques, resources and contexts, help to make all our students more receptive to science.

It seemed, therefore, essential that the investigations in this research were allowed to develop freely rather than adhering to a rigid and prescriptive model. With this freedom the professional demands of the teachers need not be compromised and the freedom of response of the students may be maximised. Hopkins (1985) made the following comments in relation to the process-led models of action research:

> ...the tight specification of process steps and cycles may trap teachers within a framework which they may come to depend on and which will consequently inhibit independent action. The original purpose of teacher research was to free teachers from the constraints of prespecified research designs. (p40)

Hopkins did not intend these comments to indicate a complete lack of structure and proposed:

> It is useful to have a guide for action, my concern is when it becomes, or appears to become, prescriptive. (p40)

The students, as the consumers, are the ones who can indicate those areas of school science and science teaching which are causing them to 'turn off'; the research mechanism should be fluid enough to be able to pick up these pointers and then use them to identify the problems and develop ways to counteract them.

The Action Research Programme

This programme identified its aims on quite a broad base initially, but as the action cycles produced evidence and information these became more refined. Figure 2.6 records the chronology of the Research Tasks with a brief explanation of each task. Figure 2.7, (the Research Log) identifies the input/feedback relationships which link the Research Tasks and Areas.

It soon became apparent that the students were frequently viewing their experiences in science lessons in a very different way to which we, the teachers, had intended. Consequently the research became finely focussed on the attitudes of the students and considered some ways in which these could be assessed and changed. Only then could we begin to consider attempting to improve techniques, resources and contexts.

I gave a great deal of thought to the way in which the action research in this programme should be approached. Hopkins (1985) counselled that the model for action research should not be so rigid that it would prevent the researcher picking up the cues and clues given by the students. If this spontaneity of approach were not permitted then it is unlikely that a true understanding of the issues creating the problem could be reached.

Hopkins does, however, specify the following five criteria which should influence the conception of the action research plan. He firstly proposed that the research should not interfere with the fundamental role of the teacher, and by implication, should not interfere with the learning processes of the students. This had already been specified as an integral part of this development. He suggested that the research problem should not only be one to which the teacher was committed but should also show a careful regard for ethical and professional procedure. His final criteria were that the methodology used for the research should be reliable and that the methods of data collection should not be too demanding of the teacher's time, this final point is a natural consequence of the first.

Figure 2.6 The chronology of the Research Tasks carried out in Phases One and Two of the research.

TASK 1. June 1987 - visits to junior schools to carry out work based on APU practical investigations.

TASK 2. June/July 1987 - ad hoc investigations to determine ways of gaining written responses from students to discover how best they could communicate attitudes and opinions.

TASK 3. September 1987 - survey of interests of Year 7 students.

TASK 4. January 1988 - survey of parents of Year 7 students to determine perceptions of relative importance of school subjects for boys and girls.

TASK 5. May 1988 - year 11 option choice survey (pilot).

TASK 6. May/June 1988 - survey of Year 9 students to discover their perceptions of the interest and relevance of science, their ability in the sciences and their attitudes towards gender issues in the sciences.

TASK 7. September 1988 - individual interviews with Year 10 students who had participated in the attitudes surveys (Task 6).

TASK 8. October 1988 - revised option choice survey for Year 11 students.

TASK 9. February 1989 - snowball discussions with Year 10 girls.

TASK 10. April 1989 - questionnaires relating to the conduct of science lessons and interest in science, issued to Year 9 students.

TASK 11. May 1989 - questionnaires relating to Suffolk Science units (basic and enhanced descriptors).

TASK 12. June 1990 - interviews with upper band Year 9 students.

TASK 13. June 1990 - observation of Suffolk Science lessons with lower ability Year 9 students.

TASK 14. July 1990 - interviews with lower ability Year 9 students.

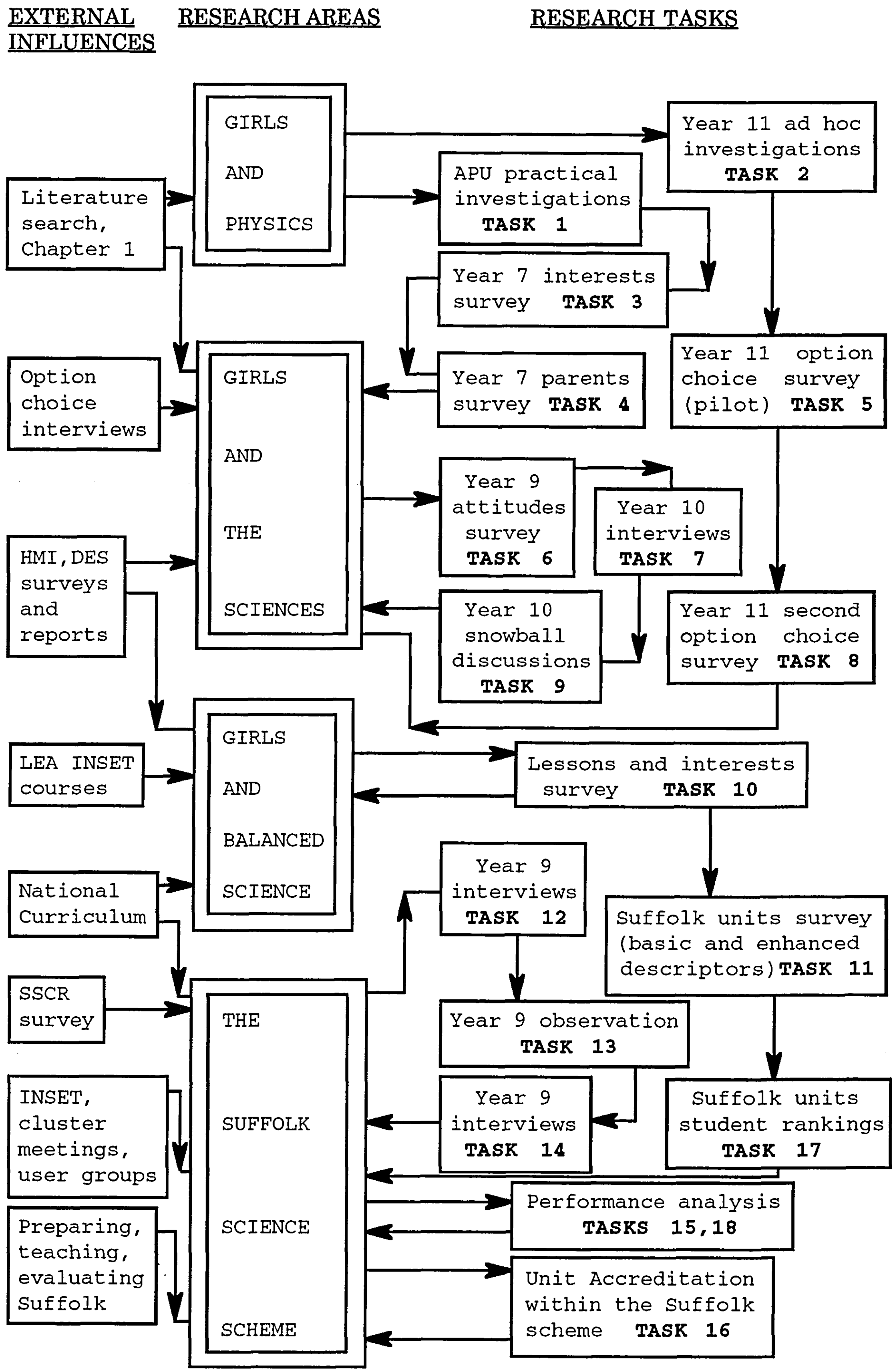
TASK 15. September 1990 - performance analysis for first Suffolk Science cohort (Year 9, 1989-1990).

TASK 16. November 1990 - development of scheme of Unit Accreditation to complement the Suffolk Science assessment framework.

TASK 17. April 1991 - survey of Year 9 and Year 10 students to determine the popularity of the units in the Suffolk Science Introductory Year.

TASK 18. September 1991 - performance analysis for Year 9 and Year 10 cohorts for academic year 1990-1991.

Figure 2.7 The Research Log - Phases One and Two



As the focus of the entire project was the attitudes, achievements and interests of the girls in relation to science I wished to begin by observing a group of girls at work on science related activities. I did not, however, want this activity to be tinged in any way by their perceptions of the school or their status within it. I resolved that the only way in which this would be possible was to work with a group of girls in one or more of the feeder junior schools. The girls would then be on 'friendly soil' and they would have no conception of my position.

The nature of the work should also be non-threatening so that they could work in as natural a fashion as possible. I was fortunate to obtain, on loan, an APU 'Practical Testing: Science at Age 11' kit early in 1987 and decided to use a circus of experiments from the Kit in June, prior to the girls' transfer to my school in the September of that year (Task 1).

The headteachers of two schools were extremely supportive and allowed me to use a free room in each of their schools. The girls were selected by their class teachers, they were simply told that I wished to try out some new experiments and equipment. I stressed that I would like to work with girls of all abilities who would be prepared to talk to me about their work.

I was pleased to observe that the girls, although working with unfamiliar materials and new concepts, demonstrated a high degree of competence and confidence. Some six months later a special timetabling arrangement in another area of my school removed all the boys from one of my science groups and I repeated the circus with the girls (aged 12 and 13) from that teaching group. In contrast to the juniors they did not display the same confidence in either their work or their decision-making and yet both groups of girls were equally competent in their practical skills.

This work was, however, simply a preparatory exercise which enabled me to spend some time working with and talking to students in a different context without the implications of my role within the school colouring the situation. It also allowed me to create a different type of relationship with a small number of my students. These students are now in their final year and it appears to me that they have a more open and relaxed relationship with me than most of my students.

Prior to launching into the major research programme I identified two areas in which I wished to carry out preparatory work. The first of these was to enable me to familiarise myself with methods of data collection and processing. The second was to satisfy myself that my students had similar pre-school and early childhood experiences to the students investigated in other research projects (as described in Chapter 1).

I decided to combine these by investigating the science related activities and interests of all the Year 7 students entering the school in September 1987 (Task 3) and by canvassing parents in relation to their perceptions of the importance of various subjects for their child in that cohort (Task 4).

For the main research I decided that, because of the usual rather distant nature of the relationship between teacher and students a more direct and personal approach would be inappropriate. Secondly, as I was wishing to gain information from a large population in discrete areas at regular intervals with some measure of intervention, case studies also seemed unsuitable. I concluded that much of my data gathering would best be achieved through a range of surveys, with questionnaires being the main tool.

Questionnaires have been used throughout this research programme as a simple and immediate method of obtaining quantifiable data. Hopkins' (1985) discussion of the main advantages and disadvantages of this method of data collection points out that questionnaires are easily administered, quick to complete and, in the school situation, are easy to follow up. They permit direct comparison of both groups and individuals and provide quantifiable data in a wide range of situations. He does concede, however, that the analysis can be time-consuming. When preparing the questionnaire it can be difficult to obtain questions which are straightforward and/or penetrating. The students completing the questionnaire may misread or misunderstand questions, they may not respond candidly or may perceive some responses as being 'correct' and select these in an attempt to please the researcher. There is, however, the advantage that the level of response will approach 100%.

Many of the disadvantages of enquiry by questionnaire as suggested by Hopkins do not appear relevant in this particular action research programme for the following reasons. The data gathering exercises were intended to obtain quantifiable data and, therefore, the above criticisms of the method are applicable. The uses to which the ensuing data were put, however, neutralise these to a certain extent. The investigations were concerned with student attitudes and perceptions and these are not absolutes. Furthermore, the objectives were to identify areas where these attitudes and perceptions were negative and were contributing to lack of opportunity for the individual students and then investigate these areas. The data obtained by analysing data would be used to indicate further areas of investigation rather than provide a basis for theorising about the situation.

Consequently, if a certain curriculum area, teaching method or assessment tool appeared to be a contributory factor towards the negative viewpoint of some of the students then any remedial action would be worthwhile. In addition, the strategies which were of benefit to those students who had identified a problem would be likely to enhance the learning situation for the remainder of the cohort, thus adding to the success of the intervention.

In some of the preparatory and pilot studies the population size was restricted by only using my own, or a cooperative colleague's teaching groups. For the above studies and the major surveys, however, the identified cohort was the entire year group.

The students will naturally interpret the survey and the issues raised in the survey in different ways. These variations will arise for many reasons, for example, previous experience on the part of the student, differing relationships between the student and the teacher/researcher and the developmental level of the student. In order to validate my data I attempted wherever possible to obtain corroborating evidence by incorporating alternative methods of data collection (for example, group discussion, interviews and free-response tasks); additional data was also obtained from other schools and by employing researchers from outside the school. This method of validation, collecting information relating to a single situation but from three individual sources is known as triangulation and was developed by Elliott and Adelman (1976).

Unlike most research projects of this nature it was very difficult to specify the first stage of the action research programme. It was quite easy to identify the major aims of the research, but this did not immediately define the procedure as the progress of the research depended upon the identification of problem areas by the students themselves. Only when the problem areas had been identified was it possible to devise a series of experimental procedures designed to counteract the negative areas specified.

It was necessary then, in the initial stages of the research, to highlight a specific issue in science education and then to identify a cohort for whom this issue may have some special significance. A data gathering exercise would then, hopefully, throw some light on this issue and indicate further areas for investigation. The research log, (Figure 2.7) indicates the development of the programme.

I spent some time talking and listening to my students (Task 2) and reading research papers in areas other than that of the science/gender difference. I finally decided that I would investigate the career choices of a Year 11 cohort and ask them to attempt to relate their option choices to their career aspirations (Task 5). The pilot questionnaire (May 1988), in Appendix 5, also endeavoured to explore issues related to the students' likes and dislikes in relation to their science lessons.

The pilot proved, for reasons which will be discussed later in Chapter 3, to require modification in certain areas. The survey was then repeated (October 1988) with another Year 11 cohort but using a greatly revised questionnaire (Task 8), see Appendix 7.

Whilst preparing the pilot survey and analysing the data I continued to explore the gender issue. The project at Stamford High School (Smith, 1986) where girls were taught in single sex groups in mathematics lessons interested me. On investigating the survey in more detail I found the APU/NFER Mathematics Attitude Questionnaire format offered the opportunity I required to investigate the attitudes of the Year 9 cohort towards science (Task 6).

This questionnaire (included as Appendix 8) was based around a five-point Lickert scale asking students to agree or disagree with a series of statements. I set about devising a suitable series of statements which would allow me to compare the attitudes of girls and boys towards issues in science education. The statements and the way in which they were presented were piloted by two chemistry groups (mixed groups containing approximately 25 students each) who gave up much of their own time to discuss with me their own responses to the issues.

The final format consisted of a set of 42 separate statements. The cohort were simply asked to agree or disagree as appropriate with these statements. The statements had been either manufactured by myself or derived from my discussions with students from Years 10 and 11 and were designed to investigate three areas of student attitudes and perceptions, these were:

1. perceptions of the interest and relevance of science,
2. perceptions of personal ability in science, and
3. attitudes towards gender issues in science.

These were drawn from the research detailed in Chapter 1, with fourteen statements being allocated to each area.

In addition to comparing responses by gender I wished to explore the attitudes of the students towards the separate sciences. I prepared three separate questionnaires, each contained forty two statements which were identical except that in one questionnaire the statements specified biology as the science, in another chemistry and in the third, physics. For example, statement 3 on the biology questionnaire read 'Most of my friends think BIOLOGY is boring'. Statement 3 on the chemistry questionnaire was 'Most of my friends think CHEMISTRY is boring' and on the physics questionnaire, 'Most of my friends think PHYSICS is boring'.

In order to further reinforce the subject specificity the questionnaires were administered in the appropriate lessons so that a particular student would be completing, for example, a biology questionnaire which had been given to them by their normal biology teacher in the biology lesson.

The entire Year 9 group of 1987-1988 was used as the cohort for this survey. Students were asked to complete the questionnaires over a four week period (May-June 1988) after they had completed their science options for their GCSE examination courses in upper school.

The responses were coded to indicate positive or negative responses towards the issues in that particular science discipline. The 'agree' and 'strongly agree' responses have been combined to give an overall 'AGREE' response and the disagreement responses have been similarly treated to give an overall 'DISAGREE' response. These positive and negative responses to each of the three investigative areas (interest and relevance, ability, and gender respectively) were then compared graphically, by gender (Figures 3.13, 3.14 and 3.15). This compression of the scale was carried out to enable an immediate visual comparison to be made in order that trends in student opinion rather than specific responses could be highlighted. The 'not sure' responses were generally small and have been ignored for this comparison. The full 5-point scale of responses was retained when carrying out the statistical treatment of the data.

In an attempt to gain a deeper insight into the attitudes of the students and to ascertain the possible mechanisms by which they developed, I decided to interview a small number of the students who had participated in the surveys in Task 6. The students were chosen from my own teaching groups. This restricted the possible choice to only 42 but I preferred to speak to them as their class teacher. Had I removed students from other teaching groups then they may possibly have been influenced by my position as the Head of Science. I further restricted the choice to students who had completed all three of the 'attitude' questionnaires, finally interviewing five girls and two boys in September 1988 (Task 7).

I wished to look, in more detail, at the students' perceptions of their own ability in the sciences and the relative difficulty of each. I also wished to investigate the relationship between the students' option choices and their career aspirations. In October 1988 I issued the revised options/careers questionnaires to all Year 11 students in the upper band who were studying either separate sciences or modular science (Task 8). I did not include the lower band in the cohort as they had no choice about their upper school science courses and all followed a Mode 3 Modular Science scheme.

Having paid due regard to both the boys and the girls in all the surveys and having restricted the students in both questionnaire and interview to my questions and their thoughts and opinions, I decided to introduce a change of strategy. There had been very little opportunity for students to express individual opinions in any extended form and there had been no formal opportunity for students to discuss their opinions jointly.

I resolved to investigate the girls' attitudes towards physics through a series of snowball discussions (Task 9). A cohort of 20 Year 10 girls was released, at my request, from timetabled lessons during February 1989. They were asked to discuss their recollections of their Year 9 physics lessons. They were allocated rooms where they could simply talk to each other with no input from myself or any other teachers. The girls were friendship-paired for the initial round of discussion and were allocated a time of thirty minutes to identify any factors which they felt had contributed to the 'turning-off' process in physics.

After this initial period they were asked to move into groups of four with their lists, to consider the issues raised by the pairs. The group responses are collected in Appendix 9. Two larger groups were then formed and finally the entire group came together to talk. I was invited by the girls to participate in the final session.

By this time the decision to move towards balanced science courses in upper school, using Suffolk Science as our vehicle, had been taken. I had by now gained some insight into the opinions of our students in relation to the science and its teaching. The Suffolk course provides a comprehensive set of lesson notes which may be simply taught, or used as a resource to develop one's own teaching strategies and contexts. The topics and concepts appeared to us, as teachers, to be interesting and relevant. Our students had, however been quite critical of school science in both the questionnaires and discussions and I resolved to experiment with teaching and learning strategies in order to deliver the Suffolk course as successfully as possible.

In April 1989 a Year 9 cohort was surveyed by the questionnaire in Appendix 11 to ascertain what they perceived as interesting and attractive methods of delivering both theory and practical work in the sciences. In addition I also attempted to obtain from the students an indication of which of the Suffolk Science teaching units they thought they would find the most interesting by asking them to rank, for interest, nine biology module titles (from a brief verbal explanation given by myself to the students). They were then asked to rank nine chemistry modules and nine physics modules in the same way (Task 10).

The students' responses to the questions relating to the Suffolk Science units illustrated, once again, the many different ways in which the students perceive the comments and questions of the teachers. The numbers of units involved also made the students' task far too complex. I decided to restrict the survey to the twelve units in the Suffolk Science Introductory Year and attempt to determine how influential a teacher's preparatory comments were in relation to a student's perception of the nature of the work.

I selected the Year 8 group of my school as the target cohort for this exercise as they would be studying these units the following year. I also reinforced the results by issuing the survey questionnaire to Year 8 students in another of the schools in our Suffolk Science 'cluster'. The questionnaire broke the units down into the three science areas, with four units in each, the students being asked to rank them on the basis of which units they thought they would find the most interesting (Task 11).

Two separate questionnaires were prepared (see Appendices 12 and 13), these were identical in format, but on one set of questions the units were described in a 'traditional text-book' way. On the other questionnaire the units were given enhanced descriptors in order to make the units sound more appealing. Some students received the questionnaires with the basic descriptors, others received those with the enhanced descriptors and the responses were compared. A brief discussion of this survey and its findings was published in the Newsletter of the Suffolk Development (Collins, Spring 1990), and will be considered in more detail later in this thesis.

Suffolk Science was intended to be applicable to the full range of abilities. In my school, we intended from the beginning to use this course for all our students, irrespective of ability. However, because many of our lower ability students experienced difficulty in reading they had been excluded from the questionnaires relating to Suffolk Science units. These students' opinions of the Suffolk course were also relevant to our planning for a successful science course but were surveyed in a different way.

These students were questioned individually, during the science lessons, about the nature and enjoyment of their work and how they perceived the work and the teaching methods. This survey was carried out with the assistance of the Advisory Teacher for Science in the LEA. He came into the school over an extended period of time, attending science lessons with the two lower ability groups and working with them on practical and assessment tasks (Task 13). The students were surveyed during the actual lessons for the most part, although it was necessary to arrange interviews for some students (see Appendix 15 for interview schedule) because of their poor attendance patterns (Task 14).

By the time analysis of this data was complete the Suffolk course was already being taught. My intention was that individual teachers should decide how much the implications of the research would affect their teaching. It would also have been extremely difficult to formulate a common departmental policy as each teacher was only to teach three of the Introductory Year units. Standardisation of teacher techniques across different teaching areas in the first year of teaching a course would have been unmanageable. In order to promote student satisfaction, I felt that it was necessary that the teachers themselves were completely familiar and relaxed with what and how they were teaching. There was also the possibility that the newer Suffolk course material would be more thoroughly prepared by teachers than the more familiar contexts and this would, therefore, tend to be better received by the students.

CHAPTER THREE

The preliminary investigations

This chapter provides in-depth consideration of the first phase of the research, the preliminary investigations. These initial Research Tasks commenced with a series of practical investigations based on earlier work by the APU, moving on through a series of small-scale surveys designed to gather information regarding the students, their perceptions of science and their career aspirations. This first phase concluded with the attitude surveys of an entire year group within the research school. The discussion then considers the investigations in terms of plans for further action and monitoring within the field of gender differences in science.

Some of the theories relating to the origins of the gender differences in science, as discussed in Chapter 1, were based on investigations by both APU and GIST into the science-related activities and interests of students. Research Task 3 was intended to investigate both of these issues with the entire Year 7 cohort of September 1987 by means of two questionnaires (see Appendix 3) issued to the students during the first week of term.

The first focussed on science-related activities in both the school and the home environments, the results are listed in Table 3.1. The second asked which science related topics they would like to learn more about in school, these results are listed in Table 3.2. A third survey (Research Task 4, Appendix 4) asked the parents of this cohort to indicate which school subjects they felt were important for their child in Year 7. In this way I hoped to be able to investigate any gender bias in parental expectations without alerting parents to the gender issue. The results of the parental survey are reproduced in Table 3.3.

In terms of domestic activities Table 3.1 clearly shows the expected pattern of girls being more involved in the household chores, the boys' responses indicated a greater involvement in those activities requiring the use of specialist tools, traditionally the male preserve. In the science related activities there was little difference in the responses with the exception of 'tinkering' activities involving construction materials (Lego etc.) and working models (e.g. remote control cars). The boys showed a greater involvement and interest in these areas, reflecting the previous research reported by Harding, Kelly, Smail and others, as mentioned in Chapter 1.

Table 3.2 also reflects the pattern we have come to expect in student preferences with the girls leaning more towards those areas of study which suggest an interest in people, for example, food and diet, looking after our bodies, child development and so on. The boys responses demonstrated their traditional preference for 'doing' by wishing to study electrical models, motor cars and the like.

Table 3.1 Responses to the Year 7 questionnaire (September 1987), Research Task 3.

'Do you?'	% BOYS responding			% GIRLS responding		
	often	sometimes	never	often	sometimes	never
Wash the dishes......	25	52	23	39	60	1
Look after animals..............	52	33	15	66	18	16
Read books about science...............	8	40	53	6	31	63
Take photographs......	25	57	18	38	51	10
Change a plug.........	21	21	58	6	12	82
Watch TV science programmes............	9	52	39	4	63	33
Hoover and dust.......	27	48	25	45	52	3
Play with Lego or Meccano............	24	40	36	6	12	82
Play with remote control cars..........	29	39	32	4	13	82
Model with plasticine............	6	19	74	10	19	71
Play with paints or crayons............	13	47	41	21	59	20
Collect rocks..........	5	23	72	13	17	70
Collect flowers and plants.............	6	19	74	15	45	40
Watch TV animal programmes............	46	46	9	58	33	9
Repair a bicycle.....	41	38	21	12	43	46
Cook..................	35	54	10	46	46	9
Use washing machine................	5	26	69	18	28	54
Iron..................	12	25	64	38	41	21
Use screwdriver or other tools........	52	37	11	8	45	47
Use a microwave.......	28	16	56	42	21	36

Table 3.2 Responses to the Year 7 questionnaire (September 1987), Research Task 3.

'Which of the following would you like to learn more about in your science lessons?'

	--------BOYS-------- % responding YES	--------GIRLS------- % responding YES
Eyes and seeing..............	18	21
Animals as pets..............	60	76
Cameras and photographs......	43	46
Trees and flowers............	23	47
Stars and planets............	65	34
Electrical models............	84	43
Muscles and movement.........	36	55
Acids and chemicals..........	75	69
Volcanoes and earthquakes....	43	35
How motor cars work..........	71	21
Computers....................	86	75
Microscopes..................	56	44
Science in sport.............	62	56
Plants we can eat............	27	50
How children develop.........	46	68
Looking after our bodies.....	51	75
How a television works.......	71	40
Building models..............	86	58
Animals in the jungle........	53	67
Measuring....................	18	26
Food and our diet............	35	70
Making a record..............	54	61
Rainbows.....................	23	49
Ears and hearing.............	22	24
Our bodies...................	54	73

Both of these surveys showed that the students followed the typical gender differentiation pattern in both activities and interests. This was a reassuring discovery because it implied that any benefits recorded by action on the part of other researchers would be likely to be equally beneficial to my own students. In addition it suggested that any positive aspects of my own research may be useful in other schools. The surveys themselves also allowed me to experiment with the questionnaire in structure and format. On the first questionnaire, for example, several of the questions simply assumed that the student had access to certain items e.g. bicycle, microwave, tools, remote control cars etc. and these assumptions were not necessarily correct. I did not feel, however, that on this particular survey these points were detrimental to the conclusions.

Table 3.3 indicated that the parents of our students held the traditional views of gender differentiation as outlined in Chapter 1. It is expected that these values will have been transmitted to their children. In terms of the sciences, physics was ranked more highly for boys, chemistry was ranked similarly for both boys and girls but, surprisingly, biology was ranked much higher for boys than for girls. Table 3.4 shows the rank position and score for each of the school subjects in the survey, by gender. The score was calculated by combining the percentage responses for 'very important' and 'quite important' from Table 3.3. I combined the two sets of responses because I was not sure what criteria the parents used for deciding which response to make and I decided that it would be better to simply use all the positive (important) responses in order to obtain an overview.

It was anticipated that this project would ultimately lead to a greater understanding of the formation of student attitudes towards science and the way in which these attitudes influenced student behaviour and achievement in science. I decided to approach this area by investigating the influences upon the students' selection of science option choices at the end of Year 9. I also wished to investigate the students' perceptions of the relationships between science and career aspirations. This was first attempted in May 1988 (Research Task 5) using the questionnaire in Appendix 5.

Table 3.3 Responses to Year 7 parents questionnaire (January 1988), Research Task 4.

	BOYS		GIRLS	
	VERY IMPORTANT	IMPORTANT	VERY IMPORTANT	IMPORTANT
Art	22	73	12	77
BIOLOGY	30	95	46	89
Careers Education	67	97	67	94
CHEMISTRY	31	83	32	82
Computer Studies	71	95	65	92
Cookery	21	77	52	89
Drama	5	25	7	43
Economics	48	95	44	93
English	93	100	95	100
French	14	69	27	80
Geography	44	92	44	89
German	20	74	29	76
Health Education	77	95	73	97
History	41	88	30	90
Mathematics	99	100	95	98
Music	11	50	16	67
Needlework	5	32	23	80
Physical Education	69	95	58	95
PHYSICS	50	89	34	76
Religious Education	14	61	15	68
Sex Education	56	94	60	97
Technology	66	94	36	87
Wood/Metalwork	50	95	8	55

Figures are percentages, the 'IMPORTANT' response being obtained by combining the responses for 'VERY IMPORTANT' and 'QUITE IMPORTANT'.

Table 3.4 Parental ranking of importance of school subjects by gender (Research Task 4).

	----BOYS----		----GIRLS----		---OVERALL---	
	RANK ORDER	SCORE	RANK ORDER	SCORE	RANK ORDER	SCORE
Art....................	18	73	17	77	16	75
BIOLOGY...............	4	95	10	89	9	92
Careers Education.....	3	97	6	94	3	96.5
CHEMISTRY.............	15	83	14	82	14	82.5
Computer studies......	4	95	8	92	8	93.5
Cookery...............	16	77	10	89	13	83
Drama.................	23	25	23	43	23	34
Economics.............	4	95	7	93	7	94
English...............	1	100	1	100	1	100
French................	19	6	15	80	19	74.5
Geography.............	12	92	10	89	10	90.5
German................	17	74	18	76	16	75
Health Education......	4	95	3	97	5	96
History...............	14	88	9	90	12	89
Mathematics...........	1	100	2	98	2	99
Music.................	21	50	21	67	21	58.5
Needlework............	22	32	15	80	22	53
Physical Education....	4	95	5	95	6	95
PHYSICS...............	13	89	18	76	14	82.5
Religious Education...	20	61	20	68	20	64.5
Sex Education.........	10	94	3	97	3	96.5
Technology............	10	94	13	87	10	90.5
Wood/Metalwork........	4	95	22	55	16	75

Scores obtained from 'IMPORTANT' responses, Table 3.3.

Analysis of the completed questionnaires from Research Task 5 revealed that some areas of the questionnaire were not as productive as I had originally hoped. This was mainly due to the fact that the questionnaire had been constructed in such a way that it was possible for the students to interpret and answer some of the questions in different ways. For example, in question 6 I had intended that the students answer yes or no to each of the six alternatives presented. In fact most of the students only responded to one of these alternatives, presumably selecting the one which influenced them the most. Other questions which were also seeking multiple responses were treated in a similar way by the students. The comments obtained from the students in response to questions 12, 13 and 14, however, were interesting and provided me with ideas for structuring the second version of the options/careers questionnaire. The comments are included as Appendix 6.

The second questionnaire (Research Task 8) was produced as a result of the amendments made to the first options questionnaire. It was more tightly structured, indicating to the students exactly what was expected of them in terms of nature of response, number of responses and so on. A copy of this questionnaire is presented in Appendix 7. The questions relating to perceived ability were broken down subject by subject, as were the questions relating to perceived difficulty. The questions which were designed to investigate those aspects of science lessons which the students liked and disliked offered a greater number of choices, some of which had been suggested by my own students during informal discussions and some by students on the first questionnaire.

On question 2 only 28% of the boys as opposed to 53% of the girls in this cohort indicated that they had some career in mind at options time. The results of question 3 indicated that 68% of the boys and 74% of the girls selected their science options on the basis of a liking for science. Table 3.5 shows the responses to questions 4, 5, 6 and 7, which asked how the students perceived their own ability in science and which science subject they liked best, and questions 10, 11 and 12 which asked the students for their perceptions of the difficulty of the individual sciences.

Table 3.5. Responses to questions relating to perceived ability in and perceived difficulty of the sciences (Research Task 8).

	PERCEIVED ABILITY			PERCEIVED DIFFICULTY			
	GOOD	AVERAGE	BELOW AVERAGE	QUITE DIFFICULT	AVERAGE	FAIRLY EASY	LIKE BEST
BOYS (% RESPONSES)							
Biology	18	49	8	12	48	17	15
Chemistry	22	48	11	32	42	8	29
Physics	25	54	15	34	43	17	48
GIRLS (% RESPONSES)							
Biology	13	81	2	13	62	21	75
Chemistry	11	60	26	42	47	8	13
Physics	2	49	45	43	51	0	6

Questions 8 and 9, which asked students to indicate their likes and dislikes in relation to science lessons, gave interesting responses (Table 3.6) which were later used as a basis to investigate student preferences in relation to the structure of science lessons. This investigation (Research Task 10) yielded data which would be included in the discussions during subsequent planning for the delivery and development of the Suffolk Science course.

Table 3.6. Responses to the questions 'What do you like/dislike about science?' (Research Task 8)

	LIKE		DISLIKE	
	%BOYS	%GIRLS	%BOYS	%GIRLS
Experiments	95	83	3	8
Calculations	22	6	38	42
Drawing diagrams	29	53	20	28
Written work	9	28	68	40
Science in everyday life	52	45	6	8
Listening to teacher	20	19	28	49
Talking to teacher	5	13	15	8
Group work	43	47	5	6
Practical assessments	32	19	18	38

The main data relating to the attitudes towards science of the students were provided by the survey of the entire Year 9 cohort in my school (Research Task 6) and were collected during May and June 1988. Again, the survey was completed by questionnaire (Appendix 8). This seemed the most suitable method of surveying an entire year group of widely differing abilities across a range of topics. The structure of the questionnaire was dictated by the attitudes I wished to investigate. These were:

1. the students' interest in science and their perceptions of the relevance of science in their everyday lives;
2. the students' perceptions of their own ability in science;
3. the students' attitudes towards a range of gender issues in science.

I hoped to be able to compare directly the boys' and girls' attitudes and opinions towards these issues. The questions themselves were introduced as a series of statements which had been made by students from Years 9 and 10 whilst discussing their science lessons. The cohort were asked to respond to each of these statements using a five point Lickert scale. The responses were coded to indicate positive or negative attitudes towards the specific issue with the questions being phrased so that agreement with the statement did not necessarily indicate a positive response.

The questionnaire was structured to contain 14 questions relating to each of the three issues. Some of the questions were derived from my own research but many of them were suggested by Year 10 students during discussions and conversations. In order to permit an exploration of the students' attitudes in each of the three science areas I decided to prepare three identical questionnaires in terms of the 42 questions which were to be asked. This was achieved, as explained in Chapter 2 by writing the questions on each questionnaire so that they referred to only one science subject. Question 32, for example, on the biology questionnaire was 'I usually understand a new idea quickly in BIOLOGY' and on the chemistry questionnaire 'I usually understand a new idea quickly in CHEMISTRY' and so on for each question and subject.

In order to further reinforce the subject specificity of the questionnaires, the students were, as outlined in Chapter 2, asked to complete each questionnaire in the appropriate lesson. The questionnaires are presented in their entirety in Appendix 8, but for direct reference the questions are listed in Table 3.7 (interest/relevance issues), Table 3.9 (perceived ability) and Table 3.11 (gender issues). Tables 3.8, 3.10 and 3.12 show the boys' and the girls' mean scores in each of the three survey areas. These are based on a score of 1-5 with a low score representing a positive response and a high score a negative response. I intended to supplement the results of this survey by conducting individual interviews with a number of the students at a later stage in the programme.

The questions which addressed the students' interest in and relevance of their sciences showed a definite polarisation in terms of both gender and the individual subject. This proved to be the only one of the three areas of investigation where the negative responses were greater than the positive responses. This is indicated in the barcharts in Figures 3.13, 3.14 and 3.15 which show the boys' responses in biology, and the girls' responses in both chemistry and physics to be negatively skewed. The research discussed in chapter one has clearly demonstrated that biology is perceived as being a 'feminine' science with chemistry and physics as 'masculine' sciences.

Statistical analysis using the Mann-Whitney U test revealed that many of the U-scores were close to the critical values (see Appendix 21) but only the interest/relevance responses for biology (in favour of the girls) and the perceived ability reponses for physics (in favour of the boys) were statistically significant (both at the 1% level). This suggests that the girls in general only see biological science as being interesting or relevant and that the boys perceive themselves as being particularly able in physics.

The data yielded by this aspect of the survey suggest that this subject polarisation functions either as a self-fulfilling prophecy or that both the way in which we teach science and the contexts we use to illustrate it precipitate this gender difference. This is an area which requires further investigation and will be reconsidered at a later stage in the thesis when evidence from another survey will be included.

Table 3.7 Questions from Research Task 6: INTEREST/RELEVANCE

1. Once I've left school I won't think about most of my B/C/P anymore.
3. Most of my friends think B/C/P is boring.
6. I don't find much use for B/C/P out of school.
7. I find B/C/P lessons interesting, whatever we are doing.
11. I enjoy the fact that there's always something new for me to learn in B/C/P.
12. I would like to spend more time learning about the B/C/P of things in and around our homes.
14. Learning about B/C/P is helpful in understanding how things around us work.
17. I enjoy doing the graphs and charts in B/C/P.
20. I can use B/C/P to solve some everyday problems.
25. I find drawing the diagrams in B/C/P really boring.
31. I can get so interested in a B/C/P experiment that I don't know what's going on around me.
33. I like having to think things out in B/C/P.
36. I only want to learn useful things in B/C/P.
39. I think that we should use B/C/P to learn how to help other people.

Table 3.8 Statistical data from Table 3.7 showing boys' and girls' mean scores in each of the separate sciences.

Q	BIOLOGY		CHEMISTRY		PHYSICS	
	B	G	B	G	B	G
1	2.43	2.98	2.92	2.84	3.12	2.95
3	1.85	2.84	2.82	2.70	2.97	2.04
6	2.34	3.07	2.71	2.37	3.09	3.30
7	2.09	3.10	3.27	2.88	3.33	2.32
11	2.88	3.77	3.70	3.60	3.90	3.35
12	3.33	2.89	3.06	2.85	2.50	2.61
14	3.28	3.76	3.88	3.80	4.23	4.01
17	2.70	2.98	3.22	3.01	3.28	3.06
20	2.51	3.05	2.82	2.62	3.20	2.99
25	2.80	3.31	3.27	3.00	3.36	2.94
31	2.19	2.61	2.88	2.57	2.65	2.35
33	2.64	3.07	3.39	2.74	3.37	2.79
36	2.23	2.38	2.14	2.42	2.35	2.23
39	2.87	2.52	2.83	2.65	2.72	2.48

Table 3.9 Questions from Research Task 6: PERCEIVED ABILITY

2. When I do well in a B/C/P test I consider myself lucky.
5. We go on to new work in B/C/P far too quickly for me to follow it.
9. I can't remember half the things we are taught in B/C/P.
10. I find it difficult to understand B/C/P even when the teacher explains it to me.
16. I am quite good at B/C/P.
18. The experiments in B/C/P are usually fairly easy.
22. I have more trouble understanding B/C/P than any other subject.
23. A lot of the topics we do in B/C/P make no sense to me.
27. I find it difficult to make conclusions from the results of my B/C/P experiments.
29. I'm scared of it going wrong when we do B/C/P experiments.
32. I usually understand a new idea quickly in B/C/P.
37. I would rather work on my own in B/C/P experiments.
40. I enjoy working on the mathematical problems in B/C/P.
42. Each term, B/C/P gets harder for me to understand.

Table 3.10 Statistical data from Table 3.9 showing boys' and girls' mean scores in each of the separate sciences.

Q	BIOLOGY		CHEMISTRY		PHYSICS	
	B	G	B	G	B	G
2	2.71	2.88	3.24	2.66	3.37	2.73
5	3.50	3.64	3.77	3.24	3.55	3.36
9	2.81	3.41	3.11	3.06	3.43	2.89
10	3.51	3.88	3.66	3.57	3.65	3.23
16	2.39	3.13	3.27	2.85	3.54	2.63
18	3.32	3.44	3.60	3.75	3.41	3.62
22	3.67	4.09	4.03	3.81	3.97	3.31
23	3.17	3.82	3.62	3.38	3.63	3.25
27	3.16	3.28	3.27	3.03	3.45	3.08
29	3.93	3.56	3.98	3.40	3.74	3.54
32	3.00	3.40	3.42	3.02	3.77	2.83
37	2.46	2.25	2.58	2.28	2.66	2.21
40	2.18	2.01	2.21	1.84	2.55	2.07
42	3.39	3.71	3.83	3.38	3.65	3.20

Table 3.11 Questions from Research Task 6: GENDER ISSUES

4. It's not really important for girls to do well in B/C/P exams at school.

8. B/C/P teachers seem to pay more attention to the girls in the class.

13. Boys are always trying to get the teacher's attention in B/C/P lessons.

15. When we do experiments in B/C/P the boys always seem to get the apparatus first.

19. Girls don't often ask questions in B/C/P lessons.

21. Doing experiments in B/C/P is more for boys than for girls.

24. Boys do B/C/P experiments better than girls.

26. When you're thinking of a career B/C/P is more important for boys than for girls.

28. I would rather have B/C/P lessons just with pupils of my own sex.

30. I think that girls concentrate better in B/C/P than boys.

34. I think B/C/P is more relevant for girls than for boys.

35. When the B/C/P teacher asks a question it's always the girls who try to answer first.

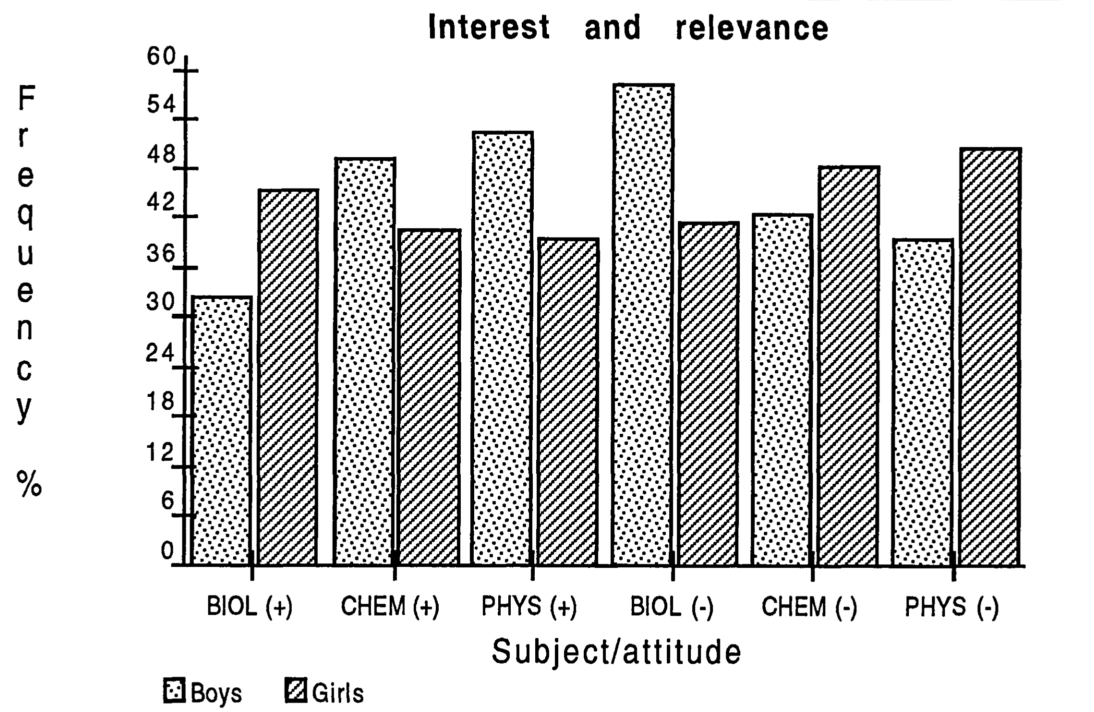
38. I think B/C/P is the most important of the sciences if you are a boy.

41. The teachers seem to think that the boys are more important in B/C/P.

Table 3.12 Statistical data from Table 3.11 showing boys' and girls' mean scores in each of the separate sciences.

Q	BIOLOGY		CHEMISTRY		PHYSICS	
	B	G	B	G	B	G
4	3.93	3.52	4.14	4.27	4.04	4.07
8	2.90	1.82	2.76	2.03	2.35	1.81
13	3.61	2.64	3.65	2.69	3.90	2.90
15	3.52	3.16	3.51	2.87	3.75	3.00
19	3.14	3.58	3.15	3.26	3.04	3.01
21	4.14	4.18	3.97	3.97	3.93	3.70
24	3.49	4.17	3.29	4.15	3.48	3.98
26	4.04	4.37	3.76	3.99	3.47	3.42
28	3.74	3.67	3.70	3.67	3.80	3.84
30	3.20	3.25	2.35	2.96	2.12	2.80
34	2.62	2.12	1.79	1.95	1.90	1.90
35	3.14	2.20	2.77	2.31	2.61	2.07
38	4.18	4.17	3.80	3.98	3.04	3.37
41	3.67	3.98	4.00	3.93	3.83	3.62

Figure 3.13 Year 9 cohort (1989-90), attitudes survey (Research Task 6).

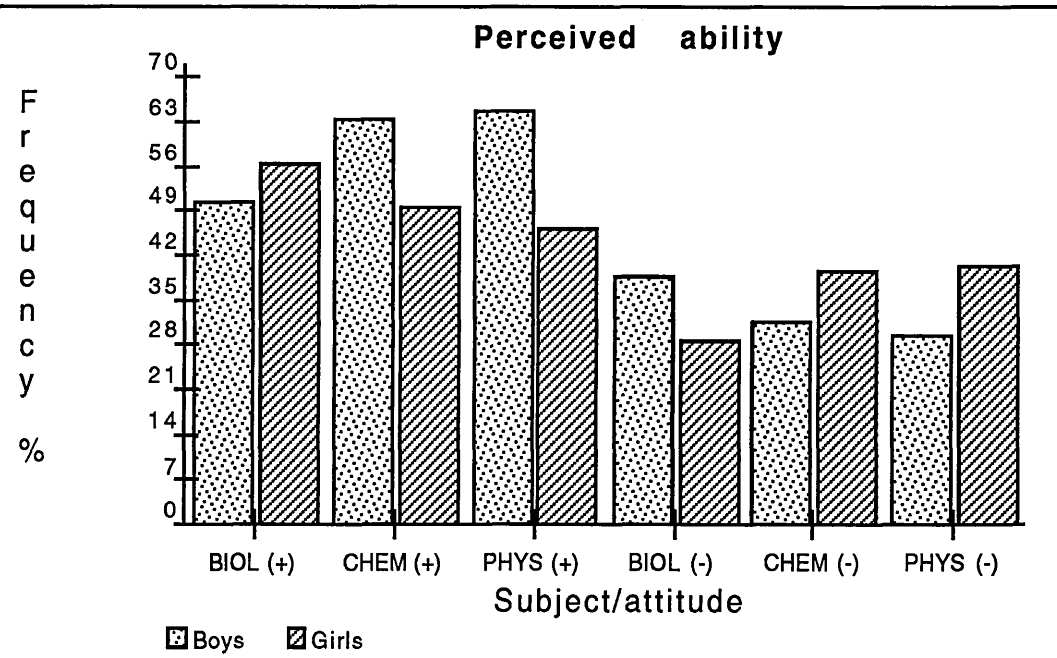


Close inspection of the students' responses to individual questions across the three sciences raised some interesting issues. It could be seen in biology, for example, that the girls' responses were less negative than the boys' on only 2 questions (nos 12 and 39). These two questions related to the application of biological science in a domestic or caring way and the responses reflect what are considered to be traditional female traits. The chemistry survey showed the boys to be more negative than the girls in relation to questions 6, 7 and 33 but none of the other questions showed responses which were very different in this particular subject area. The negative responses suggested that we were using teaching contexts which were unfamiliar to our students and, therefore, largely irrelevant to them. This would naturally tend to reduce the students' interest in the lessons. In terms of interest in physics the data showed again that the boys were more negative in their responses than the girls. On almost all the questions, however, the responses of both boys and girls tended to be negative. This negative response to the interest in and relevance of science was predominant across all three of the sciences. It suggested that, for our

Year 9 science students, we had got our approach wrong and were actively contributing to the turning-off process, an area in which further investigation was vital.

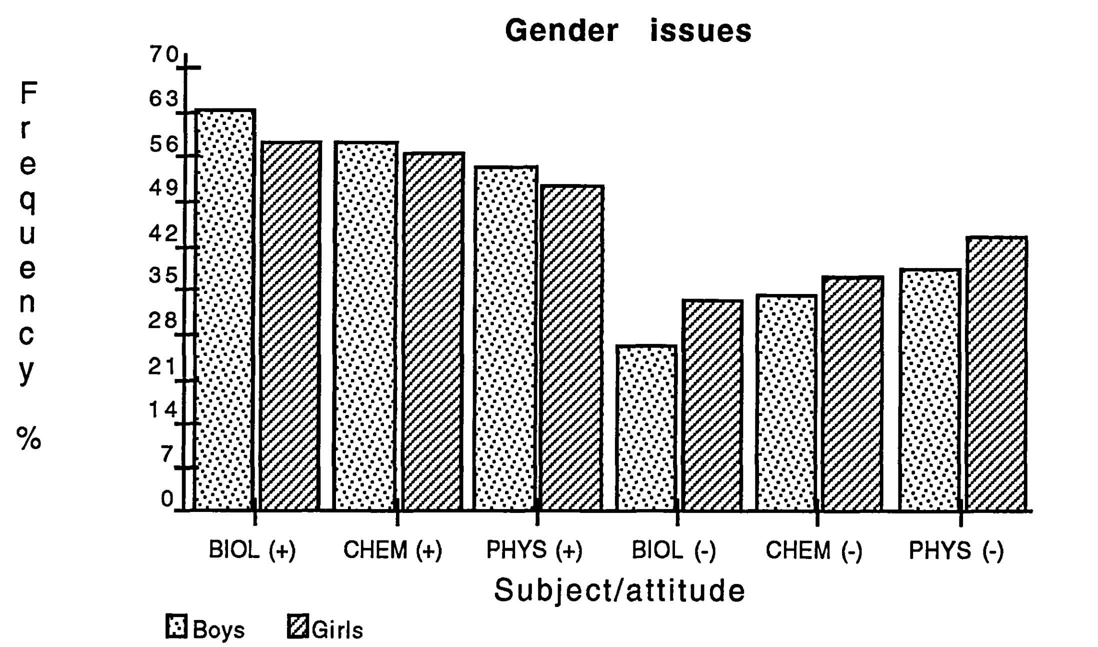
When the students' perceptions of their own abilities in science were compared (Figure 3.14) the responses were very much as would have been predicted on the basis of the evidence in Chapter 1. The girls showed a steady decrease in positive responses moving from biology through chemistry to physics and an increase in negative responses in the same direction. The boys showed the same trends but in the reverse direction.

Figure 3.14 Year 9 cohort (1989-90), attitudes survey (Research Task 6).



If the data from these questionnaires are restricted to being used to identify areas for more in-depth study at a later date then the questionnaires were extremely useful, homing in on certain factors which appeared to adversely affect attitudes towards science. There was a temptation to use the data in a more analytical way to attempt to produce hypotheses relating the science and science teaching to the development of attitudes towards these two factors.

Figure 3.15 Year 9 cohort (1989-90), attitudes survey (Research Task 6).



This was, however, an unrealistic expectation because the questionnaires were issued to students who had completed their option choices fairly recently. They would be likely to have been comparing the subjects they liked and disliked, the teachers they liked and disliked and the relative importance in prospective career terms of each of their subjects. In addition their opinions would have been coloured, consciously and unconsciously, by parents, peers, friends, relatives and teachers. These influences would have reinforced some choices and perhaps caused others to be rejected.

Consequently, at the time when I asked this cohort to respond to these questionnaires it is likely that they had been giving a great deal of thought to themselves as individuals and making choices which would in many cases affect their future lives. In addition they were at the age when a great many schoolchildren are struggling to develop a sense of identity, when their entire personality is changing rapidly and being affected by unfamiliar stimuli.

The pressures created by the students attempting to incorporate the various socialisation and sex-role expectations of their peers, their families and society must also have a profound effect on this decision-making process. The stereotypical pictures of masculinity and femininity will be strong in the students' minds at this age and if an individual is to be seen to reject these 'norms' then they must either have a very good reason in the eyes of their peers or they must have a powerful sense of self which will give them the internal strength to be different.

A desire to continue to study science, particularly the physical sciences, can result in a conflict with this gender-role definition. This conflict is likely to discourage girls from selecting science. Saraga and Griffiths (in Kelly, 1981) attempted to explain the operation of this influence by suggesting that girls will:

> ...internalise beliefs, attitudes and expectations about science, themselves and their future roles which will generate not only negative attitudes towards activities such as science - which are seen as male-appropriate - but which also press against the choice of cross-sex activities and result in female under-achievement in them. (p89)

The selection of the physical sciences thus becomes another of those activities which have, since early childhood, been observed by the girls as being inappropriate for their sex.

When these students, boys and girls, are presented with a questionnaire such as this one, which probes their attitudes towards gender issues in science in such an open fashion they will tend to rely to a certain degree on their finely developed sense of sex-appropriate behaviour and attitudes which has been gradually inculcated in them by their parents and their peers. The other questions, which probed perceptions of interest, relevance and ability in science will also be coloured, but perhaps less obviously, in the same way. The net result of this will be that the responses to these questions, just like the choices of subject options, are made from different standpoints and for different reasons by boys and girls.

CHAPTER FOUR

The nature of Coordinated Science (The Suffolk Development)

This chapter introduces the second phase of the research programme. The research had, by this time, led the author away from the initial focus of gender differences in the sciences. The emphasis was moving towards a wider view of student performance within a balanced science framework, but with particular interest in girls' achievement. The Suffolk scheme is considered as one of the ways to deliver a balanced science curriculum. The structure of the scheme in terms of both teaching and assessment is detailed and its origins explored. The Research Tasks which relate to the Suffolk Science course are discussed.

The Coordinated Science course known as the Suffolk Development (or more usually, Suffolk Science) moved quite quickly from its conception (1983) through its pilot phase (1985) to its adoption by over 10% of secondary schools in this country (1990). It appears that the many teachers involved in the writing and development of the course were intent on producing a course which would prove to be suitable for both students and teachers.

Dobson (1987) points out that the coordinated structure enabled teachers to teach, wherever possible, to their individual strengths in each of the three central science subjects, but that an important factor in the selection of the topics was its 'teachability'.

The model of curriculum development adopted by the team was defined by Dobson (1987, p3) as the organic model and described as follows:

> (a) a new product is highly unlikely to emerge as perfectly adapted to the environment that stimulates its production - and therefore needs to have a built in capacity for rapid change:
> (b) in the unlikely event of the novel organism being highly successful, the immediate environment may well be changed so greatly as to render the organism obsolete - with much the same implications for evolutionary capacity.

Dobson indicated that a set of rules were in operation to govern the inclusion of a topic or concept in the teaching programme. In order to be included a topic should be able to match some of the criteria given below. The topic should be:

> UNDERSTANDABLE from the 'bottom' up;
> RICH IN OPPORTUNITIES for deploying and developing enabling skills and learning processes;
> RELEVANT - as perceived by pupils, as well as parents and employers;
> ACCESSIBLE or 'user friendly';
> USEFUL AND USABLE for further study, problem-solving and enjoyment. (p4)

Dobson also discussed the differences between learning science and doing science, stressing the importance of the methods and processes involved in the learning and their applicability in other contexts. He stated (p5) that:

(a) the way of getting there is as important as where you get to;
(b) learning to learn is as important as what you learn.

The course content was structured on a modular basis and concentrated on the practical skills and process skills of science and on the knowledge and understanding of a body of scientific knowledge which was, from the outset, intended to be much smaller than that required for the individual GCE/GCSE syllabuses.

The course was to be assessed by an inbuilt scheme which was both formative and summative. The formative aspect of the course was intended to enhance students' involvement in their own learning and development processes. The assessment methods, performance criteria and attainment levels are open to the students throughout the course, allowing individuals to investigate their progress at any time. This system was selected to enable students to be aware of any problem areas so that remedial action may be instigated immediately. In addition, the students' successes would be immediately rewarded allowing self-motivation to play an important part in the developmental processes. The course is summative in that the final award would be based on the students' performance in the various assessment areas throughout the course.

The assessments are made in the following three areas. Practical skills are assessed by a series of simple practical tests known as 'can-do' tasks. These are arranged so that there are usually two of these can-do tasks to be passed per unit. There are opportunities for some of these tasks to be assessed in more than one of the units allowing for student development, absences and so on.

The knowledge and understanding aspects of the science are assessed by end-of-unit tests. The criteria for each test are specified for each unit in the text books in order that the student may choose to take the test at one of three levels of attainment (foundation, merit or special). The questions are designed to test recall, recognition and understanding. In order to pass at any one level a student is expected to gain 80% of the available marks. There are various safety nets in operation at the borderline areas so that a student may pass a test at the level lower than the one examined by obtaining a creditable result. The selection of the appropriate level of test for an individual student is achieved by negotiation between the teacher and the student. Teachers within the local cluster group have observed that gender differences are apparent in level selection and this will be discussed during the evaluation of the course.

Process skills are assessed by criterion matching at the appropriate level (foundation, merit or special) with two skills being assessed per unit. The eight process skill areas are observing, planning and designing, verbal communication, non-verbal communication, exploring and investigating practically, exploring and investigating by data search, collaborating effectively and demonstrating an awareness of applications of science within the community.

In order to achieve the double award a student must achieve certain minimum requirements in terms of the number of assessments passed by gaining points for passing tests and meeting assessment criteria. The points awarded for the end-of-unit tests and process skills are weighted according to the level attained by the student and these weightings also increase in successive years of the course.

It is essential that students are fully aware of both how the course and the assessments within it function <u>and</u> of their performance at each stage of the course. The way in which this is achieved is one of the main reasons why we selected the Suffolk course. The students are informed of the mark achieved in the end-of-unit test as soon as the tests are marked (usually the following lesson), the process skills assessments are also quite open as are the results of the can-do tasks, feedback for these two also being virtually immediate. A student can ask to see his/her results for a particular unit or the summative totals at any time during the course.

The administration of the course may be carried out in two ways. The first is the traditional mark book method involving considerable teacher input, particularly when marks have to be transferred to record sheets for the moderator or examining board. The second method is by computer, software is available (the school using the version developed by C. E. Johnson) to enable the teacher to input the results of all the assessments for each student for each unit. These results may be readily viewed at any time by the students.

This software will also determine students' overall percentage scores and rankings for either teaching groups or the entire year group from the assessment data. It will print out reports for students for individual units or progress reports based on all their available data. Students are free to investigate their previous marks and print out their own reports at any time if they so desire. The teachers have an accurate record of attainment which enables them to discuss students' progress more freely and more regularly with the students and with each other. This in turn means that any problems or any noteworthy performances can be observed quite easily and any necessary action can be taken. The software will also estimate final GCSE grades at any time during the course on the basis of the number of units completed. This is a powerful motivational tool and has been used as a basis for individual target-setting.

It was suggested by the Suffolk Science team that a positive system of assessment and an open system of recording would help to increase motivation and reduce the 'turning-off' effects which are usually found amongst the girls and the less-able students when following the more traditional type of science courses. It was also anticipated that the nature of the course and the way in which it was designed would increase the students' enjoyment of and attainment within science.

The validity of these arguments has been tested and the results of these enquiries will be discussed in Chapter 5. It is apparent, however, that there is one area where the programme is likely to fall down and that is the actual teaching. Dobson was well aware of this and throughout the Teacher's Book (1987) he stressed the need to remain aware of the aims of the course. He emphasised that the teacher would need to develop new skills in teaching, monitoring and assessing, moving away from the traditional role as a transmitter of knowledge and aiming instead to stimulate, encourage and enable learning. There would also be times when traditional teaching instincts would suggest intervention, but the nature of the active learning would demand a more discreet presence.

In order to meet the suggested criteria for successful teaching within the Suffolk scheme Dobson emphasised the need to reconsider the traditional role of the science teacher. He did not reject the traditional role but suggested that teachers should also consider ways in which they could both become more student-centred and develop those skills concerned with the management of the students' learning processes. He stressed that:

> .....for many, perhaps for all pupils, the pleasures and problems of the journey may be more significant than the destination. (p10)

Osborne and Freyberg (1985) suggested a model for teacher development based on three specific objectives:

1. clarification of the students' knowledge or understanding of a topic;
2. modification of these views where appropriate or necessary;
3. consolidation of these modifications within the students' experience.

They outlined a programme designed to achieve these objectives which was centred around a series of preconditions which they considered to be essential for successful learning. These preconditions placed considerable emphasis on the role of the teacher and the development of new skills. The preconditions suggested that the teacher needed to:

1. understand the views of themselves, their students and the 'scientists' in relation to a particular teaching topic;
2. allow the students opportunity to investigate their own ideas during the early stages of a particular topic and to discuss them with each other;
3. provide opportunities for the students to explore the context of the concept and provide, where possible, an everyday situation for this to take place;
4. create an environment which would allow consolidation of the

new concepts within a range of situations.

Dobson suggested a scheme for teaching science concepts, based around the programme as outlined by Osborne and Freyberg, which could be used in a variety of situations ranging from a conversation with a student through writing a lesson plan to the development of an entire module of work. The basic sequence he proposed was:

1. find out what ideas children have;
2. begin where the children are;
3. make it intelligible;
4. make it plausible;
5. allow it to be fruitful;
6. check what has been learned.

The final stage in the sequence must be considered in the light of Dobson's usage of the word 'learned'. He intended that the students should understand a topic and be able to apply it in both familiar and unfamiliar situations rather than simply be able to reproduce scientific theory. In the same way his usage of the words teacher and teaching suggested a wide range of skills, not all of which are included within the traditional role of the teacher. He proposed ways in which teachers could utilise and adapt their existing skills and develop new ones within the framework of the Suffolk course to enable them to work to the programme sequence.

In Phase One of the research programme the teachers in the science department were asked to cooperate with data collection and so on. During Phase Two, however, they were to be participating in a more contributory fashion. Dobson's ideas discussed earlier required that the members of the department consider and evaluate their own practice. This process also involved support for the new syllabus and a willingness to try out new teaching methods and contexts and develop new assessment strategies. Consequently, in order to enable me to assess the validity of my own observations and conclusions, it was necessary to survey the other members of the department regularly, although the format was fairly unstructured. In general this was achieved by means of discussions in department meetings. From time to time, however, short questionnaire-type memos were circulated by me in order to obtain rapid feedback. Naturally, more informal discussions were also held between individuals whenever information needed to be shared or opinions required.

The collaborative nature of different aspects of the research is indicated in the text and throughout this thesis the source of opinion and data is reflected in the use of 'I' and 'we'. The use of 'we' indicates that the theories, observations and so on arise from joint departmental debate and belong to the department as a whole. Where the opinion or decision was purely my own, then 'I' has been used to reflect that it is personal.

In 1986 the SSCR were invited to evaluate the Suffolk Scheme. Initial discussions between the two bodies during 1987 identified a set of criteria upon which the evaluation would be based. These criteria were jointly selected from the 16 major recommendations for science education which had been identified by the SSCR during its developmental phase. The joint criteria specified that science should:

1. be relevant to all young people and attractive to girls and boys;
2. encourage active and self-directed pupil involvement;
3. be assessed formatively (including self-assessment) to monitor achievement, with mechanisms to match the learning objectives;
4. use teaching approaches matched to learning objectives;
5. provide a programme that is society-linked, incorporating social implications and related to the world of work and leisure;
6. be reduced in content so that pupils can become competent in scientific skills and processes.

It was also decided that the evaluation should investigate:

7. the time given to INSET, both in and away from school, to enable teachers to understand the requirements of the new scheme and to identify the most important elements of that provision;
8. the provision of resources in terms of teaching materials and other support,
9. the general climate of support within the school.

The small-scale evaluation was carried out in 1987 using direct observation of Suffolk lessons and by discussion with all personnel in the schools who were involved with Suffolk i.e. teaching staff, administrative staff, technical support staff and the students themselves. The report considered each of the above points in turn and offered a series of comments and recommendations in each area.

In the introduction to the report the Director of the SSCR made the following reflections on the evaluation exercise and on Suffolk Science (Kirkham, 1987 pii):

> By the very nature of the exercise the comments in this report are based on limited evidence but we were very impressed by what we saw, and Suffolk and its teachers are to be congratulated on what has been done. We are encouraged by the built-in developmental aspects which should enable many of the points we make to be taken on board where judged appropriate and necessary.

The SSCR evaluation document also considered the role of the teacher highlighting the change in the nature of science teaching which was required by the Suffolk scheme commenting:

> Suffolk Science teachers are to be congratulated for encouraging the active involvement of pupils in science lessons. Most of the pupils spoken to valued the chances offered to plan and execute their own experiments. This is good and should be fostered. (para 5).

The SSCR also highlighted a problem within this teaching approach:

> There is evidence that some teachers are finding it difficult to come to terms with the new role as guide and adviser in the classroom. We think that more dissemination of good practice of this issue would help: by meeting to discuss it, by enabling teachers to observe good practice in the classroom, and by bringing together teacher support material that already exists. (para R4)

Development of individual teaching strategies through staff cooperation was one of the aims of this research programme (Chapter 2). Another way for teachers to become aware of alternative teaching methods is to read the relevant research literature, however, Tobin (1988) indicated:

> .....there is evidence to suggest that science teachers tend not to read science education research literature. (p475)

He suggested that:

> .....the majority of teachers apply their craft in the isolation of their own classroom and teaching strategies are based largely upon the well-established schema of what constitutes effective teaching and experience with what works and what does not. (p475)

According to Tobin, teachers may be reluctant to change their practice if they perceive their existing practice as being effective. They must, in other words, perceive the need for change. Aspects of this research programme have indicated that the students' perceptions of the effectiveness of science teaching are frequently at odds with the teachers' perceptions and this has suggested areas where changes may be useful. When we consider the extent to which the Suffolk Scheme has been adopted in schools it must be concluded that the scheme itself must have been seen, by the teachers who introduced it and by those who adopted it, as a change worth pursuing.

It is worth noting at this point that the Suffolk Scheme is unique amongst all the balanced science courses in providing a comprehensive range of lesson notes for each of the years of GCSE study. The SSCR survey identified this aspect of Suffolk:

> Teachers in general found the lesson plans helpful without being prescriptive. In most cases additional resource worksheets and booklets had been prepared... (para 13)

The author's department had investigated a variety of other balanced science syllabuses with a range of approaches (modular, integrated, coordinated etc) and found these both lacking in terms of guidance and overpowering in terms of both content and depth. Having decided on the Suffolk Scheme, however, none of the teachers was happy to follow slavishly the published lesson plans. Many have developed worksheets, approaches to specific concepts and even rewritten entire units to their own design. The assessment format of Suffolk allows the teacher this freedom and in turn allows the students to experience a better style of science teaching.

The Suffolk material appeared to act as a catalyst to allow the teachers in the department to be more creative in providing teaching materials which were better suited to the needs of our students in terms of level, context and relevance. In addition, materials and approaches could be developed in order to respond specifically to the comments and opinions expressed by the students during the earlier Research Tasks. The success of this approach was reflected in both the performance and apparent motivation of the students in the early stages of running the course. It was also interesting to note quite early on that the girls were beginning to outperform the boys, this will be further discussed with supporting evidence in Chapter 5.

In 1987 the Association for Science Education (ASE) published 'Three Into Two Science', a review and evaluation of the balanced science courses which were available at the time. The evaluation focussed upon the following aspects of the 12 syllabuses reviewed:

1. the view of science taken by the syllabus;
2. the contexts in which the syllabuses were developed;
3. the utilisation of coordination or integration techniques;
4. differentiation;
5. the 'breadth and balance' of the syllabuses;
6. the extent of the syllabus content;
7. the reflection and/or reinforcement of the view(s) of science by the assessment methods.

Some of these areas were further subdivided to highlight specific aspects of science provision.

Many of the syllabuses reviewed were not explicit in their view of science but with reference to the Suffolk Scheme, the document commented:

> This range of materials clearly does represent the view of science taken by the syllabus - in a very real sense it <u>is</u> the view of science taken. (p32)

Most of the syllabuses for which assessment materials were available, Suffolk included, were criticised for placing undue emphasis on the recall of factual knowledge. The evaluation team indicated that many questions ostensibly relating to understanding or process in science did fall into this area and thus the relative weightings for assessment as specified in those syllabuses were inaccurate.

There were some areas in which the Suffolk Scheme was criticised for an apparent mismatch between aims and actual presentation but it must be remembered that Suffolk actually provides teaching materials in addition to specifying content, process and assessment mechanisms and that these materials were also being studied by the evaluation team. With the other syllabuses only the aims, content and assessment material could be viewed as the classroom component would be developed in the school itself.

The course is, therefore, much more open to criticism than other balanced science syllabuses because, by presenting curriculum materials, it permits (although, because of the supportive rather than prescriptive nature of the scheme, 'invites' may be a better term) individual teachers to make judgements on the materials. With a syllabus specifying content only, the curriculum contexts and delivery are dependent entirely on the teacher. By offering teaching schemes the Suffolk Course makes one vehicle for delivery available but this does not have to be the one selected. This viewpoint was reinforced by the SSCR who recommended that:

> Consideration should be given to providing teachers with more help in varying their teaching styles. A greater variety of teaching styles was observed with year 3 units than year 4. This might arise because of greater confidence in using the material or as a result of revision which encouraged a greater revision of teaching styles. (para R10)

The ASE remarked that:

> The course is well supported by curriculum materials. These provide lesson plans and technician's notes. These materials develop a process-centred approach and will be of great value to teachers embarking on this novel syllabus. It is emphasised, however, that the course is organic: capable of change and evolution. The teacher's guides are not intended to impose a particular pattern on classroom practice. Good teachers, like good cooks, the book tells us, will add their own special ingredients here and there. (para 3.113, p30)

This has proved to be the case in my own school. In the first year of teaching the course our teaching materials tended to be developed to complement the lesson notes and approaches as outlined by Suffolk. As we became more confident within the framework of the course, however, we began to develop more individual approaches to certain key lessons within the units. This development has now reached the stage where, for some of the units, little or none of the published lesson notes are being used. The checklists in the Assessment Specification which indicate the areas of experience necessary for students to gain success at the three differentiated levels form the basis for planning the teaching of a specific unit. One specific example of this developmental approach to teaching is discussed in Appendix 10. This illustrates the diversity of approaches which are possible in order to achieve common aims. It also indicates how the Suffolk teaching material can function as a catalyst rather than a recipe for teaching.

The SSCR had recognised this facility within the Suffolk Science scheme and recommended:

> The contexts in which the units are set need to be developed so that they can be handled in different ways; so they are more attractive to the least able, or make more demands on the most able. Teachers need to be encouraged to develop more pathways through the material. (para R25)

The comments in relation to the differentiation of teaching materials reflected concerns amongst teachers in my own department which had also been expressed at cluster meetings, particularly in relation to the demands of the course on the least able students.

Although we were quite prepared for teaching the Suffolk scheme to the full range of abilities the assessment of the scheme, particularly the end-of-unit tests, began to create problems for those students of lower ability. Throughout the units they had been experiencing success with both the can -do tasks and the process skills but the tests were obviously causing them problems. This became a major demotivator, even though these students were experiencing success <u>during</u> the unit they were experiencing both discomfort and failure with the final stage of the unit, the tests.

Discussions at the cluster meetings revealed that this problem was not confined to my own school. Some schools had reverted to using Mode 3 schemes for the less able students but this was contrary to the ethos of the Suffolk Scheme. In addition, this was not in accordance with paragraph 80 in 'Science 5-16: A statement of policy' (DES, 1985) which stated that the science provided for less-able students should not be different from that provided for other students.

Our less able students appeared to be quite happy with the demands of the course (Research Tasks 13 and 14), although the teachers had to tailor their approach to teaching and assessment carefully in order to maintain interest and motivation. However, because of literacy problems these students were experiencing difficulties with the end-of-unit tests resulting in frequent failure. This failure suggested that although the assessments (the can-do tasks and the process skills) were allowing these students to experience success they would be unlikely to be achieving pass grades at the end of the GCSE course.

The scheme of Units of Accreditation administered by the Northern Partnership for Records of Achievement seemed, at that time, to offer a useful alternative. A unit involves, basically, meeting certain criteria which have been specified by the author of the unit. The evidence for meeting these criteria (which may take many forms; graphs, written accounts, models, teacher checklists and the like) is then moderated. The student receives a certificate for that unit which sets out exactly what work they have completed and the certificate can be included in the students' Record of Achievement.

This seemed to have even more merit when it was explained that a unit could be written to include 'alternative outcomes'. This entailed writing the outcomes to be accredited in such a way that the student could gain accreditation by meeting a number, but not necessarily all, of the specified outcomes. Consequently a student could work to the best of his/her ability and receive credit for the work he/she had completed. Any students who were absent and missed an assessment would also not necessarily be penalised, unless, of course they were persistent absentees. Examples of

Unit of Accreditation proformas are included in Appendix 16.

My intention was to write Units of Accreditation to mirror the teaching and assessments in the Suffolk units (Research Task 16). In this way all students could follow the Suffolk course, albeit in differentiated form. Their practical work and assessment materials could then satisfy the dual function of fulfilling the outcomes for the Units of Accreditation and the requirements of the GCSE course. There was a danger that this scheme would be perceived as being specifically for the less-able students. The intention was that all students participate in Units of Accreditation regardless of ability in order that it was not devalued in this way.

The Unit of Accreditation scheme is only applicable students from Years 10 and 11, this meant that the Introductory Year (for Year 9 students) could not be included. This still left a total of 21 Suffolk units which could be unitised, which seemed a formidable task. I proceeded to write a Unit of Accreditation for one of the Year 10 units and then took this to the department for their consideration. After long discussions I convinced the staff that we could run the two systems in parallel without creating an impossible workload for ourselves in relation to the assessment. The LEA was supportive of the idea and funded a one day INSET to release two teachers from each of the Suffolk schools within the authority. After an initial discussion session these teachers agreed to spend the rest of the day participating in groups made up from different schools, in writing units. The result was that we unitised 7 of the 12 units from the Year 10 course. The LEA funded another INSET session later in the year to permit the writing of units for the Year 11 course which resulted in five more units being produced.

In July 1991 I presented an outline of the proposed scheme to the delegates at the annual Suffolk Science Conference organised by North West Education Services. The response was positive, many delegates expressing a desire to participate in the scheme. The Area Moderator for my own cluster group has taken details of the proposals to Regional Moderators meetings, the response again being favourable.

However, due to the 1992 revision of the National Curriculum, the Suffolk Science course had to change in order to accommodate the modifications to Attainment Targets, Statements of Attainment and so on. As discussed in more detail in Chapter 8 these and subsequent changes to GCSE assessment resulted in the replacement of Suffolk science in the author's school with an alternative syllabus. This in turn made it impractical to continue to operate a system of Unit Accreditation.

CHAPTER FIVE

Investigating Suffolk Science in the school context

In this chapter the second phase of the project is discussed through action research. The gender issues were analysed as were other issues relating to the students' attainment, motivation and interest. The data for the analysis were provided by the Research Tasks which centred on the Suffolk Science course. Additional evidence is provided in the form of the author's personal experiences from teaching Suffolk Science over a two-year period. Further data are provided from performance analysis, which illustrate the progress made by all students, but particularly the girls. The author proposes that these improvements arose largely as a result of the particularly effective assessment methods provided by the Suffolk Science course.

In Chapter 3 the preliminary investigations (Research Tasks 1-9) and their findings were discussed in depth. The second stage investigations (Research Tasks 10-16) were concerned with Suffolk Science, considering both student responses to the course and developmental work carried out within the department.

During April 1989 the Year 9 students were surveyed by questionnaire (Research Task 10, included as Appendix 10) in an attempt to ascertain which teaching strategies already used by the department were preferred by the students. The units offered during the Suffolk course were also listed under three headings (biology, chemistry and physics) with 9 topics in each group. The students were asked to indicate which topics they thought they would find the most interesting by ranking the 9 topics in each group (Table 5.1). It was hoped that the results from this exercise would prove to be useful in planning the units for future teaching.

The responses to question 1, which raised the issue of notemaking, were inconclusive but did reflect our students' lack of enthusiasm for writing in general. However, when asked to present written work in some alternative form for display (posters, leaflets and so on) the quality and quantity of their written work is generally high. The Suffolk scheme allows students the opportunity to produce the work required for the written assessments in a variety of ways (for example, creative writing, posters or poems) according to the interests and abilities of the students. It was decided that, wherever possible, the students would be asked to produce written work in a format which would allow them the opportunity to be creative rather than simply descriptive.

The students also expressed a clear preference in response to question 2 relating to the ways in which the class teachers described how the students were to carry out their experimental procedures. This preference was for a single demonstration of the technique by the teacher prior to the students carrying out their own experiment. The option of having a student from the teaching group carry out the experiment as a demonstration in front of the group was not favoured by the students, presumably because of fears of embarrassment. The least favoured alternative was the option of the teacher writing or drawing the instructions on the board.

Table 5.1 Year 9 students' rankings for the Suffolk units (1989).

UNIT TITLES	----RANKINGS---- BOYS	GIRLS
BIOLOGY		
Food and digestion	7	4
Cells and life	6	6
Microbes	7	8
Patterns of reproduction	1	1
Use of energy	4	7
Plants	9	9
Life around us	5	5
Animal behaviour	2	2
Controlling our body	3	2
CHEMISTRY		
Raw materials	7	6
Gases	1	4
Elements	3	8
Chemicals we eat	7	1
Controlling reactions	5	3
Metals	2	7
Structure and properties	9	9
Chemistry in the home	3	2
Energy and chemistry	6	5
PHYSICS		
Energy investigations	6	7
Sports science	2	1
Microelectronics	4	4
Machines and work	3	2
Using electricity	1	3
Using light	5	5
Structures and forces	7	9
Forces and movement	7	6
Choosing materials	6	5

Table 5.2 Responses to questions 1,2 and 6, Research Task 10. Scores are means from student rankings.						
ITEM	QUESTION 1		QUESTION 2		QUESTION 3	
	BOYS	GIRLS	BOYS	GIRLS	BOYS	GIRLS
A	5.2	4.6	3.7	3.9	3.8	3.7
B	4.0	3.1	4.6	4.7	2.2	2.5
C	5.6	5.8	2.1	1.7	3.0	2.5
D	5.5	5.1	3.6	4.0	3.8	3.6
E	3.1	4.2	5.4	5.3	2.2	2.7
F	3.8	3.3	4.3	3.8		
G	3.7	5.0	5.2	4.8		
H	5.1	5.0				

The students expressed a preference for working together in pairs to carry out experiments, possibly because this is less threatening than working alone and gives less opportunity for failure but does permit more 'hands-on' time than working in larger groups. The students' response to question 5, where 89% of the boys and 84% of the girls indicated that they would not object to working with students of the opposite sex is not reflected in their responses in the laboratory when actually asked to do so.

Table 5.3 Responses to questions 4, 5 and 7, Research Task 10. Scores are percentages.						
ITEM	QUESTION 4		QUESTION 5		QUESTION 7	
	Boys	Girls	Boys	Girls	Boys	Girls
A	6	4	9	8	9	15
B	74	67	89	84	91	85
C	20	27	2	8		

The responses to question 6 suggested that the students preferred experiments where they could actually make some 'discovery' rather than simply demonstrate something they already knew or record their observations. Again, the Suffolk scheme is praiseworthy in this area as many of the experiments demand that students draw conclusions from their experiments. In addition the experiments, where possible, are rooted in 'real-life' situations in order to make the experimental work relevant and valid for the students.

Table 5.4 Responses to questions 8, 9 and 10, Research Task 10. Scores are means from student rankings.

ITEM	QUESTION 8 (PHYSICS) Boys	Girls	QUESTION 9 (BIOLOGY) Boys	Girls	QUESTION 10 (CHEMISTRY) Boys	Girls
A	5.9	4.3	5.7	5.4	5.5	5.5
B	5.4	5.4	3.3	5.1	3.8	3.1
C	5.9	6.8	4.7	5.9	4.0	4.8
D	3.3	3.2	5.7	2.9	3.9	3.9
E	4.7	6.4	4.8	4.6	2.8	4.7
F	6.8	7.4	4.6	5.7	5.0	4.9
G	5.2	4.8	6.1	6.4	6.2	6.6
H	3.7	3.3	4.7	3.5	6.2	5.4
I	4.0	3.3	5.1	5.2	7.6	5.7

Watts and Ebbutt (1988) have asked sixth-form students their opinions of their earlier science education (from age 11-16) and commented:

> They appear to ask (i) for a science education that is relevant to their needs and displays clear continuity and relevance, (ii) for science teachers who are responsive to individual needs and, (iii) for practical work that focusses on genuine and self-directed enquiry. (p211)

This describes the path we were trying to follow in our upper school science courses and which was suggested by much of the Suffolk scheme.

The rankings expressed in Table 5.1 could not really be taken as anything more than a vague guide to preferences as the students were only provided with the titles of the units. This meant that each title was open to individual interpretations and the students would not be expressing their opinions from the same starting point. I resolved to attempt a much larger scale investigation in order to gain an appreciation of those areas of the Suffolk course where our students expressed a lack of interest.

Research Task 11 set out to repeat the ranking exercise from Research Task 10 but with three major differences. Firstly, because the range of choices in Research Task 10 appeared to have been too wide for the students to choose effectively, I decided to restrict the choices to the Year 9 units only. Secondly, in order to further restrict the range of choices I decided to split the 12 units into their subject areas so that the students only had to rank 4 units at a time. Thirdly, in order that all students were commencing the exercise with reasonably consistent information I presented the main teaching points of each of the units in five short statements beneath the unit title. Table 5.5 lists the descriptors used for the biology units, the full list of basic descriptors (for the biology, chemistry and physics units) is presented in Appendix 12. The cohort for this investigation was also to be much larger, comprising the entire Year 8 population from my own school and some Year 8 groups from one of the other schools within the local cluster.

During discussions with Year 10 students about the nature and content of the Suffolk course it also became apparent that the way in which I was describing and discussing the material had an influence upon their perceptions of it. I decided to incorporate this factor into the questionnaires for Research Task 11 by devising a series of statements outlining the content of each of the units which paralleled the format in Table 5.5 but which expressed the material in a much more vivid way. I also attempted to emphasise the links between the different aspects of science within these units and the everyday lives and experiences of the students. Table 5.6 lists these 'enhanced' descriptors for the biology units. The full list of enhanced descriptors for the biology, chemistry and physics units is included in Appendix 13.

The questionnaires were issued quite randomly within each of the teaching groups so that some students received questionnaires carrying the basic descriptors for each of the units whereas others received questionnaires with the enhanced descriptors for the units. From the data the Suffolk Introductory Year units were ranked according to both the basic and the enhanced descriptors (see Table 5.7).

The rankings clearly illustrated that the students' perceptions of the units are likely to be coloured by our prior descriptions. This in turn suggests that the students' attitudes towards a unit could be formed in one of two ways. The first of these will be based upon the students' recollections of their experiences during the teaching of the unit.

Table 5.5. Suffolk Biology Units with 'basic' descriptors (Research Task 11).

FOOD AND DIGESTION

1. Identifying a healthy diet.
2. Meal analysis.
3. Starch in basic foods.
4. Feeding mechanisms.
5. The structure of the gut.

MICROBES

1. Examples of microbes.
2. Factors affecting the growth of microbes.
3. Microbe colonies.
4. Food preservation.
5. The spread and control of disease.

CELLS AND LIFE

1. Types of cells.
2. Investigating microstructure.
3. Biological organisation.
4. Characteristics of life.
5. Conditions needed for life.

PATTERNS OF REPRODUCTION

1. Types of reproduction - asexual and sexual.
2. Reproductive methods in plants.
3. Reproductive methods in animals.
4. Flower structure and human reproductive organs.
5. Dispersal methods.

Table 5.6. Suffolk Biology Units with 'enhanced' descriptors (Research Task 11).
FOOD AND DIGESTION 1. The things we need in our daily diet. 2. What did your family eat yesterday. 3. A simple look at basic foods. 4. How different animals eat. 5. What happens to our food once we swallow it. MICROBES 1. Mouldy bread and rotten apples. 2. Making yoghurt and booze. 3. Growing a family of germs. 4. How to stop germs eating our food before we do. 5. How to stop germs making us ill. CELLS AND LIFE 1. Looking at living things. 2. Using microscopes to look at our cells. 3. Making microscope slides. 4. How cells work inside a body. 5. Keeping things alive. PATTERNS OF REPRODUCTION 1. Why don't potatoes get married? 2. Why do apples grow on trees? 3. Why (and how) are girls and boys different? 4. Where did I come from? 5. Why don't tree trunks touch each other?

The second way, however, could cause the students' attitudes to be formed to a certain extent even before they have started a module. These attitudes, positive or negative will be created by the teachers' introduction to the next topic and will be based on our descriptions and comments prior to starting the unit. Students frequently ask questions like 'What are we doing next in science...?' It is important that these are not simply seen as chance remarks by the student. Our response to the questions should, along with our description of the next topic for the whole group, be seen as an important element in our teaching routine and we should give it as much consideration as lesson preparation, the assessment and so on. Unfortunately these remarks are frequently made by students at any time and anywhere around school, not just in lessons and in these circumstances we may not always be able or prepared to give our response the importance it obviously deserves.

Table 5.7. Year 8 students' rankings for the Suffolk units.

UNIT TITLES	BASIC DESCRIPTORS	ENHANCED DESCRIPTORS
BIOLOGY		
Cells	3	3
Food and digestion	2	3
Microbes	4	1
Reproduction	1	2
CHEMISTRY		
Elements	2	3
Gases	1	4
Materials	4	2
Separating	3	1
PHYSICS		
Energy	4	3
Forces	1	4
Microelectronics	3	1
Sports Science	1	2

To enable me to gather large quantities of data in a relatively short space of time most of the preceding research had been completed by means of questionnaires with a 'captive' cohort. In order to verify the existing data and to gain a deeper insight into the students' opinions, I decided that the next investigations should be more personal in both approach and response. The interviews with the Year 9 students carried out during

September 1988 (Research Task 7) had demonstrated that the students were willing to talk freely about their science studies and I decided to build upon this willingness, allowing the students more opportunity to express individual opinions.

In order to allow the students even greater freedom to respond I resolved to use someone who was a stranger to the students to carry out the interviews. I was fortunate that the LEA had recently appointed an Advisory Teacher for Science and that the appointee was someone who I knew personally and who was sympathetic to the aims of my research. We resolved to approach the students using, as the basic structure for the interviews, a questionnaire developed as part of a joint venture between my LEA and Sheffield City Polytechnic (now Sheffield Hallam University).

The Science Adviser for my LEA had requested that I work with the Centre for Science Education at Sheffield Hallam University in order to develop a consultancy programme. One of the results of this programme was the development of a series of investigations into the use of reading in science lessons within the context of the Suffolk course. This particular area had been identified due to the emphasis on communication within the Suffolk Science process skills assessments, many of which required creative writing by the students. In addition, several areas of the course, including the end-of-unit tests, require a considerable amount of reading and comprehension. The survey covered all four Suffolk Science schools within the local cluster, the Advisory Teacher and the consultant from Sheffield Hallam University interviewing the science teachers in these schools.

The Advisory Teacher and myself decided to adopt a similar procedure with some upper-band Year 9 students in my school. He would interview a number of students (from the group who were being taught by me at that time). He introduced himself to the interviewees as a teacher from another school trying to gain information in order to decide whether to introduce Suffolk Science within his own school. This allowed him to probe, during the second part of the interviews, the students' opinions about the nature of the course, the science topics, the teaching, the relevance of the material and so on. His final question to each interviewee was 'Would you recommend that I introduce this course for the students in my school?'

The basic format for each interview (Research Task 12) was specified beforehand during our planning discussions, a schedule is included as Appendix 14. In relation to the final question the students all responded in the affirmative, some even qualifying their response to suggest that they found the course to be 'fun', or 'enjoyable', and indicating that it would be a worthwhile addition in the interviewer's school.

The responses in the structured part of the interviews to the questions pertaining to reading skills, writing skills, pupil talk and teacher talk, indicated that there was actually quite a wide range of activities being offered to the students during the lessons. The range of activities offered to students was also noted by the inspectors during an OFSTED inspection of the school in 1993. This, coupled with the variety in the nature of the topics and the experimental opportunities offered by the Suffolk Science format appeared to increase enjoyment of the course. An additional benefit was that understanding also appeared to improve for the majority of the students. As discussed in Chapter 4, however, the written test paper did not appear to be a suitable method of testing this understanding for some of our students.

We decided to extend these interview-based investigations to some of our lower-ability students, who were experiencing the most problems with the testing procedure, in order to try to identify the stages involved in the breakdown of interest and understanding. These were the students who were, as noted in Chapter 4, making progress and experiencing success with the process skills and can-do tasks but were losing motivation through not passing the tests. The 1989/1990 Year 9 cohort had within it two groups who were identified as being less able. The Advisory Teacher was to observe and work with these two groups of students over a period of a few weeks (Research Task 13).

He attended the majority of science lessons within a complete unit with each of these two groups. During the observation period he initially 'sat in' with the groups to get a feel for the level at which they were working, the areas which gave them problems, the dynamics of the group and so on.

As he became familiar with the situation in that group his role gradually changed as he began to become more involved with them as individuals, assisting during practical work and helping individual students with their problems. In the final stages of the unit the situation was such that once the group's teacher had outlined and introduced the lesson the two teachers worked together as a team. This was then repeated with the second group and a different teacher.

He and I then developed the schedule in Appendix 15 to be used for a series of interviews with students from these two groups (Task 14). These interviews set out to investigate the teaching and presentation of the course and issues relating to the end-of-unit tests. Table 5.8 gives the percentages of students from the two lower-ability groups responding 'yes' to the questions about the end-of-unit tests.

Table 5.8. Responses in relation to end-of-unit tests.

QUESTION	% Students Responding YES	
	Boys	Girls
1. Do you think the tests are easy?	61	78
2. Do you like having tests at the end of each topic?	61	89
3. Are the words on the tests too long/difficult to read?	67	33
4. Are the questions clear?	78	22
5. Do the tests make you want to work hard to get a good result?	94	78

The responses to questions 3 and 4 indicate considerable polarisation between the sexes, one possible inference being that the boys are much more reluctant than the girls to admit to having difficulties with the tests as the results do demonstrate that the boys experience a lack of success in this area.

When asked about feelings experienced when the test results were returned a high proportion quoted 'feeling nervous' as a first response. This reply, coupled with the responses to question 5 indicate quite clearly that the tests do fulfil their function as a motivating factor. We can only guess at the inner feelings of the less-able student who desperately wants to reinforce the successes in the can-do tasks and process skills and yet repeatedly fails the tests. One of the reasons for moving towards the balanced science approach was to alleviate the turning-off process and yet there is an important part of the science course framework which is consistently reinforcing it. This was, as described in Chapter 4, one of the reasons for attempting to set up an alternative assessment framework, i.e. the Unit Accreditation scheme within the Suffolk Science structure.

The students expressed satisfaction with the greater part of the course (including the tests) but demonstrated extremely negative feelings towards writing activities in any shape or form. For many of these students writing is a very slow and difficult process and the recording of information is onerous for them. This must naturally be reflected in their test results because they have little material from which to revise for the tests, even if they have the opportunity or desire to do so. Reading will also present difficulties for them and yet they are expected to read material in order to prepare for tests which must also be read. Finally, they must record their responses by again going through the difficult process of writing, a process which is made even more difficult because they have to respond using their own limited science vocabulary.

The regulations governing the examination of the Suffolk scheme do not permit the reading of test questions to students (although special circumstances may permit this for individual students). The department has experimented by asking test questions directly of individual students and allowing them to respond orally, the teacher then recording the response. This has demonstrated a considerable improvement in test scores. We have concluded that the poor response in the written tests does not reflect the less-able students' knowledge or understanding of a particular topic. It is more the twin hurdles of understanding what is being asked and responding in an appropriate form which cause them to fail at regular intervals and with such damaging effect. Unit Accreditation (Research Task 16) may reduce this to some extent as the emphasis on reading and writing can be reduced when creating Units of Accreditation.

The responses to the questions regarding the teaching and presentation of the course were markedly similar to those expressed by all the other students canvassed in the previous investigation (Research Task 10). The two most popular activities were carrying out experiments and watching videos, the two lowest ranked activities were listening to the teacher and sitting the tests although getting the results of the tests was ranked third. Very little gender difference was apparent in this part of the investigation.

When asked to indicate the format they preferred for carrying out practical work both the boys and the girls expressed a preference for working in small groups. Neither appeared enamoured with the 'problem-solving' type of experiments. When asked if they preferred a 'circus' type lesson with a variety of practical activities the boys responded positively but the girls were less in favour of this type of approach.

The computer software used for the record-keeping aspects of the Suffolk course permits a performance analysis to be made from the data. The analysis is based on all completed assessments and can be made for each teaching group and for the entire cohort. The analysis indicates the number and levels of passes in both the end-of-unit tests and the process skills and the numbers of can-do tasks completed by each student within a teaching group. A percentage score is computed from the level/pass data and each student is then ranked within the group and the year cohort. The analysis can also be made between individual science disciplines and by gender, these being discussed later in this chapter (see Figures 5.15 - 5.20).

In September 1990 a performance analysis was obtained for each of the teaching groups in the first Suffolk Science cohort and the data further analysed by gender (Research Task 15). Figure 5.9 illustrates the distribution of percentage scores from the performance analysis for girls and boys from this cohort. This distribution clearly indicates that the girls were beginning to reduce the gender differential which had been observed in the school in previous years. Figure 5.10, which shows the performance analysis for the second Year 9 cohort (1990-91), demonstrates further improvements being made by the girls.

Figure 5.9 Score distribution from performance analysis.
Year 9 cohort, 1989-90.

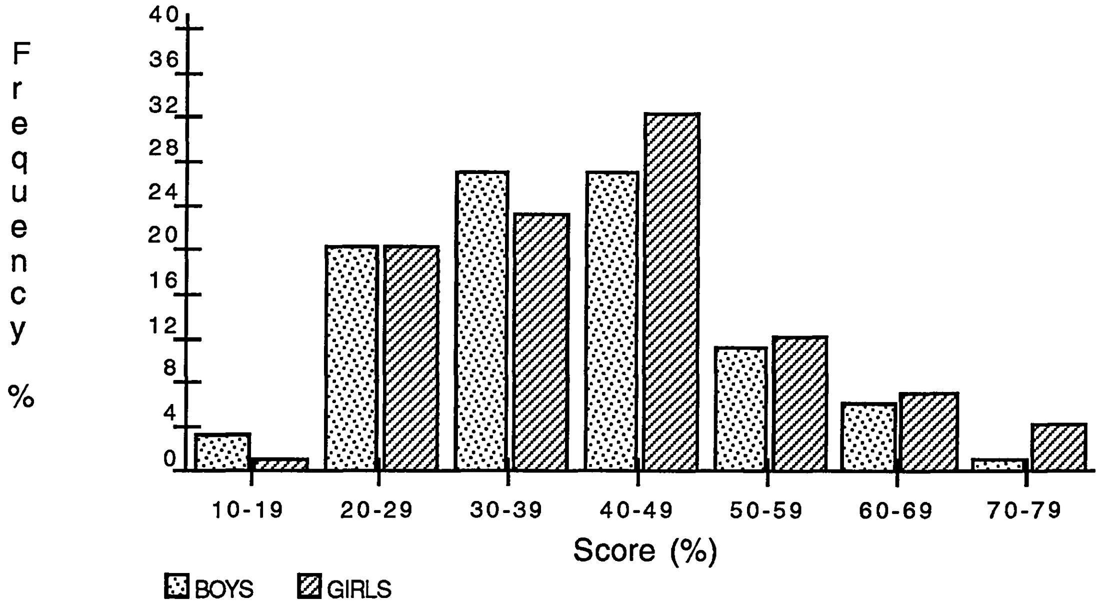
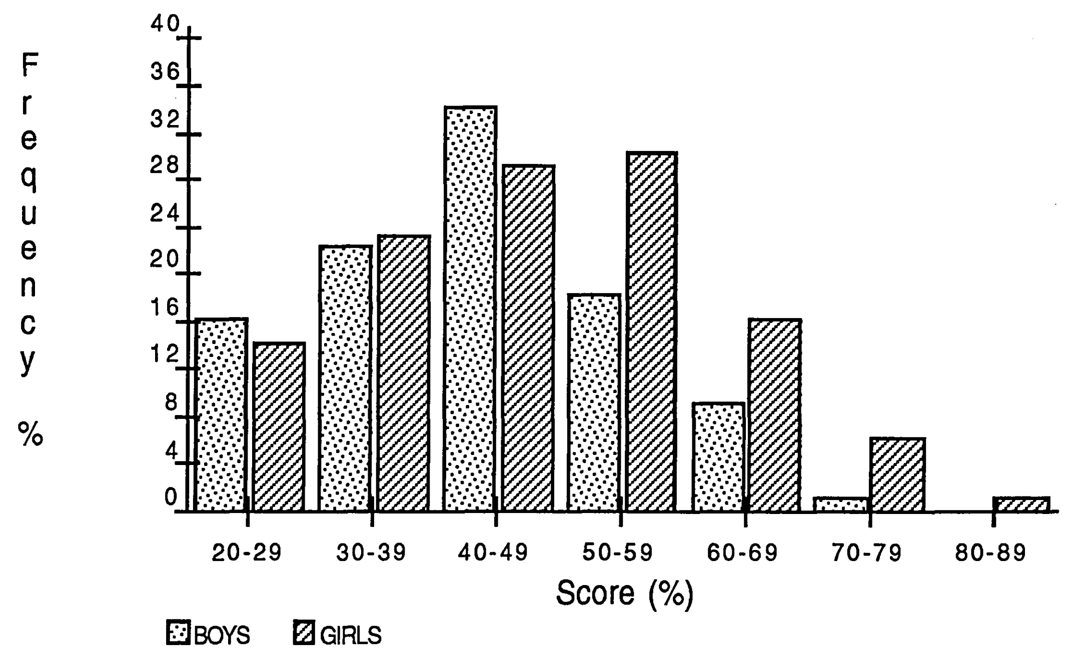


Figure 5.10 Score distribution from performance analysis.
Year 9 cohort, 1990-91.



It would appear that on the first time of teaching the Introductory Year our methods and strategies had enabled the girls to maintain interest and motivation in their science course. In the second year of teaching the course, however, the mean scores for both the boys and the girls increased (Table 5.11) and a greater differential became apparent between the sexes. Although an improvement in attainment was observed for all students the scores obtained the girls increased by substantially more than those obtained by the boys. This improvement appeared to be mainly due to our familiarity with the structure of the Suffolk course and its assessment techniques, and the implementation of those strategies designed to improve the teaching of science to the girls.

As both Year 9 cohorts (1989-90 and 1990-91) had taken identical end-of-unit tests and completed similar assessments it was possible to combine their performance analysis data and the distribution obtained in figure 5.12, based on the data in Table 5.11, was obtained. Analysis of the performance data from the first cohort to follow the GCSE Year One of the Suffolk course (Year 10, 1990-91) again revealed high scores amongst the girls, this distribution being illustrated in Figure 5.13.

The performance data for the two Year 9 distributions illustrated in Figures 5.9 and 5.10 and for the combined Year 9 and the Year 10 data shown in Figures 5.12 and 5.13 were analysed for statistical significance using a t-test (as outlined in Appendix 21). The results of these analyses are included for convenience in Figure 5.11. The data for the first Suffolk cohort (Year 9, 1989-90 and Year 10, 1990-91) showed no significant differences. This, however, helped to confirm our achievements, indicating that we had been successful in reducing the differential between the boys and the girls.

However, the data for the second cohort (Year 9, 1990-91) did prove to be statistically significant at the 5% level in favour of the girls, showing that our initiatives appeared to have actually <u>reversed</u> the gender differential enabling the girls to make significant improvements in their overall levels of attainment. In addition, combining and analysing the two sets of Year 9 data (based on identical assessments) again gave rise to a t-test score which was significant at the 5% level in favour of the girls.

From talking to the students, particularly the girls, there is no doubt that they became very satisfied with both the nature and structure of the course. The tests and the assessments clearly allow them to demonstrate and also be rewarded for what they know and can do, this success then becomes a powerful motivator.

The students have also been quite critical of the content and teaching techniques used in some units. These criticisms have been directly related to their own performance and the students have identified areas where they felt they were unable to maximise their potential. This can been seen as a healthy demonstration of the students' motivation and indicates their feelings of ownership of the course particularly when the majority of the criticism was levelled at the mechanics of how they are being taught rather than what they are being taught.

Table 5.11. Data from Suffolk Science computer-generated performance analysis, compared by gender.

	Mean percentage scores		t-test score
COHORT	BOYS	GIRLS	
Year 9, 1989-90	38.44 N=88	40.17 N=69	0.83
Year 9, 1990-91	42.80 N=74	47.22 N=82	2.15*
Year 9, 1989-91	40.43 N=162	44.35 N=151	2.65*
Year 10, 1990-91	45.00 N=83	45.97 N=67	0.47

* indicates differences significant at 5% level

Figure 5.12 Score distribution from performance analysis.
Year 9 cohorts, 1989-90 and 1990-91.

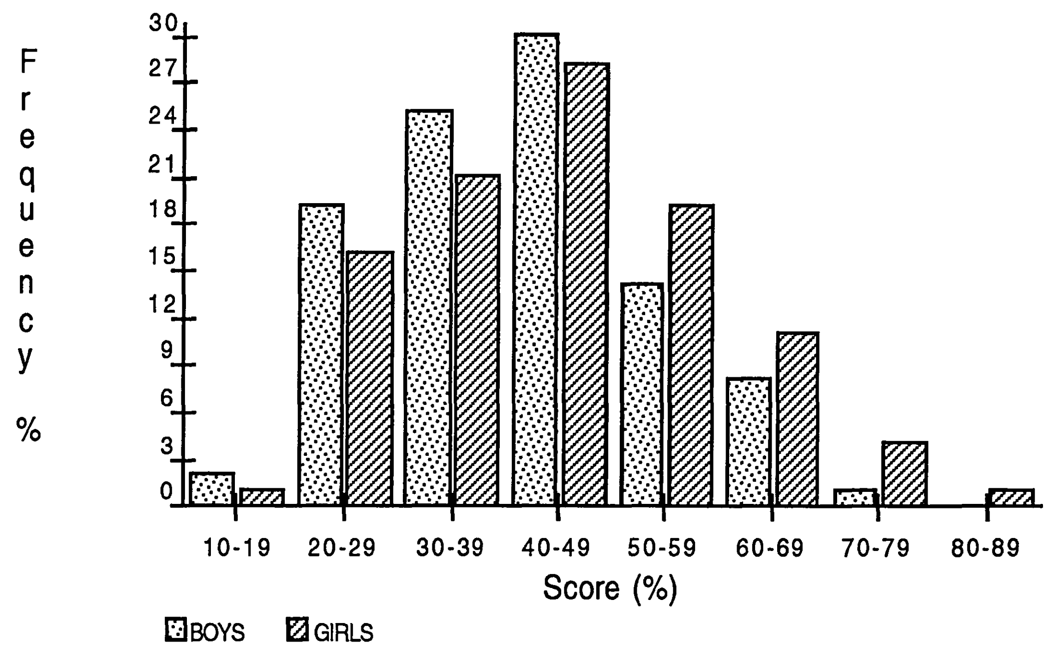


Figure 5.13 Score distribution from performance analysis.
Year 10 cohort, 1990-91.

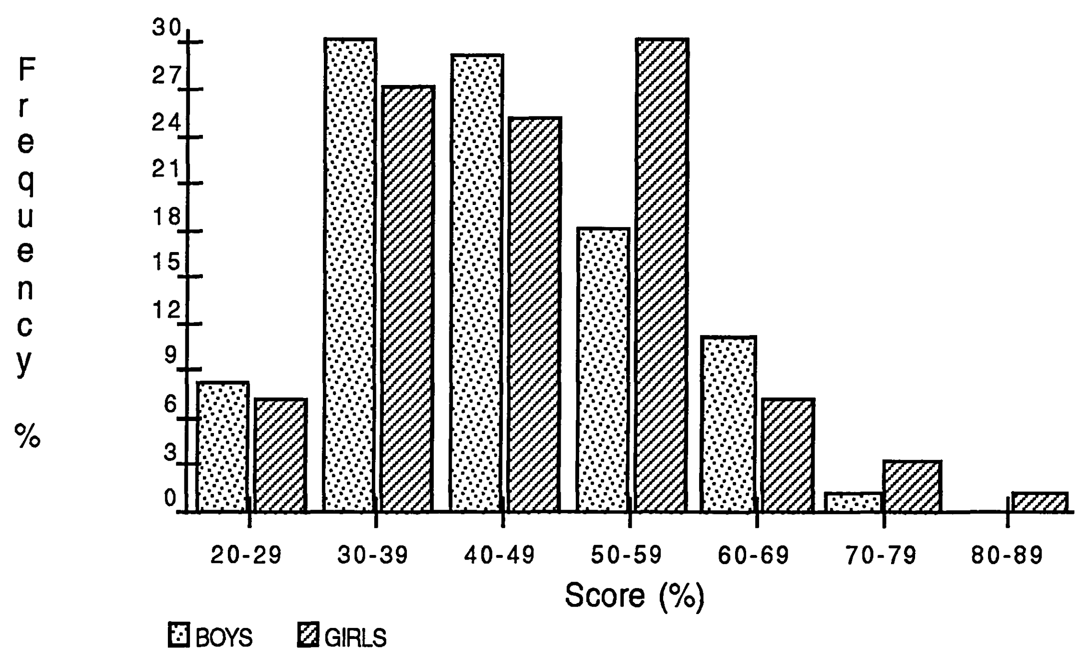


Table 5.14. Data from Suffolk Science performance analysis compared by gender for individual science disciplines.

Cohort	Science subject	Mean percentage score Boys	Girls
Year 9 1989-90	Biology	35.71	38.55
	Chemistry	40.99	44.55
	Physics	45.56	41.49
Year 10 1990-91	Biology	34.13	38.83
	Chemistry	52.33	49.71
	Physics	46.93	43.12

In Table 5.14 the performance analysis data for the first Suffolk cohort are compared in the separate sciences and by gender. It can be seen that for the Year 9 cohort the girls' mean scores for both biology and chemistry were higher than the boys' scores, the boys' scores in physics, however, were higher than the those of the girls. For the Year 10 cohort the girls' mean scores were higher than the boys' mean scores in biology and lower in chemistry and physics. A t-test indicated that the only one of these areas in which a statistically significant difference existed was between the boys' and girls' scores in biology in Year 10 (the difference being significant at the 5% level with a t-score of 2.16). The t-tests demonstrate quite clearly that there has been an improvement in the girls' performance. In addition, the lack of any significant difference between the girls and the boys in chemistry and physics in particular suggests that we had demonstrated success in reducing the existing differential between the sexes in the physical sciences.

Figures 5.15, 5.16 and 5.17 compare the score distribution for the boys and the girls in biology, chemistry and physics respectively for the Year 9 cohort. Figures 5.18, 5.19 and 5.20 illustrate the comparative distribution patterns for each subject in Year 10.

Figure 5.15 Score distribution from performance analysis. Year 9 cohort, 1989-90, biology units.

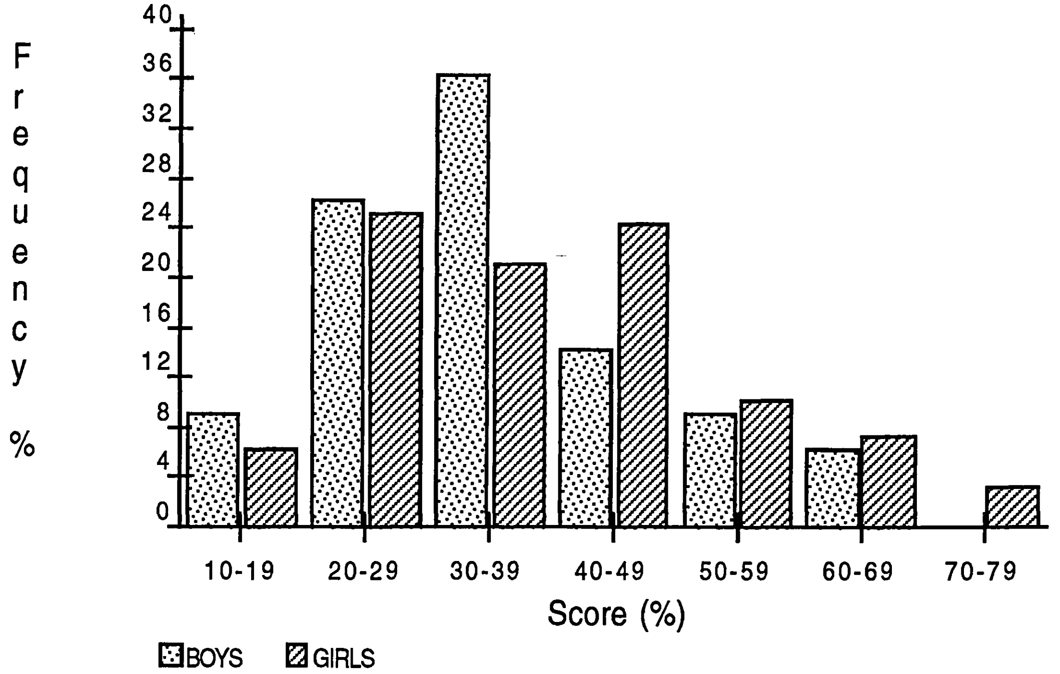


Figure 5.16 Score distribution from performance analysis. Year 9 cohort, 1989-90, chemistry units.

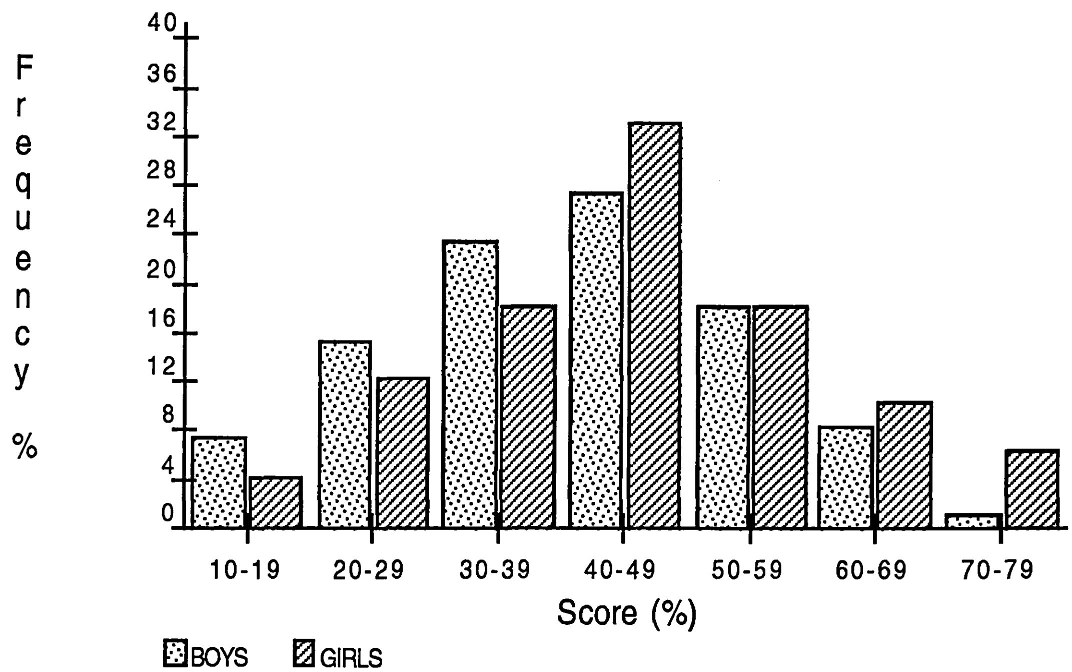


Figure 5.17 Score distribution from performance analysis.
Year 9 cohort, 1989-90, physics units.

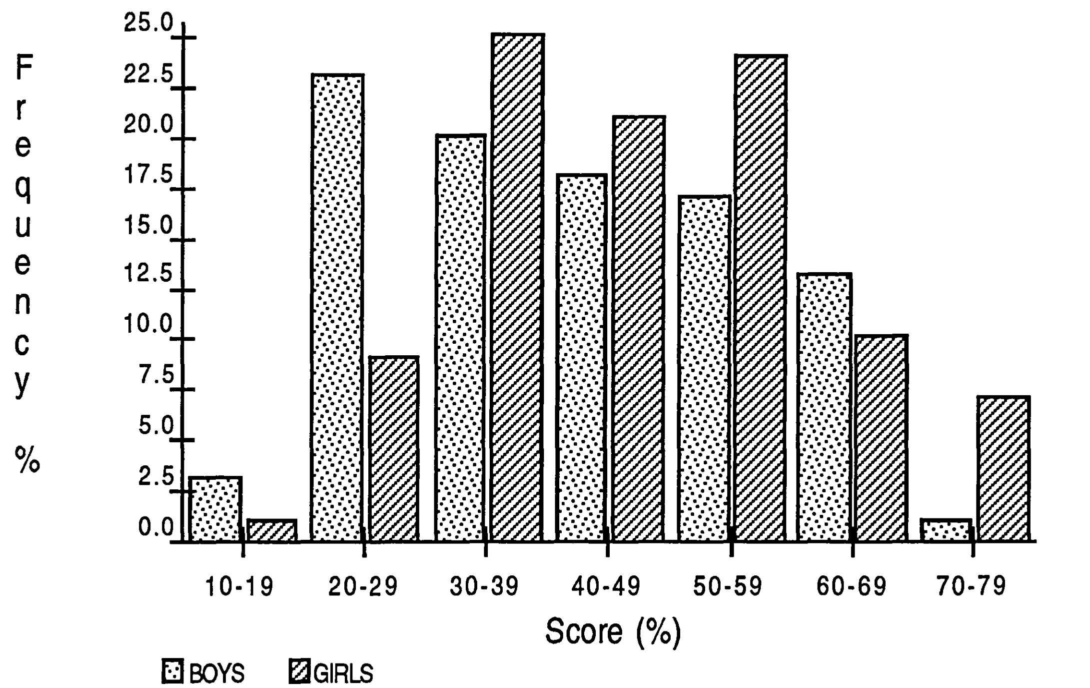


Figure 5.18 Score distribution from performance analysis.
Year 10 cohort, 1990-91, biology units.

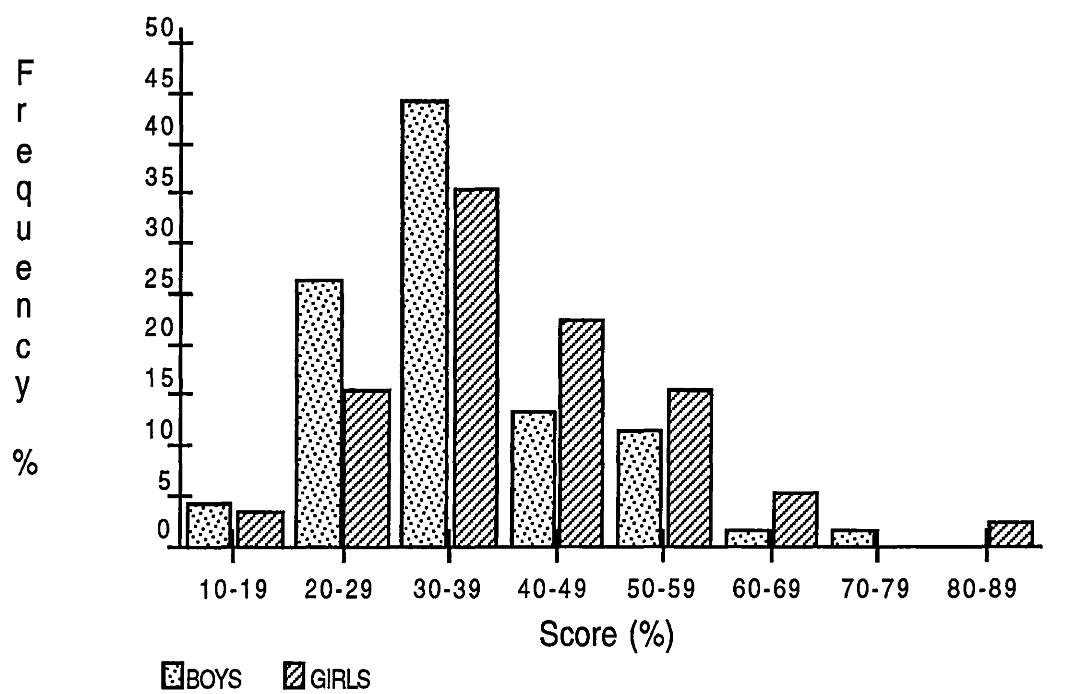


Figure 5.19 Score distribution from performance analysis.
Year 10 cohort, 1990-91, chemistry units.

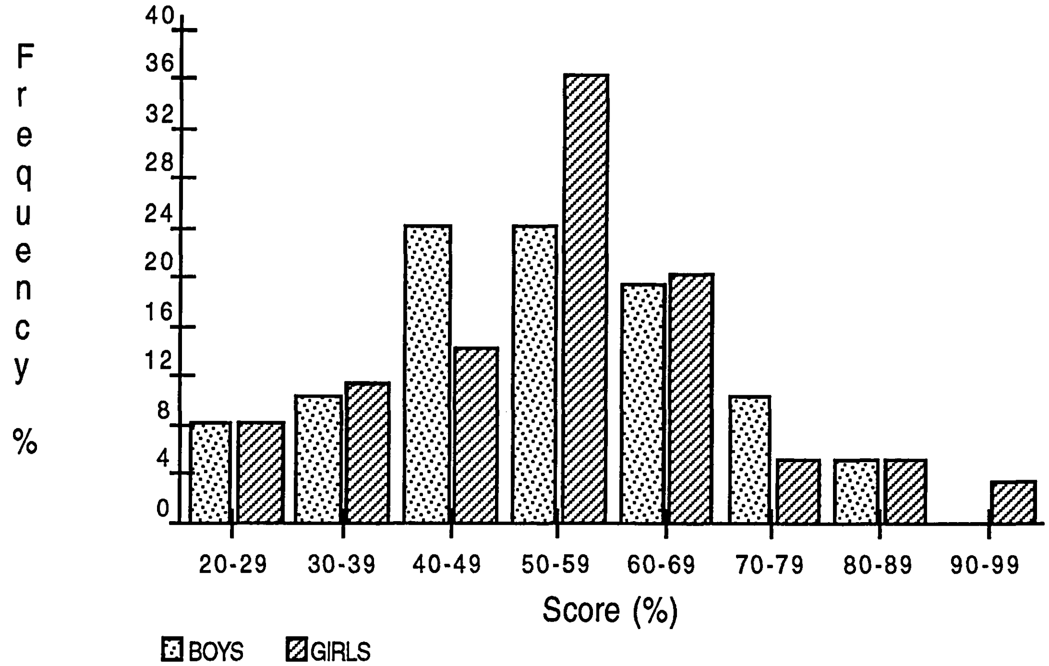
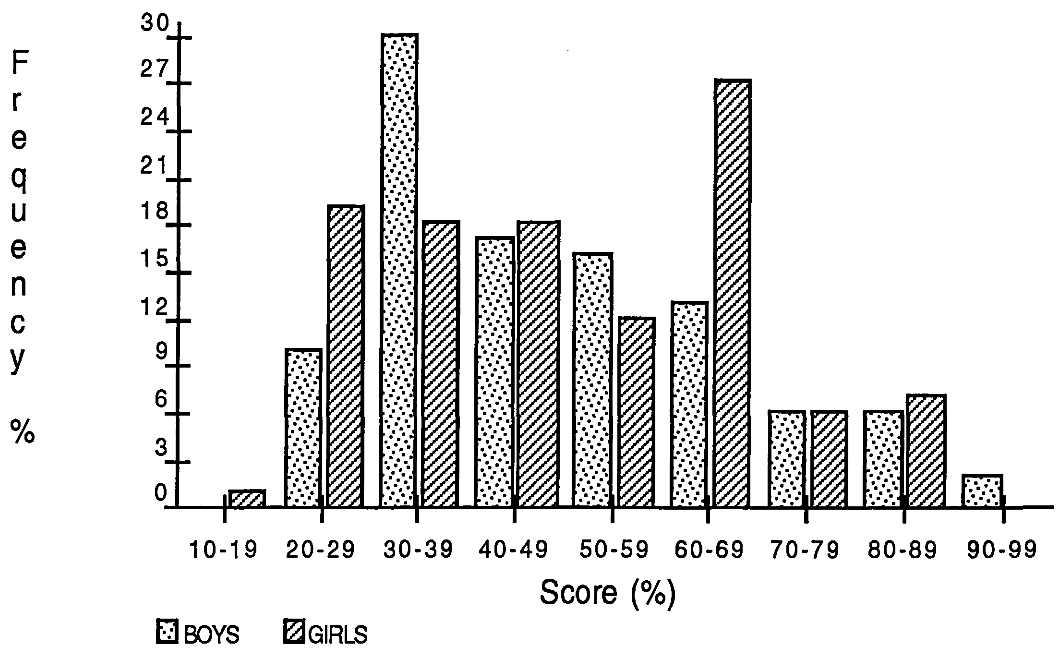


Figure 5.20 Score distribution from performance analysis.
Year 10 cohort, 1990-91, physics units.



It rapidly became apparent in the department that the nature of the assessment framework of the Suffolk course was contributing considerably towards the students' success. This was achieved quite simply by enabling the students to have regular access to their marks and explaining how their performance was affecting their (predicted) GCSE performance. The constant reinforcement of their success has had a direct and visible effect on the students' motivation.

The number of students unable to be entered for the GCSE examination in science was considerably reduced, from around 20% in previous years to less than 8% in 1992 (the first year of GCSE entry in Suffolk Science). Many of those students from the lower-ability band entered for GCSE Science will be awarded grades above the base level 'GG' grade. Table 5.21 illustrates the probable GCSE grades of the Year 11 cohort for 1992 (N = 139), as predicted by the computer software.

These figures demonstrate an improvement in performance when compared with those for the separate sciences obtained in previous years. The GCSE passes in the separate sciences for the combined 1990 and 1991 cohorts, are listed as percentages (along with the predictions for the 1992 cohort) in Table 5.22.

Table 5.21 Predicted GCSE grades, Year 11 cohort (1992).

DOUBLE CERTIFICATE GRADES	NUMBER OF STUDENTS	PERCENTAGE OF STUDENTS
AA	5	4
BB	5	4
CC	10	7
DD	12	9
EE	37	27
FF	43	31
GG	27	19

Source: Department records

There appears, at first glance, to be very little difference between the two sets of data. This lack of difference assumes more importance when we take into account the fact that the students entered for GCSE in the separate sciences in 1990 and 1991 were drawn exclusively from the upper band in Year 11 and were, therefore, the more able students in that academic year. In addition, the students had actually opted for those science subjects and it can be assumed that in most cases there was some motivation for choosing that subject which in turn suggests that those students would have a strong desire to succeed.

Conversely, those students in the 1992 cohort, the Suffolk Science students, were allowed no freedom of choice. They were compelled to follow a double science option and were given no opportunity to 'opt-out' of any unpopular science areas. These students were the 'conscripts'. In addition the 1992 GCSE cohort was the entire year group where all students, irrespective of ability, were following the same course, doing the same work (allowing for differentiated tasks set by the teacher) and being assessed under the same scheme.

Table 5.22 GCSE grades for 1990 and 1991 cohorts (percentages).

GRADE	Biology (N=95)	Chemistry (N=86)	Physics (N=59)	Suffolk (N=139)
A	0	0	2	4
B	2	2	7	4
C	7	8	12	7
D	11	6	19	9
E	19	6	17	27
F	32	33	22	31
G	22	24	12	19

Source: Department records

The similarity between the Suffolk course and the separate sciences indicates a considerable improvement in overall standard across the entire year group. In addition, the higher standards achieved by the girls within Suffolk Science indicate that they have gained considerable benefit and satisfaction from the course.

CHAPTER SIX

Evaluation of Suffolk Science in relation to GCSE Science assessment

The second phase of the research programme closes with an evaluation of the Suffolk scheme in relation to the original issue of gender differences. The major outcomes of this phase are discussed in relation to future initiatives and developments within science teaching at GCSE level. This chapter further discusses how the changes in Government legislation which relate to the National Curriculum for Science significantly affect the Suffolk Science framework. The author leads into the third phase of the research programme by suggesting that these changes, particularly the reduction of the coursework element within GCSE assessment will have a detrimental effect on students' (both girls and boys) motivation and achievement.

The aims of the research, as described in Chapter 2 may be used as a convenient starting point to evaluate this programme and are restated for convenience in Figure 6.1 below.

Figure 6.1 The research aims.
1. identify those aspects of the science syllabus which students from years 9, 10 and 11 within the research school perceive as being either unattractive or irrelevant; 2. closely monitor the performance of students in science, particularly the girls; 3. devise strategies designed to improve the performance of students in science, particularly the girls; 4. evaluate those assessment strategies developed within the GCSE framework with a view to understanding their role in improving student development and motivation.

The project did identify certain aspects of the science syllabus and science lessons which both boys and girls within the research school perceived as being unattractive and/or irrelevant. It would be unrealistic to assume that this section of the programme was able to identify and catalogue all those aspects of science which contributed to the students' disenchantment with school science. Nevertheless, the factors identified must have been important ones in the minds of our students.

Consequently, any area of content or method which appeared to the students to be unsatisfactory must be contributing towards the formation of negative attitudes and would obviously be worth further investigation. Even if the problem had only been identified by a small number of students, any enhancement of the learning situation as a result of this information would be likely to benefit the remainder of the cohort thus adding to the success of the intervention. The earlier chapters have discussed the significance of some of the factors identified by the research and the attempts to reduce their negative effects.

One of the strategies which was intended to improve some of the curricular and administrative aspects of GCSE Science was the introduction of the Suffolk Science course. This appears to have been an effective way to improve the attainment of all students. In addition, this improvement is particularly marked with the girls, as the data in Chapter 5 illustrate. Direct observation in classrooms has indicated to me, and to other teachers in my department, that this course has also produced an equally satisfying increase in both the interest and motivation of the vast majority of our upper-school students, both girls and boys.

The differential which favoured boys (as evidenced in Chapter 1) has not only been reduced but has been reversed in certain areas (Figure 5.17, for example, shows a score distribution in physics units which clearly shows improved performance on the part of the girls). This indicates that our strategies designed to improve the working and learning situation for girls have been effective. The improved attainment of all students, together with the particular success evidenced by the girls suggests that this research has been influential in reducing negative attitudes towards science and promoting student performance generally in this school. The introduction of Suffolk Coordinated Science appears to have been a major contributor towards this improvement.

As described earlier in Chapter 4 the Suffolk scheme was used as a resource rather than followed meticulously, a wide range of additional techniques and strategies being developed within the department as the course progressed. The focus of these varied from individual students to year groups, the subjects ranged across the entire syllabus and the areas targetted for enrichment included assessment methods and individual teaching schedules. Consideration was also given to improving ways of working with the students through negotiation, review mechanisms and counselling.

The investigations into gender differences and the attitudinal factors which contributed towards these differences (Chapter 1), had suggested that the development of 'girl-friendly' science would do much to alleviate the problems. This programme of action research, based on the Suffolk Science course, has illustrated that it is possible to improve both the motivation and achievement of girls in science. However, the structure of the course and the contexts used to teach the concepts have provided the opportunity for all students, girls <u>and</u> boys, to improve their performance in GCSE Science. I made no direct attempt to create a 'girl-friendly' course by artificially creating contexts and situations which would, in theory at least, appeal particularly to girls. This decision appears to have been justified by the findings, particularly those relating to the predicted GCSE examination grades for 1992 (Chapter 5).

The more-able students have, however, caused us a certain amount of concern. The very nature of a modular balanced science course necessitates a rather shallow approach to certain areas of the curriculum. In terms of preparation for A-level studies, this is not an ideal situation. The current Year 11 (1992) are the first students in my own school to complete the Suffolk course and there has, therefore, been no opportunity for feedback in this area. However, at a recent Heads of Science meeting within my LEA unsolicited comments made by the Head of Science at the Sixth Form College suggested that he had found 'Suffolk' students, from another school within the LEA, to be more confident, capable and well-motivated than 'separate science' students. He suggested that these positive aspects tended to alleviate problems caused by lack of depth of knowledge. He also stated that this alleged deficiency was quickly remedied which suggests that the approach demonstrated by these students, developed through the Suffolk scheme, may be a better prerequisite for advanced studies than a knowledge-rich curriculum. These points remain to be substantiated.

Government legislation relating to the role of coursework within GCSE balanced science courses suggests that their policy has not been guided by current research. The major aspect of the Suffolk course which has promoted the excellence of approach and achievement on the part of the students has been the assessment programme. Chapters 4 and 5 have discussed in detail those aspects of the Suffolk teaching and assessment schemes. The open assessment system with its differentiated levels of achievement, the regular testing and the emphasis on process have been highlighted by many of the students surveyed as contributing to both their enjoyment of and success within the GCSE Science course. The coursework component of the Suffolk Science course has recently (1992) been drastically reduced. The MEG GCSE Syllabus 'Coordinated Science (The Suffolk Development)' will now combine three methods of assessment for those students to be certificated in 1994:

1. Course Work component (AT1), being internally assessed by Criterion Matching with a weighting of 25%.
2. Periodic Testing (of AT's 2, 3 and 4). Students will be assessed at the end of each unit in Year 10 (12 units in all) by externally set and marked end-of-unit tests. These will together carry a weighting of 25%.
3. Terminal Examination. This will consist of three examination papers (one each for AT 2, 3 and 4) with 36% of the marks being allocated to questions on units from Year 11, the remainder will be based on 'Terminal Examination Criteria'. The terminal examination will carry a weighting of 50% of the overall assessment.

The three assessment components will retain the differentiation into 'tiers of assessment', Foundation, Merit and Special but these will now target National Curriculum Levels (as illustrated in Table 6.2)

Table 6.2 Relationship between Suffolk assessment tiers and National Curriculum Science levels.

Co-ordinated Science Tiers	National Curriculum Levels Targeted
Foundation	4, 5
Merit	6, 7
Special	8 - 10

Source: MEG (Suffolk) GCSE syllabus

A large part of the final assessment will now, therefore, be provided by a terminal examination, one of the factors in the assessment of students in science which the scheme had originally sought to remove. The ASE (1987) had actually criticised the Suffolk scheme for placing undue emphasis on the recall of factual knowledge in end-of-unit tests (see Chapter 4). The Government's decision is likely to increase this emphasis considerably. The restriction of the coursework component reflects the reluctance of the Government to consider the opinions of the teaching profession and suggests a lack of recognition of the progress which has been made in improving the performance of all students in science. This is further highlighted by the controversy which has accompanied the introduction of both the National Curriculum for Science and its programme of formal assessment. The mechanism for both delivering and assessing the National Curriculum has changed with bewildering rapidity over the last two years. The Government's repeated interventions and changes of direction have imposed considerable stress upon the teaching profession and this has had a deleterious effect in schools.

Dobson (1992), the National Director for the Suffolk scheme, has criticised the Government's ineptitude in the management of the National Curriculum and its assessment in a scathing attack published in The Guardian. He suggested that the Government had demonstrated a lack of awareness of the differentials in ability and interests, and how these changed across the Key Stages. He pointed out how the Suffolk course, as indicated elsewhere in this thesis, not only recognised these differences but set out to teach the students accordingly and, as noted in Chapter 5, did so successfully. The separation of the National Curriculum Council (NCC) and the Schools Examination and Assessment Council (SEAC) was criticised for the resulting mismatch between curriculum content and assessment and the apparent lack of ability of the NCC and SEAC to coordinate their activities. Dobson commented that: "The result has produced an unworkable scheme that is going to set science education in secondary schools back by years".

Reference to the Research Log (Chapter 2) demonstrates how the central theme of the research has been maintained in spite of these frequent and rapid changes. These external pressures could have had a much more destructive effect upon the development of both the science syllabus and the students in this school. This action research programme, by introducing a series of structured changes to the nature and presentation of the science within the school, has imposed a certain amount of control upon what has been an entropic period within science education.

Those girls who chose, in the past, to study the physical sciences as part of the separate sciences system must have done so for specific reasons, probably related to career choice. Previous research (Kelly, 1981; Head, 1985) had suggested that these students tend to have certain qualities of character (assertive, independent, less feminine, extroverted) which permit them to make what are, in gender-role terms, atypical subject selections.

Many of the girls who have achieved, and are currently achieving, high standards within Suffolk Science do not demonstrate the above tendencies. It must be assumed that the course allows these female students to express their capabilities and, consequently, achieve high status in an environment which is non-threatening in terms of both work and sex-role.

Head and Ramsden (1990, p120) related the characteristics of the girls choosing science to the nature of recent developments in science teaching, reflecting to a certain extent some of the opinions expressed earlier in this chapter:

> For girls to opt for science they have to overcome a number of hurdles. They not only need the necessary intellectual qualities but additionally the resolve to compete with boys in a male-dominated terrain. By making science more relevant to humanistic concerns, we are presumably enhancing that resolve, a conclusion that has far-reaching implications for science teaching.

Much of the earlier research, as quoted in Chapters 1 and 2, has illustrated how the boys regard the science laboratory as their personal preserve. The boys use a variety of techniques to assert their dominance in this environment by, for example, 'grabbing' equipment before the girls, physical dominance of laboratory space, disruptive behaviour when girls try to participate orally in discussions, overt and covert sexual harassment and so on. This has, in the past, been enough to dissuade many girls from choosing physical sciences as an option for external examination courses. The Suffolk science scheme does not permit the girls this freedom. They are compelled to participate in activities and within environments where their presence has been barely tolerated by the boys in the past.

The constant availability of information, the reinforcement of success, the open assessment and the active learning techniques used within the Suffolk scheme must contribute in some way towards the success of both the course and the girls. It is immediately apparent within the Suffolk course when a student is performing well and, unlike those courses with no structured and effective assessment component, it is impossible for students to hide their lack of achievement behind a wall of antisocial or sexist behaviour. Consequently a girl who is capable of achieving high standards can demonstrate this and is reinforced in this behaviour by the assessment system. This reinforcement leads to more success feeding an upward spiral of attainment. Those units which do not appeal to the individual student or to feminine areas of interest are merely one part of the course and although these areas may create a temporary setback causing the individual students' attainment level to fall, this is not enough to halt the overall momentum produced by the successes.

Similarly, those boys who would be likely to express 'territorial' claims to the physical sciences and the laboratory environment are also subject to the open assessment. When it is apparent that their own achievements are being matched, and in many cases bettered, by girls then their dominance of the environment is in question.

There has still been some expression of dissatisfaction by the students within certain curriculum areas as discussed in Chapter 5. Some of the physics units have been identified by girls as being unpopular and boys have expressed a dislike for some of the biology units. The spread of the assessment framework over such a wide range of units has, however, meant that as these unpopular parts of the course comprise only a small part of the entire scheme the overall achievement of the students is only slightly affected. The students will have participated in, and gained some knowledge of these aspects of science, even if they disliked them. Under a separate science model a student would have decided in advance which aspects of science he or she did not like and would have opted out of that subject entirely. This would have been far more damaging to the individual by closing off an entire area of scientific experience.

This aspect of the balanced versus separate science controversy indicates another area of concern. Naturally, the balanced science approach can not compete with the separate disciplines in terms of subject depth and there is a risk that balanced science may not adequately prepare students for the study of the sciences at A-level. Comments by the Head of Science at a Sixth Form College have been noted earlier in this chapter. Additional evidence suggests that in this particular case it may be the A-level courses which are found wanting and not the GCSE (see p122).

In 1991 a small group of teachers from my LEA visited another authority to investigate the implications of Suffolk Science in relation to A-levels. A Sixth form college in the host authority made the following observations after having three cohorts of Suffolk 'scientists' follow A-level Science courses. In general the Science Department in the College was obtaining excellent A-level results and the Suffolk Science students were well-motivated on commencing the courses. In biology it was felt that the Suffolk course was a distinct advantage, the students were seen as better scientists with a better approach to problem-solving activities. In the chemistry area the comments reflected satisfaction with the Suffolk course and suggested that the A-level course was the problem and needed to be changed. In physics there was less immediate support for Suffolk Science but problems with the GCSE Mathematics course were noted. A successful 11-18 school in the same LEA was also in favour of the Suffolk approach noting high motivation and achievement and recommending the positive features of the course, for example, the regular reporting and the formative feedback. This school had also expressed dissatisfaction with the A-level Science courses.

A method of reducing the disparity between GCSE and A-level was reported in the The Times Educational Supplement (20.3.92,). One school had expressed concern that, in spite of GCSE results which were considered to be 'outstanding', the A-level achievement of their first Suffolk Science cohort was poor. It was discussed how the school had looked for ways to utilise the positive aspects of the GCSE course by incorporating Suffolk Science methodology into the A-level courses, with a corresponding increase in A-level performance. The author remarked:

> Surely it is up to teachers to make the courses we offer more accessible to our students, tailoring our different approaches at GCSE and A-level to meet their widely differing needs. (p37)

This comment reflects the findings of certain key aspects of this research, of Dobson's views in his discussion of the Suffolk course (1987) and of the many other researchers quoted elsewhere in this thesis.

There is some divergence of opinion as to where the actual problem is rooted. The Headmasters' Conference (HMC) proposed, in the policy document 'Education 14-19', that it is the GCSE which fails to prepare students adequately for A-level whereas the Secondary Heads Association (SHA) in '14 to 19 Pathways to Achievement' suggests that it is the A-levels which are out of step with GCSE.

It was reported in the T.E.S. (30.9.94, p2) that the HMC had endorsed a proposal for the restructuring of GCSE and A-level provision to take the form of an advanced diploma which could be gained through a variety of routes. It would cover, significantly, the 14-19 age group rather than apply simply post-16 and draw on the best facets of the existing courses in order to lead to a General Certificate in Further Education. It was suggested that this structure could end the existing 'vocational and academic divide' and in so doing provide a varied but coherent structure which would be available to all.

The article described how both the Girls' Schools Association (GSA) and the SHA identified with the overall intentions of these proposals and that they were, furthermore, supported by the Confederation of British Industry. Labour party education policy also reflects this type of approach.

Although the different bodies advocate different routes towards the final certification it is encouraging to observe that a consensus exists regarding the nature of the problem and its origins. The definitive pattern of education 14-19 remains to be identified but at least the different opinions are based on the same problem and the different proposals are leading towards the same goals. This topic will be recalled in the final discussion in Chapter 10.

Although the Suffolk course appears to be an excellent way of encouraging students to achieve their best within a balanced science framework it must be stressed that it is the teacher who remains the prime motivator. It has been noted earlier how the students in the research school have adopted the course wholeheartedly but have been critical of teaching styles when the students perceive that their needs are not being met. However, the teacher must be able to adapt to this role and the Suffolk scheme is important in this respect. The course has a structure which allows both teachers and students to develop. The teacher, through embracing new skills and techniques, can modify his or her role in the classroom in order to meet the needs of the students. The students are then free to develop their own skills in a supportive atmosphere thus leading to a greater awareness of science and, as demonstrated, higher attainment. The research has also indicated that it is possible to reverse the inequality in science education in relation to gender in order that the girls are allowed to participate more fully in science activities. The girls have been given the freedom to demonstrate their aptitude and ability, outperforming the boys in many areas.

It remains to be seen what effect the Government's ruling on the coursework component of GCSE Science will have on Suffolk Science and similar courses. By replacing Year 11 coursework assessments by a terminal examination it will be more difficult for teachers to monitor and counsel students throughout this crucial period of the course. Students will no longer receive immediate and effective feedback on their progress and it will be impossible to use the computer software as before to predict GCSE performance accurately. This will, in turn, make the setting of short-term goals inappropriate as a tool to motivate the students. Even though end-of -unit tests are to be retained in Year 10, as they are to be marked externally under the new regulations, feedback of student performance will be slower and, therefore, less effective. The evidence to date suggests that the assessment framework of the Suffolk course has contributed greatly to the students' success. The achievements of the girls and the boys must be seen in the light of this frequent and accurate feedback. Without this reassurance it seems inevitable that much of the progress made in reducing the gender imbalance in science and in increasing the success of students of all abilities will be destroyed.

This phase of the research project has demonstrated that it is possible to improve both the status and performance of girls in science. Furthermore, this improvement has been seen to apply to all students, girls and boys, and across the full ability range within the research school. The final predicted grades obtained from the computer software for the 1992 cohort are as shown in Table 5.21. These show a considerable improvement on the results in the separate sciences for 1990 and 1991 (Tables 2.1 and 2.2) which only included students from the upper-ability band. The improvements were obtained by both reviewing the teaching methods and developing additional or alternative resources within the framework of the Suffolk course. No situations were created to appeal specifically to girls. The progress made must be viewed within these constraints, giving more credibility to the results of the research.

The research has been very successful in meeting the aims specified in Chapter 2 within the framework of a popular Coordinated Science syllabus. However, this was a small-scale project, restricted to one school and the findings must be viewed in that light. The successes with the girls (many of whom are from a poor socio-economic environment) will hopefully encourage other teachers to persevere in their attempts to motivate and encourage similar students. An important factor in promoting students' success was raising their self-esteem, an achievement which was made possible through the system of open assessment and positive feedback provided by the Suffolk scheme. The science syllabus selected by a school must, within the National Curriculum, be made to work for the students by providing achievable goals and increasing momentum rather than erecting a series of barriers to progress.

The National Curriculum for Science sets out what must be taught to our students. This research has clearly indicated that the important factor for success on the part of the students is how this is delivered and assessed. The teacher is the crucial factor in enabling the students to achieve this success. It would seem vital that the next stages of development of GCSE Science within the framework of the National Curriculum should consider:

1. raising the status of the students within the boundaries of the syllabus selected by a school by encouraging an open and easily accessible assessment framework;
2. developing approaches to learning designed to enhance the involvement and interest of students;
3. developing teaching contexts which encourage the students to perceive science as being real and important;
4. reflecting on the appropriateness of individual teaching styles in order to foster positive attitudes amongst the students.

CHAPTER SEVEN

The changing pattern of achievement in GCSE Science

This third phase of the programme commences with an investigation of the improvements in the performance of girls in science observed by the author within the research school. The data are compared with that obtained from other schools using the Suffolk syllabus within the collaborating LEA. Further gender comparisons are made on a larger scale using DFE statistics and performance data in the separate sciences from some Examining Boards. The reasons behind the improvements recorded by the author are discussed in the light of this current programme and some of the published research.

This research programme has demonstrated that, within the author's school, the students' performance within GCSE Science has been improved. Furthermore it has proved to be possible to improve the performance of the girls without introducing any measures specifically designed to enhance the position of the girls within GCSE Science or which discriminated against the boys. The gender differential described in the earlier chapters, which favoured the boys, has been reduced. Equality of opportunity has been made available to all students irrespective of gender or ability. The majority of students in the Year 11 cohort are now being entered for the GCSE Science examination course, the small number of students who are not entered are generally excluded because of their poor attendance.

It would appear that the introduction of the Suffolk Science course has played an important part in these observed improvements within the author's school. It is necessary, however, to extend this investigation in order that a more informed explanation for the improvement in girls' attainment within GCSE Science can be made. This may be achieved by considering both the nature and structure of the Suffolk Science course and the students' performance within its assessment framework. In addition some consideration must be given to both the students' perceptions of the course and the way in which it was taught.

It is also desirable to compare the findings within the author's school with the results obtained in other schools teaching Suffolk Science for GCSE. The detailed comparison of data from their pre-Suffolk cohorts, as carried out in the author's school and described in the earlier chapters, will not be possible. However, current Suffolk data will enable the gender balance in other schools to be compared with the situation in the research establishment. Earlier research (Chapter 3) has demonstrated that the students within the author's school are fairly typical of secondary students from similar backgrounds. In addition, Chapter 1 has clearly illustrated the typical gender imbalance which exists within science. The comparative data may suggest that a pattern exists in Suffolk schools which is atypical when compared with this. On the other hand, the promotion of achievement by the girls may only be evidenced within the author's school.

This chapter will discuss quantitative data relating to differential performance in GCSE Science and qualitative data relating to students' attitudes and perceptions. The qualitative aspects of the research will be considered by discussing the importance of GCSE coursework to the findings of this research programme later in the thesis.

Table 7.1. GCSE Science grades (1992) in six 'Suffolk' schools, by gender. School 1 is the research school.
Figures are percentages.

		GCSE Grades								
		A	B	C	D	E	F	G	U	N
SCHOOL 1										
	Boys	3	6	4	19	25	26	17	0	72
	Girls	5	7	8	10	19	32	16	3	62
SCHOOL 2										
	Boys	8	12	27	10	22	12	6	3	59
	Girls	4	11	9	24	22	24	7	4	57
SCHOOL 3										
	Boys	5	11	11	24	26	18	5	0	38
	Girls	0	13	13	31	23	21	0	0	39
SCHOOL 4										
	Boys	13	21	13	13	9	18	12	1	109
	Girls	15	12	13	14	11	20	13	2	123
SCHOOL 5										
	Boys	12	13	7	25	25	12	6	0	68
	Girls	8	13	11	15	33	16	1	3	79
SCHOOL 6										
	Boys	6	2	6	15	17	26	19	9	53
	Girls	2	12	12	10	10	21	21	12	58

Source: LEA records

Table 7.1 illustrates the data from the six Suffolk schools within the collaborating LEA, comparing the boys' and girls' GCSE grades in science. Table 7.2 combines these figures to show the gender pattern across the six schools. Table 7.3 further condenses the information from Table 7.1, illustrating the percentage of boys and girls in each school being awarded A grades and A-C grades.

Table 7.2. Combined data from the six Suffolk schools comparing 1992 GCSE Science pass grades by gender. Figures are percentages.

	GRADE						
	A	B	C	D	E	F	G
Boys	8	11	11	17	20	18	11
Girls	7	11	11	15	19	22	11

Source: LEA records

Table 7.2, which combines the data from the six schools, shows little difference between the boys and the girls across the full range of GCSE pass grades.

The data in Table 7.3, however, show that there are differences between individual schools and that these favour the girls in schools 1 and 6 and the boys in schools 2, 4 and 5. School 3, on the basis of this data shows little difference in achievement between boys and girls.

Table 1.8 illustrated a differential in favour of the boys in physics examinations in mixed schools in 1983. The boys in mixed schools achieved higher grades than those in single-sex schools. The same table also illustrates how girls in single-sex institutions achieved higher grades than boys in corresponding single-sex schools. This would suggest that although the girls were at least as capable as the boys when educated in a single-sex situation, their performance deteriorated when educated with boys.

If the earlier data from Chapter 1 are compared with the author's current data it can be seen that the girls are now improving their overall performance in science by achieving higher grades and noticeably reducing the gender differential.

Table 7.3. Data from six Suffolk schools comparing 1992 GCSE Science grades A-C by gender. Figures are percentages.

	GRADE A		GRADES A-C	
	Boys	Girls	Boys	Girls
SCHOOL 1	3	5	13	20
SCHOOL 2	8	4	47	24
SCHOOL 3	5	0	27	26
SCHOOL 4	13	15	47	40
SCHOOL 5	12	8	25	21
SCHOOL 6	6	2	14	26

Source: LEA records

Table 7.4. Comparison of 1992 and 1993 GCSE pass grades in science, by gender, in the author's school. Figures are percentages.

	GCSE pass grades in science							Total
	A	B	C	D	E	F	G	A - C
1992								
Boys	3	6	4	19	25	26	17	13
Girls	5	7	8	10	19	32	16	20
1993								
Boys	2	11	21	27	19	16	5	34
Girls	14	4	19	13	24	19	7	37

Source: Department records

The comparative data in Table 7.4 illustrate that the girls have shown a great improvement in the percentage of GCSE A-grade passes and although the overall A-C pass grade figures are similar, the girls are still ahead of the boys.

Using the 1992 data to carry out a chi square test (see Appendix 21) gives a value of 8.55 which is less than the critical value of 12.59 at 6 degrees of freedom and does not, therefore, show the gender differences for this cohort to be statistically significant. The 1993 data, however, give a chi square value of 25.9 which exceeds the critical value of 16.81 at the 1% level (6 d.f.). This clearly shows that there has been an improvement from 1992 to 1993 which has resulted in significant differences between the girls' and the boys' GCSE science performance. This indicates that the action research initiatives have been successful in promoting the girls' achievement. In addition, all GCSE students in the school have shown a distinct improvement from 1992 to 1993 which again indicates that the benefits are applicable to all students.

Table 7.5. GCSE Science data.
Figures are percentages.

	GCSE pass grades						
	A	B	C	D	E	F	G
BIOLOGY							
Boys	20	21	20	13	10	10	5
Girls	16	17	17	14	13	14	8
CHEMISTRY							
Boys	16	20	16	18	14	10	4
Girls	14	19	16	18	15	12	5
PHYSICS							
Boys	19	16	29	15	8	9	3
Girls	18	21	26	15	9	8	3

Source: MEG statistics (1991)

This pattern is repeated nationally in the separate science disciplines. The GCSE statistics from the Midland Examining Group (MEG, 1991) and the University of London Examinations and Assessment Council (ULEAC, 1992) are reproduced in Tables 7.5 and 7.6 respectively.

Table 7.6. GCSE Science data.
Figures are percentages.

	GCSE pass grades						
	A	B	C	D	E	F	G
BIOLOGY							
Boys	16	21	24	19	12	5	2
Girls	23	20	23	16	10	5	2
CHEMISTRY							
Boys	19	26	29	16	7	3	1
Girls	18	28	30	12	6	4	1
PHYSICS							
Boys	23	15	27	14	6	3	1
Girls	33	18	24	14	6	3	1

Source: ULEAC statistics (1992)

The Department for Education Statistical Bulletin 15/93 (DFE, 1993) provided an analysis of both GCSE and A-level results for the period 1991/92. It was reported that the percentage of boys and girls being awarded 5 or more GCSEs at grades A-C had increased significantly. The figure for boys had risen to 34.1% whereas the figure for the girls was considerably higher reaching 42.7%. It was noted that 'achievements of girls remained well above those of boys' (p1). The report also observed that 79% of boys and 85% of girls gained at least 5 GCSE across grades A-G. At A/AS level, however, it was noted that 12% of boys compared to 8% of girls achieved scores of 30 or more. This figure tended to disguise the fact that the numbers of A-level passes achieved by the girls had increased although this improvement was not necessarily accompanied by higher grades.

Table 7.7 reproduces part of Table 5 from the DFE bulletin to illustrate student performance in GCSE Sciences during the period 1991/92. From this table it can be seen that the entries and the success rate for boys and girls were remarkably similar in 1991/92, which is a great improvement on the data quoted in Chapter 1. In the physical sciences the situation favours the boys, the girls are slightly ahead in biological sciences. Within the balanced science framework, however, the data are very similar indicating that the girls have succeeded in significantly reducing the gender differential. In a survey of women in post-compulsory education the DFE (1993) also noted that at GCSE girls generally had achieved better results than boys in the period of the survey (1991/92).

Table 7.7 GCSE entry and pass data 1991/92.
Figures are percentages (N=474900).

	GCSE entry		Grades A-C		Grades A-G	
	Boys	Girls	Boys	Girls	Boys	Girls
All Science subjects	85	87	36	37	81	84
Science (single award)	16	19	3	4	14	17
Science (double award)	52	54	23	23	50	52
Biological sciences	9	11	6	7	9	11
Chemistry	11	8	8	5	10	8
Physics	13	6	9	4	12	6

Source: DFE Bulletin 15/93 (1993)

The data in these tables clearly show that the traditional pattern of gender imbalance, with the girls being superior to the boys in biological sciences whilst being under-represented and under-achieving in the physical sciences, has changed.

The changes evidenced within the author's school within a balanced science framework appear to be echoed within the separate sciences as evidenced in Tables 7.5 and 7.6. This is contrary to the prediction earlier in the research programme that the girls would suffer through being forced to study all aspects of science as part of a balanced science course. In addition, this appears to contradict the author's original suggestion that it was purely the assessment framework of the Suffolk Science course which led to the observed improvements.

In order to explain the observations it is necessary look at all the aspects of the research carried out by the author and by others in similar fields, for example, the GIST programme, and attempt to draw these together and search for clues. The author's original concerns regarding the position of girls in science were neither original nor isolated and there will have been many initiatives introduced in schools in order to counter the problem. The promotion of equality of opportunity has challenged the subordinate position of girls and women in society. Teachers have recognised the problems discussed earlier in this thesis and these will have been tackled in schools in various ways. Harris, Nixon and Rudduck (1993) proposed that the girls themselves may have gradually developed various strategies which have enabled them to work and succeed within the constraints imposed by the gender conventions operating within schools.

Teacher training will also have raised these issues with students and this is likely to have affected the way new teachers approach the problem. When legislation was introduced making the wearing of seatbelts compulsory in motor cars it was much easier for learner and new drivers as they did not have to 'unlearn' bad habits. Similarly new teachers who are entering the profession with an awareness of and sympathy for the gender issues in science education will treat the problem in a different way to someone who is trying to change his/her existing practice in order to counter the gender problem.

Careers education will also have had a part to play in the changes observed above. Girls have been encouraged to look far beyond the traditional career patterns by a variety of initiatives, for example, WISE (Women Into Science and Engineering) and introducing positive female role models. In order to step outside the traditional roles girls have had to give more careful thought to their academic career at both Year 9 options and post-16 selection.

A combination of experience, direct observation and discussions with students suggests, however, that the way in which science is taught and assessed will be likely to have the greatest effect on the attainment of girls in secondary education. It is the way in which the science is presented in lessons and the way in which the students' work is assessed which creates the attitudes and motivation necessary to enable students to improve. Consequently, the more detailed research into this area within the school concentrated on the two cohorts to have followed the Suffolk course through to GCSE.

In order to obtain a general view of how the students had perceived their GCSE Science course the author surveyed, during the academic year 1992/1993, the first and second Suffolk cohorts from his school. The first cohort had left school by this time and were surveyed by postal questionnaire (a copy of the questionnaire is included as Appendix 17). The second cohort were in their final year of the course and were surveyed directly by the author. The data obtained from postal questionnaire were used to prepare a series of questions which the students from the second cohort were asked during a science lesson. The 1993 cohort were also allowed the opportunity to make a much more free and individual response through both large group and small group discussions. Transcripts of two of the small group discussions, held during May 1993, are included as Appendix 18.

The vast majority of the boys stated that they felt that they should have worked harder for GCSE (Q6). The girls, on the other hand, showed a roughly equal split between "I worked to the best of my ability" and "I should have worked harder". A similar pattern of response was noted by Harris, Nixon and Rudduck (1993). They also found that the boys were using disruptive behaviour as a means of asserting their masculinity in lessons. It was noted in Chapter 1 how Taber (1992) had observed boys behaving in a disruptive fashion in order to promote interactions with the teacher. Harris et al also commented that the girls appeared to be under less peer-pressure to misbehave and that they also found ways to maintain their own standards of work in most classroom situations. The girls were also more likely to try to improve and to do what the teacher wanted. It was noted, however, that the boys made little effort to overcome their problems.

The boys acknowledge their lack of achievement through the statement "I should have worked harder". The girls, however, appear to use this statement in a way which illustrates their perceived inferiority to the boys. General discussion with students has clearly demonstrated that the students accept certain gender differences as natural. The students often actively perpetuate these perceptions, even when the documentary evidence has clearly illustrated the fact that the girls have been working at least as well as, if not better than, the boys. In general, all the students responded "Yes", they had enjoyed their science course (Q14) although a few (mainly girls) also responded "Very much" or "Not really".

Questions 15 and 16 considered students' performance in end-of-unit tests and process skills respectively. With regard to the end-of-unit tests the boys considered their performance to be average. The girls responses were similar but they did have a slightly higher proportion of responses for "Very well". In the process skills the boys again responded "Average" but a good proportion of the girls responded "Very well". This suggests that the girls responded well to the process skills area of the coursework and felt encouraged by their performance in this area of the course. Other evidence has suggested that the girls do prefer the opportunity to concentrate their efforts in a more individual fashion through personal research and written communication rather than the more threatening classroom question and answer work or the stressful sitting of examinations. Macaire (1993) commented:

> Girls' outstanding GCSE results can, to a certain extent, be attributed to the coursework element, which encourages girls' greater willingness to research and to write at length... (p8)

Those questions which attempted to link student preferences in terms of subject and/or teacher with performance (Q 17, 18, 19, 20) showed greater gender differences. In terms of subject preferences, which were investigated in terms of the units studied, over half of the students responded "No preference". Where any preference was expressed, the boys' preferences were mainly for physics (some chemistry and no biology) and the girls' were for chemistry, with none in favour of physics or, surprisingly, biology. One of the girls' 'no preference' responses did actually qualify it as 'except physics'.

Qualter (1993), researching into student preferences in science topics, observed that topics which related to people and animals were not identified by the boys as being unpopular but proved to be more popular with girls. Abstract areas of science proved to be unpopular with boys and very unpopular with the girls. In general biological topics were much more popular than physics topics for both sexes. In addition, the girls held more negative feelings towards physical science topics than the boys. The boys may be less negative than the girls in this area because they perceive the physical sciences as being important for career requirements. Qualter suggested that students of both sexes simply respond better to those topics which they see as relevant to their interests. If this is the case then, as suggested earlier in this research, we need to be more aware of the nature and formation of the students' interpretations and perceptions of relevance. Qualter questioned the assumption that biological topics were automatically preferred by the girls suggesting that the perception of relevance was more important in their choices.

The response to question 18 indicated that, as was to be expected, the students frequently did enjoy science more with some teachers than others. The response from the girls was, however, more positive in this respect and indicates that this may be a more crucial aspect for them than for boys.

The fact that the girls actually expressed a subject preference for chemistry, rather than the expected response of biology, suggests that the students' preference may be formed more on the basis of who teaches them and how the topic is presented, rather than the actual content. The responses to Question 18 reinforce the hypothesis that the girls are happier, and likely to be more successful, when they feel at ease with the teacher. This recalls the work by Eggleston, Galton and Jones (1975) quoted in Chapter 1 which identified three styles of teaching and then investigated in order to determine the styles with which the girls were most comfortable.

Students, boys and girls, within the research school have indicated that they consider physics to be generally difficult and unsuitable for the girls. When this is coupled with the fact that teachers of physics often tend to display those teaching characteristics identified by the girls as being unpopular this can explain the subject polarisation. The perceived difficulty of physics and the teaching style appear, for the girls, to completely override any interest these girls may have in physics, or any perceptions they may have of its worth or relevance. Kruse (1992) has highlighted various factors which appear to be acting against the best interests of girls in science, especially in physics, observing:

> ...discrimination against girls through the physics curriculum, the materials, the teaching practices of the predominantly male teachers... (p85)

Two thirds of the girls indicated that they felt that their marks were better with some teachers than with others (Q19). The girls also responded that they obtained better marks with the teachers they liked but were roughly equally split as to whether they obtained poorer marks with the teachers they did not like (Q20). The boys answered that their performance was roughly the same with all teachers (Q19) and yet their responses to question 20 disagreed with this suggesting that, like the girls, they obtained better marks with the teachers they liked. The boys also replied, by a substantial majority, that they obtained poorer marks with the teachers they did not like.

These responses appear to give more indication of the students' motivation than their likes and dislikes. It would seem that the boys responded in the first instance that their performance was constant (Q19) with all teachers. However, the deeper questions suggested that they did actually achieve better with the teachers they liked, this is consistent with the girls' responses. The girls, however, indicated in a very positive fashion that their achievements were better with the teachers they liked. It may be assumed that the teacher who creates an environment in which the girls are happy to work is more likely to be successful in raising the levels of performance of all students, particularly the girls.

The situation changes, however, when we look at the responses to the question regarding performance with unpopular teachers (Q20, part 2). The girls' response suggests that they are more conscientious with their work, although some do not manage to match the levels of performance they obtained with teachers they liked. The boys, however, appear to unilaterally reduce their expectations and efforts with teachers they do not like as almost all the boys indicated that in this situation they obtained poorer marks.

Experience has shown that boys and girls do differ quite considerably in their classroom behaviour and performance with teachers they either do not like or can not build up satisfactory relationships with. In general the boys' response tends to take the form of negative behaviour and a low work ethos resulting in sharp fluctuations in levels of attainment with a rapid downward trend. The girls, however, tend to respond in one of two ways. Some adopt a resigned approach in these situations, often becoming uncommunicative and displaying a gradual drop in standards. Others adopt negative behaviour patterns similar to the boys, although not generally as openly confrontational, but with an identical sharp drop in standards.

With girl students from the upper ability band there also appears to be an added factor built into these responses, the students become frustrated in both the lack of adequate opportunity for them to make progress and in their lack of progress. They then appear, both individually and collectively, to accuse the teacher of failing to meet their academic needs and feelings of resentment towards the teacher begin to build. This accusation tends not to take the form of direct confrontation and argument but appears more as 'switching off'. If the students have no other teachers in the department to turn to for assistance, this will tend to be the point at which they are lost. A modular system, where students are taught by different teachers during the course has been identified in both interviews and discussions as being of particular relevance and benefit when this situation arises.

In summarising these issues in the surveys the general response from both boys and girls was "Yes, the assessments were affected by the teacher"

(Q27). All students responded strongly and affirmatively when asked if they thought the nature of the science assessments helped them to achieve a higher GCSE grade (Q25).

A series of informal small group discussions were held with Year 11 students which allowed some of these hypotheses to be explored in more detail. The groups were generally pairs and based on samples of convenience. Transcripts of two of the paired student discussions are included as Appendix 18 and it is from these students (from the most able science group) that any quotes used in the following discussion were taken.

In relation to the questions regarding subject preferences girl H (a girl in the first discussion pair) commented "...I find physics more difficult than biology but at least it's not easy all the time" (line 58), reflecting the earlier comments. All students involved in the discussions, like girl J and girl H, said that they liked a mixture of biology, chemistry and physics units. Not many students were as honest as girl K and girl D in the second discussion who admitted that there were no units they had really enjoyed. All four students could, however, readily identify the units they didn't like.

When the relative importance of the teacher was investigated the students were much more forthcoming and were, as can be seen from the transcripts, often highly critical of the teachers and teaching. It was noted by the author that the larger the size of the discussion group, the greater the reluctance of the students to commit themselves in this area of the discussion. The students involved in the discussions did seem to appreciate the benefits of the rotation of the teaching groups, "... what happens if you get a teacher that you just don't like, you just end up completely ruining everything...whereas if you get teachers that you like and teachers you don't like you see what you can do and how it affects you" (girl H, discussion transcript 1, line 69).

It was noted that the students did appear to feel that a particular teacher could seriously affect their attainment "...if you get a teacher that you just don't like, you just end up completely ruining everything" (girl H, transcript 1, line 65) and "You don't do any writing with [A] so you can't revise for the tests..." (girl J, transcript 1, line 77)."If you draw the short straw and get somebody who's boring then it's good to be able to change..." (girl K, transcript 2, line 102), "I've got [E] now and [E] does...biology and chemistry but [E] doesn't know anything about physics so it's better that way. [E's]...a specialist." (girl D, transcript 2, line 105).

It has been noted that the students quoted above were from the upper ability sets in the school. Other students involved in the discussions made similar comments. The higher sets made a definite connection in their conversation between the individual teacher and their own performance in the units taught by that teacher. Students in the lower sets generally confined their discussion to their treatment by the teacher and whether they found the lessons boring. These students did not generally equate these comments with their own performance or behaviour in science lessons.
It was very rare that the individual science subject was related to low achievement. Where connections were made these were generally of the form "I find physics more difficult..." (girl H, transcript 1, line 58). Any comments which were more specific related to individual units, for example, "Microelectronics, I hate that" (girl J, transcript 1, line 190), "That structures [unit] was (sic) stupid" (girl D, transcript 2, line 83).

The data from MEG and ULEAC (tables 7.5 and 7.6) are clear examples of the improvement in the performance of girls at GCSE level, which is taking place nationally. When this is transferred back to this research project, it is apparent that the improvements which the author has witnessed are unlikely to be solely attributable to the Suffolk Science course. Some credit must be given to Suffolk in terms of teacher motivation. The new course had been unanimously selected by the department and everyone put their best efforts into ensuring that the launch was successful. This type of enthusiasm is infectious and must have been transmitted to the students.

The assessment scheme in the Suffolk course proved to be attractive to both the staff and students and there is no doubt that this has contributed in no small way to the students' success. However, the Suffolk assessment framework was simply one way of delivering the requirements for GCSE coursework. Much of the improvement in other GCSE subjects can also be attributed to the assessment of coursework. The role of coursework in GCSE will be discussed in more detail in Chapter 8.

In the case of the Suffolk Science course the assessment framework was based on 100% coursework with no terminal examination. This has an obvious attraction for those students who are well-motivated. If they are prepared to maintain a reasonable workload throughout the GCSE course then they are likely to benefit much more from this approach. It has been noted earlier in this programme, and by other researchers, how girls tend to be better motivated than the boys and are usually more prepared to maintain a consistent level of performance throughout the GCSE course . This research has evidenced how this system of assessment appears to have reinforced hard work and progress enabling the girls to outperform the boys in many areas of the science curriculum.

CHAPTER EIGHT

The role of coursework in GCSE

This chapter provides an overview of the changing emphasis on coursework within GCSE assessment and in so doing provides the link between the second and third phases of the research. The role of the various government agencies in reducing this emphasis is critically reviewed and the possible consequences of this reduction for students in GCSE science are discussed. The author also discusses how his department responded in order to meet the changing demands of the Key Stage 4 science assessment.

Coursework is clearly a major element within the GCSE assessment framework. It is difficult to consider the role of coursework, however, without first having defined the term. For the purposes of this research, coursework has been considered as that part of the GCSE course which is not assessed by a terminal examination, but does include end-of-unit tests in modular courses. This means that the Suffolk science scheme, in its original form, (i.e. up to July, 1993) was assessed entirely by coursework.

Scott (1991) discussed the role of coursework referring to the Beloe Report (1960) which had suggested that there was a place for teacher assessment within the existing public examination system. He recalled how, initially, the GCSE was designed to provide a more productive integration of systems of coursework assessment and the more formal methods of examination. He noted that many important student skills were unable to be accurately assessed by a formal terminal examination and suggested that an element of teacher assessment would increase the validity of the more rigid assessment frameworks.

During his research Scott (1991) had observed that GCSE coursework practice differed quite noticeably and in a variety of ways which resulted in a range of effects. This observation was supported, as discussed later in this chapter, by reports from HMI. Scott noted four main areas into which these differences could be grouped. These were; between individual LEAs in terms of both input and support; between schools, which frequently led them to adopt policies which had an effect on classroom practice; between departments within a school, which appeared to result in the creation of specific teaching strategies and marking procedures and finally between teachers who interpreted the coursework procedures to meet or suit their own practice and preferences.

The Schools Examinations and Assessment Council (SEAC), formerly the Secondary Examinations Council (SEC), held a conference in May 1990 to discuss coursework assessment. An account of the proceedings, subtitled 'Creating and making best use of opportunities' was published in March, 1991. The introduction noted that coursework assessment had originally been introduced in order to complement terminal examinations. The account further highlighted issues which had originally arisen as a result of the introduction of GCSE. One concern expressed at the time was the lack of balance in the demands of the coursework assessments within different syllabuses. The SEC had set out to review good practice in this area.

The review followed a publication (Working Paper Number 6, July 1988) which considered basic principles of coursework management and gave examples of observed management and planning devices. Examining groups also reviewed the coursework demands of their syllabuses. They attempted to identify areas where coursework in related subjects (for example, in the sciences) could be linked in terms of skills and criteria to make the exercise more effective. SEC also looked into developing methods of using coursework to promote inter-disciplinary approaches in the recognition of students' achievement. This review and feedback progressed so much that by 1990 coursework management had become based within school departments, the assessments becoming integrated into teaching schedules enabling teachers and students to view the coursework assessments as a normal and useful aspect of teaching. In science, for example, it made sense to assess students while they were engaged in various aspects of practical investigations. The results of the assessments would then provide a starting point for discussions with the students in relation to their progress and attainment.

SEAC was originally established under the terms of the Education Reform Act (1988) in order to review school examinations and assessment, subsequently advising the government and carrying out programmes of research and development where necessary. With the introduction of the National Curriculum, the government, through SEAC, stated that GCSE should provide the basis for assessing Key Stage 4. Furthermore, <u>all</u> GCSE syllabuses were to contain a balanced proportion of coursework and terminal examinations. The general and subject-specific GCSE criteria for English, mathematics and science set out the coursework/examination balance and proposed guidelines for curriculum development.

The SEAC conference report, published in March 1991, had considered good practice in GCSE coursework, support for teachers and students involved in coursework, the demands and management of coursework and coursework monitoring. The conference had seen coursework in a positive light, recognising its benefits for students and teachers. However, within 6 months, the Secretary of State for Education, Kenneth Clarke, announced in DES press release 393/91 (20.11.91) that the role of coursework in GCSE was to be substantially reduced and be replaced by terminal examinations. He suggested that '...if the credibility of GCSE is to be maintained the proportion of marks allowed for coursework should be limited' (p1). The release suggested that '...coursework assessment may not give a true and honest indication of a pupil's ability' (p2). Both SEAC and HMI were said to have observed coursework assessments which were inconsistent in terms of level of task, marking and moderation and which provided opportunities for cheating to take place. In support of these statements the Secretary of State referred to 'The Introduction of the GCSE in Schools 1986-88' (HMI, 1988) and 'Examining GCSE; First General Scrutiny Report' (SEAC, 1990). The release set a new limit for science coursework of 30%, quoting the existing limits as 20 - 30%. According to this author's earlier definition of coursework the Suffolk scheme was obviously well outside the SEAC recommendations.

In press release 429/91 (13.12.91), Kenneth Clarke announced that terminal examinations would be extended to play a greater part in modular GCSE courses. SEAC had recommended (21.11.91) that at least 50% of the marks in modular syllabuses be assigned to terminal examinations having balanced the recommendations of the teaching profession against their own and HMI's opinions. Clarke resolved this issue by accepting the benefits of a modular approach in formative assessment but not in final assessment (12.12.91). He amended SEAC's proposal stating that for modular courses in mathematics and science which were to start the following September (1992), at least 50% of the final assessment would have to come from terminal examinations.

In press release 1/92 (3.1.92) the new Secretary of State for Education, John Patten, was reported as saying that coursework limits were being reduced because too much coursework was undermining the value of GCSE to employers. He stated that courses based on 100% coursework would not be allowed to continue and indicated that in future the coursework content of GCSE syllabuses would be dictated nationally and not by individual examining groups. The coursework limits were confirmed by the Education Minister Baroness Blatch in May (press release 139/92, 7.5.92), applying to English, mathematics and science with effect from September 1992 and to all other National Curriculum subjects as they became operational within Key Stage 4. She remarked 'It is very difficult to mark grades fairly if there is too much coursework' (p1).

Press release 299/92 (1.9.92), which followed a report made to the Secretary of State by HMI in August 1991, indicated that urgent action was necessary in order to maintain standards in GCSE. Patten suggested that there may be problems with the examining groups but that these should not detract from students' and teachers' efforts. He also stated that urgent action was necessary in order to maintain public confidence in GCSE. He went on to say that HMI had identified poor practice in some examining procedures and suggested that matters for concern were the erosion of standards, uneven quality of examination papers, insufficient objectivity and consistency in award criteria, insufficient emphasis on spelling, punctuation and grammar and insufficient supervision of coursework tasks.

HMI in 'GCSE Examinations Quality and Standards' (DFE, Summer 1992), reported specifically on the following areas of GCSE: question papers,mark schemes and marking; coursework assessment and moderation and the award of grades although some consideration was also given to spelling, punctuation and grammar. The report was produced as a result of HMI attending a range of GCSE-related meetings within all four examining groups. The main findings have been taken directly from the report and are reproduced as Figure 8.1.

In relation to coursework, the report noted a 'significant improvement' (p5) in GCSE coursework noting that syllabus guidelines were clear ranging from minimum advice to quoting examples of good coursework material. Examining Group training sessions were praised and moderators' feedback to schools was recognised as being particularly valuable, although

Figure 8.1. The main findings of the HMI report 'GCSE Examinations Quality and Standards'. Summer 1992, (p2).

1. HMI have limited confidence that standards are being maintained; confidence would be more secure if the criteria for awarding were more objective and the procedures used across groups were more consistently rigorous;
2. grading is least satisfactory where little use is made of scripts from previous years, where the views of experienced examiners are marginalised, or where there is too little consideration of year-to-year and syllabus-by-syllabus statistical comparisons;
3.the assessment of spelling, punctuation and grammar was inconsistent and this had an adverse effect on the validity of grade awarding;
4. the range and quality of the guidance provided by the examining groups to support teacher assessment of coursework are generally good;
5. minor adjustments to teachers' marks are usually sufficient to ensure reasonable consistency of coursework marking, except for a small minority of departments whose marking and/or administrative procedures are unacceptably poor;
6. the need to adjust teachers' marks would be reduced if the examining groups vetted coursework tasks more thoroughly;
7. the quality of examination papers is uneven, with the lack of suitable challenge for the more able remaining a particular concern;
8. safeguards to eliminate unreliable questions are usually, though not universally, effective;
9. mark schemes are normally rigorous and have enough detail to secure a reasonable measure of consistency in marking standards.

it was suggested that variations among moderators' standards, and the reasons for the differences were not always identified. It was suggested that those schools where the coursework was inadequate needed more specific guidance to remedy this. The need for internal moderation of coursework within departments was also stressed. Other criticisms highlighted departments where the necessary administrative procedures had been ignored, for example, coursework had been set or marked without reference to syllabus criteria and marking which had not been moderated internally and, therefore, lacked consistency. Such practices made large demands on moderators' time reducing the efficiency with which moderators could operate.

The report concluded that, with respect to coursework, the observed improvements should be used as a basis for further progress. It was suggested that this could be achieved through improving consistency between moderators and their feedback to schools. HMI also suggested that it should be possible for Examination Groups to penalise schools which operated in this fashion and detracted from the general effectiveness of GCSE.

This report appears to have been used as the stimulus to enable the Education Secretary to introduce a mandatory code of practice for GCSE examinations. In September 1992 he asked SEAC to provide him with their opinions of the HMI report and subsequent proposals for GCSE reform to take effect in 1993 and 1994. The code of practice suggested by SEAC in their report (GCSE Examinations: Quality and Standards, 1992) was based on the HMI report, the response made by the Joint Council of the GCSE to the HMI report and scrutiny of GCSE examinations carried out by SEAC itself. It was suggested that the report should cover the following six points:

> a) standardisation of marking, so that all examiners mark to agreed schemes;
> b) setting of question papers and mark schemes;
> c) coursework assessment and moderation;
> d) arrangements for modular testing;
> e) setting of grade standards and boundaries;
> f) assessment of spelling, punctuation and grammar. (p6)

It was also stressed that 'archival material, statistical information and grade descriptions are employed where appropriate' (p6) in each of the six areas of the Code of Practice. The acceptance of this advice by John Patten was made public in press release 345/92 (20.10.92).

The SEAC document followed the format of the HMI report, referring to the same aspects of GCSE. In the section on coursework, it referred to those aspects which the HMI report had highlighted as displaying good practice and concurred with these statements in general terms. The advice, however, concluded that the HMI suggestions for coursework development and control were inadequate if the assessment and moderation of GCSE coursework were 'to command full confidence' (p26). According to the document, further improvements were required by the new criteria in relation to setting and assessing coursework tasks. The role of the examining groups was seen as facilitating and regulating these procedures. SEAC suggested that much firmer control was needed in both the management and moderation of GCSE coursework. Where HMI had simply encouraged examining groups to take a firmer role, SEAC proposed the introduction of formal arrangements which should be invoked wherever the school was felt to be inadequate in these two functions.

Where the SEAC report used evidence from their own scrutiny of GCSE, this too was broken down into the same areas. The comments from the 1991 programme in relation to coursework identified the need for significant input from the examining groups in the form of (a) more effective systems of moderation; (b) better guidance on coursework to schools either through better advice on tasks or firmer criteria for assessment and (c) more informative feedback on moderation procedures to schools. The schools themselves were required to provide more detailed and systematic evidence on how assessment marks were awarded and instituting more rigorous standardisation procedures. The 1992 scrutiny programme noted ineffective coordination of moderators through problems of time and/or materials; mark schemes which were too vague or too rigid or which disadvantaged candidates; inadequate in-school standardisation and teacher training and one example of a coordination meeting where the discussion of the standards was considered to be inadequate. The SEAC scrutineers attended over 230 examination meetings during the 1991/1992 period quoted in the report and were involved in 'a large number' of discussions with chief examiners and board personnel. The areas of concern discussed above were indicated by number in the report and totalled 41, it was not made clear whether these were 41 separate instances of concern or whether certain examinations were prone to many problems. No judgemental comments were given in the report so it was not clear whether these occurrences gave great cause for concern or were simply observed and noted.

Press release 345/92 (20.10.92) announced that the Education Secretary had accepted the SEAC advice and was to introduce a mandatory code of practice in time for the 1993 examinations. It was stated that OFSTED (the Office for Standards in Education which replaced HMI in September 1992), would have a role to play in observing and reporting on the conduct of GCSE examinations. The SEAC report suggested that the code of practice was necessary in order to maintain public confidence in GCSE. It was suggested that the code should cover setting question papers and mark schemes, standardisation of marking, setting of grade criteria and boundaries, coursework assessment, modular testing and the assessment of spelling, punctuation and grammar. John Patten asked SEAC to prepare the code and ensure that it was in place by the end of the year, he informed the Examining Groups that his approval for GCSE would depend upon their compliance with this code and that they should cooperate with SEAC and OFSTED allowing them access to all stages of the GCSE process.

SEAC proposed that it should take responsibility for appointing assessors who would have unrestricted access to GCSE examining processes, in order to provide an external guarantee of quality, consistency and comparability across Examining Groups. It was also strongly suggested that the groups should introduce common practice for the responsibilities of their key personnel and that these responsibilities should be subject to SEAC approval. SEAC further proposed that groups be allowed to continue syllabuses only if the scrutiny recommendations were implemented. A review of the GCSE Examining Groups was also required by SEAC prior to the 1994 examinations which would not only look at the processes and procedures for examining GCSE but also the structure, funding, governing and so on of the groups, these findings would then be used for comparative purposes. The role of the Joint Council for the GCE was also to be reviewed in detail. The Education Secretary responded to these suggestions by encouraging SEAC (in a letter dated 20.10.92) to consider the implications and funding for appointing and introducing external assessors, he suggested that the Joint Council and the Examining Groups may wish to respond to the other suggestions and he would reserve judgement until these responses had been made.

Lord Griffiths, the Chairman of SEAC outlined a three-point plan to ensure quality in GCSE at the annual conference of the Girls' School Association (GSA, 12.10.92) stating that 'GCSE is a good examination that can be made world class' (SEAC Press Notice 92/6). The plan condensed all the previous discussion points into the following;

1. standards would be maintained through a mandatory code of practice,
2. the system would be supervised by external assessors appointed by SEAC,
3. action would be taken immediately to help schools where the GCSE procedure was perceived to be inadequate.

He reminded the GSA how SEAC advice to the government regarding GCSE had led, in 1991 and 1992, to the introduction of a tougher upper target (i.e. level 10), differentiation by task in examinations, new coursework limits, terminal examinations, an allocation of marks for spelling, punctuation and grammar, new quality regulations and had streamlined the supervision and feedback cycle for examination boards. He discussed these points and those outlined in the mandatory code of practice.

The chairman described how SEAC had advised the government to reduce the coursework limits in GCSE subjects. He did concede, however, that GCSE coursework was useful in that it could assess abilities which could be neither easily nor adequately tested by conventional terminal examinations. He conceded that the assessment of coursework enabled the review of a greater body of the students' work and one which could cover the full programme of study. In addition coursework had enabled many students to experience success throughout the course and could, therefore, act as a powerful motivational tool. He also commented that the use of coursework was an effective way of helping to alleviate the stress which could be created by the terminal examinations.

He also discussed some of the problems associated with coursework, for example, the difficulty of ensuring originality if the work is completed out of school and the time spent on such in-depth work reducing the time available for broader subject coverage. He stated, however, that the main problem, as far as SEAC was concerned was the difficulty of achieving standardisation particularly due to the number of variables involved, such as, task-setting, marking and moderation both within and between schools.

Scott (1991) had also identified some of the variables which could affect coursework quality and provision. He suggested that the timing of the coursework tasks within the GCSE course had an effect on the outcomes of the work but counselled that students did not necessarily produce their best work later in the course. Teacher and parental interventions can radically affect a students' motivation and the level of his/her performance. Scott was of the opinion that these interventions needed careful monitoring and that the nature of the interventions combined with the location in which the bulk of the work was completed to raise issues relating to security and originality. Scott highlighted how the nature of the task would also affect the outcome as students reacted differently according to whether the investigations were open or closed-ended and summative or formative. If the task is too closely tied in to the teaching programme Scott was of the opinion that the work became indistinguishable from normal classroom practice thus losing some of the motivational gains provided by successfully managed coursework.

Lord Griffiths' comments indicated that SEAC could not adequately fulfil its main function of maintaining consistency of standards. This difficulty appeared to be due in part to the extended use of coursework in GCSE and also to the wide variations in coursework provision as discussed earlier. SEAC had, therefore, proposed the reduction in the emphasis on the use of coursework as a method of GCSE assessment. This appeared to be contrary to the advice given by HMI, who had recognised and stated the value to students of coursework, from the chairman's earlier comments this had been clearly understood and acknowledged by SEAC. SEAC also suggested that the assessment of coursework lacked rigour and proposed more rigid control of coursework. The chairman stated that, in future, the examining boards must regulate coursework procedures more tightly by controlling four areas of the GCSE process more rigidly. He stated that the boards should set (or approve) the coursework tasks and also set criteria to be used by teachers (for marking) and moderators (for checking). The boards were also to determine the conditions under which the assessments were to take place and require teachers to supervise these assessments.

During the course of this research programme there have been both internal and external pressures on the science curriculum. The internal pressures have been fuelled by the need to improve the science for all students in the author's school and the desire to improve the attainment of the girls in science. The external pressures have also been in two distinct areas. The first of these has been the government's repeated tinkering with the structure and format of the National Curriculum for science, the second has been the drastic reduction of the coursework element of GCSE assessment.

The Suffolk science course relied heavily upon the formative scheme of assessment which was itself rooted in the coursework component of the course. This component has been eroded by the repeated changes imposed through SEAC. The Suffolk scheme was perceived by its supporters as being efficient for the teachers and both motivating and stimulating for the students. Consequently, when the various coursework initiatives were introduced by SEAC there was an attempt to absorb them within the existing Suffolk scheme in an effort to retain as much of the original flavour as possible.

The time scale within which the changes were delivered to schools certainly made this 'damage limitation' approach preferable. In addition the changes imposed on GCSE syllabuses were made in a series of small, but significant, steps. These have, according to discussions held at LEA meetings for Heads of Science, considerably damaged science teachers' morale. GCSE structure and assessment was subject to drastic changes (as outlined below), in a short space of time, which had to take effect immediately thus affecting the assessment scheme for students who were already following the GCSE course.

These changes were intended to reduce the emphasis on coursework and move towards terminal examinations to provide the greater part of GCSE assessment. These changes were delivered in two stages, this may have been to lessen the blow to schools and if not promote teacher compliance, at least reduce opposition. It appears, however, that as a result of the first administrative change the resulting assessment procedure was seen to be difficult to administer and supervise.

The first change was to replace the Year 11 module tests with a terminal examination, the process-skills assessment based on Sc 1 was to be retained as was the end-of-module testing for Year 10. The Year 10 module tests were then to be subjected to a Standing Agreement (approved by SEAC) which regulated the scheduling and marking of the tests. These regulations, however, were seen to be in conflict with the aims of modular assessment. Consequently the Year 10 module tests were replaced, shortly after the cohort had commenced the course, with an end-of-year (Year 10) examination. The letters outlining and explaining these changes are reproduced in full in Appendix 19. Both of these changes became effective immediately necessitating considerable and urgent course revision for the cohort to be examined in summer 1994.

These changes, as far as the Suffolk science course was concerned, completely altered the nature of the assessment scheme, reducing the effect of those aspects of the course which we had found so attractive. This resulted in, as far as the author's department was concerned, the creation of an altogether different course. The new Suffolk scheme was seen as a hybrid which aimed for, but missed, both the attractions of the old scheme and the requirements of the National Curriculum. The Sc 1 process-skills assessment, for example, contained an extra strand (communication) so that whereas National Curriculum required students to be assessed in three strands of competency in practical investigations, the Suffolk course required four. It is ironic that a course selected on the basis of its user-friendliness has, due to government intervention, become a less attractive proposition as it now places an extra burden (in the form of an additional assessment) on its students.

My department reluctantly decided, therefore, to change its GCSE science provision. The Suffolk course has been replaced (September 1993) with the MEG GCSE Science course for all students (Year 10 and 11). This course offers both Single and Double certification and permits, for the lower National Curriculum levels, modular testing in conjunction with the terminal examination. The skills the department has developed during the lifespan of the Suffolk course, and which have been highlighted by this research will transfer to the new course. The department is, however, of the opinion that assessment with such a large emphasis on a terminal examination is not the most suitable for many of our students. It is anticipated that the progress seen in science in the school in recent years will be eroded and that this effect will be most noticeable in the GCSE science results for 1994.

The Code of Practice for GCSE has necessitated further changes in the assessment procedure. In the original Suffolk scheme students had been required to provide evidence only for the individual process skill in which they were being assessed. The assessment criteria have also been repeatedly changed. The first change required students to provide evidence of all skills (or strands) irrespective of which one was actually being assessed. This too was short-lived and students work for Sc 1 must now be in the context of a 'whole investigation' with the students' written work being assessed, and levels awarded, in each of the three strands. The levels recorded for the final GCSE assessment, however, need not be taken from the same investigation. This has rapidly proved to be very time-consuming to operate and difficult for many of the students to achieve and is consequently causing problems for teachers and students.

The National Curriculum level statements for Sc1 have been severely criticised. They are non-sequential and do not enable students to demonstrate progression through the levels of attainment. In addition, some level statements in different strands require the same written evidence from the students but demand repetition in order that the level be awarded. Access to higher levels in the strands is also proving to be extremely difficult even for the more able students. Standardisation meetings within the author's school are finding that levels 4 - 6 are the norm for students in Key Stage 4, which is intended to cover levels 7 - 10.

Appendix 20 reproduces extracts from a letter which illustrates how the meaning of the level statements for Sc1 and the way in which they are awarded are open to widely differing interpretations. This letter was sent to the Oxford and Cambridge Schools Examination Board and expresses dissatisfaction with the differences between the levels awarded by the Regional Moderator and the teachers involved in the Suffolk cluster meeting. The letter also highlights how the moderator has made level assessments based upon National Curriculum Statements of Attainment rather than the Operational Performance Indicators provided by the Suffolk framework and used by the teachers at the cluster meetings.

CHAPTER NINE

The effect of the reduction of coursework in GCSE Science assessment

This chapter provides the final quantitative data of the research programme. The GCSE science results of the first cohort to be examined under the amended coursework regulations are presented and compared with those of previous cohorts which were examined under the Suffolk scheme. The author uses these comparisons to investigate the current differences in attainment between the girls and the boys in GCSE science.

Since the introduction of the Suffolk Coordinated Science scheme in the author's school in 1989 there has been a consistent improvement by all students in GCSE science and the improvement has been particularly noticeable on the part of the girls. The overall GCSE entry has increased and the students' levels of attainment in GCSE have shown a distinct improvement. In addition, the usual gender pattern of boys' superiority in the physical sciences has been reduced to a marked extent with the second cohort. The small-scale interventions described elsewhere in this thesis can thus be seen to have been effective at local level. These improvements have also been reflected to a lesser extent at national level and this suggests that they may have occurred as a result of some large -scale initiatives, for example, the widespread use of coursework in GCSE assessment and attempts to promote the status of girls in science subjects.

The positive aspects of coursework in promoting student achievement at GCSE level has been discussed by Scott (1991), Bousted (1992), Bland (1993) and others. GCSE courses which use coursework assessment to a large extent in order to decide the final grade are, however, open to criticism if the assessment methods are not seen to be suitably rigorous. In addition there must be a system which enables them to be moderated against other courses and assessments. The Suffolk science course, in its initial format, was assessed entirely by coursework and this gave ample opportunity for questions to be asked regarding rigour, fairness and so on.

It was relatively easy, under the initial Suffolk testing framework, for teachers to use the system in order to provide an unfair advantage for their students. The test papers for the entire year for all units and all levels were sent to the schools early in the academic year and it was then the responsibility of the individual science departments to provide the necessary security. The same tests were used throughout the year, for example, all students taking the merit level test for the 'Metals' unit sat the same test irrespective of when the test was taken. Obviously this gives an opportunity for students to collude to a greater or lesser extent. Dobson (1987) had suggested that this need not be a problem as students are made aware at the end of each unit exactly what they will have to know in order to pass a particular level. This forms the basis for the students' choice of level.

He states that 'As the *content* element of each test is openly known from the published criteria, traditional exam secrecy to avoid question-spotting is no longer relevant' (Dobson,1987, p58).

However, as the tests are used repeatedly throughout the year they are no longer secret to the teachers. As Dobson points out, the level criteria set out quite clearly what the students should know and should be able to do in order to achieve success at a particular level. However, the fact that the contexts used in the tests are new does not always hold true as there may be a problem which teachers may not recognise or acknowledge because they may not be aware that it exists. This is the unconscious assimilation of some of the novel contexts from the tests by the teachers. Having taught a unit, tested the students and marked the tests for perhaps three sessions during a year it is quite probable that a new, interesting context for a question may unintentionally become part of the teachers' teaching plans.

We are always searching for appropriate, relevant or more interesting examples of science in order to maintain students' interest and motivation. These are continually being acquired from the world around us, through reading, the media, direct observation and so on. The tests may become just another source and we may inadvertently draw upon these contexts, particularly when our minds are searching for an alternative approach to clarify a point during lessons.

The only way in which the Examining Board can get around this problem is by having different tests for each session. This, however, then creates a logistical problem which is much more difficult to solve. If different tests are to be offered for each unit for each test session then the question bank must be impossibly large. The only solution is the one which was actually taken by the Examining Boards, as described in Chapter 8, which was to set specific dates for the module tests and to incorporate an element of terminal testing into the assessment programme.

It can also be difficult to achieve and maintain standardisation of marking of the tests between a large number of teachers. A marking scheme for each Suffolk end-of-unit test was provided by the Examining Board. Any alternative answers or interpretations were to be discussed at cluster meetings and then taken back to moderators meetings in order that any changes could be disseminated. Teachers' marking was also to be scrutinised by the moderator, this being achieved by individual teachers taking marked scripts to cluster meetings. In addition moderators could ask to see marked scripts during their visits to individual schools when security and so on were also investigated.

The GCSE science course currently used by the author's department offers a modular scheme of assessment leading to either single or double certification but with only a limited (levels 4-7) GCSE grade available. The module tests must be taken by the students on certain specified dates throughout the year. In addition, the module tests are externally set and marked in order that the requisite rigour can be maintained and we can be confident that the tests reflect the students' honest endeavour. Once again we may draw upon contexts introduced in test questions to use in our normal teaching but as the tests are externally set we have no way of knowing if these contexts will appear in subsequent end-of-module tests.

The criticisms regarding rigour and standardisation are also applicable to the assessment of process-skills in Suffolk science. Teachers were required to take samples of students' work to cluster meetings in order that assessment standards could be moderated. The criteria for the selection of samples were that a teacher should take three samples of work, preferably one from each level. These were then re-marked and the resulting assessments discussed, the teacher then being expected to cascade the findings to his or her own department in order that any necessary action or amendments could be made by the entire department.

A frequent problem which was encountered when assessing the students' work in this area was the interpretation and application of the criteria statements. The moderator was expected to take any insoluble problems to moderators' meetings for clarification. However, the system worked reasonably well and although needing some refinement, contributed in no small way to the improved attainment and motivation of the students, particularly the girls. As discussed in Chapter 8 it was this part of GCSE assessment which bore the brunt of the government's sweeping changes. It appears that a perceived lack of rigour within GCSE assessment was reported by HMI (1992) and this was then interpreted by the government as implying that the coursework assessment component was too large and did not lead to an accurate representation of the students' true ability. Consequently an appropriate, effective and useful assessment tool was severely reduced and the emphasis shifted to terminal examinations.

Had the role of the Examining Boards in coursework assessment been revised and strengthened, as was the case with the testing arrangements, then the coursework assessment frameworks could have remained intact. HMI (1992) had also remarked how coursework standards were improving and had suggested ways in which the Examining Boards could incorporate this progress with changes in assessment methods, criteria and the like in order to make the coursework assessment more rigorous. Unfortunately the recommendations were largely ignored by the Secretary of State for Education who instructed SEAC to proceed with a complete revision of GCSE testing and assessment.

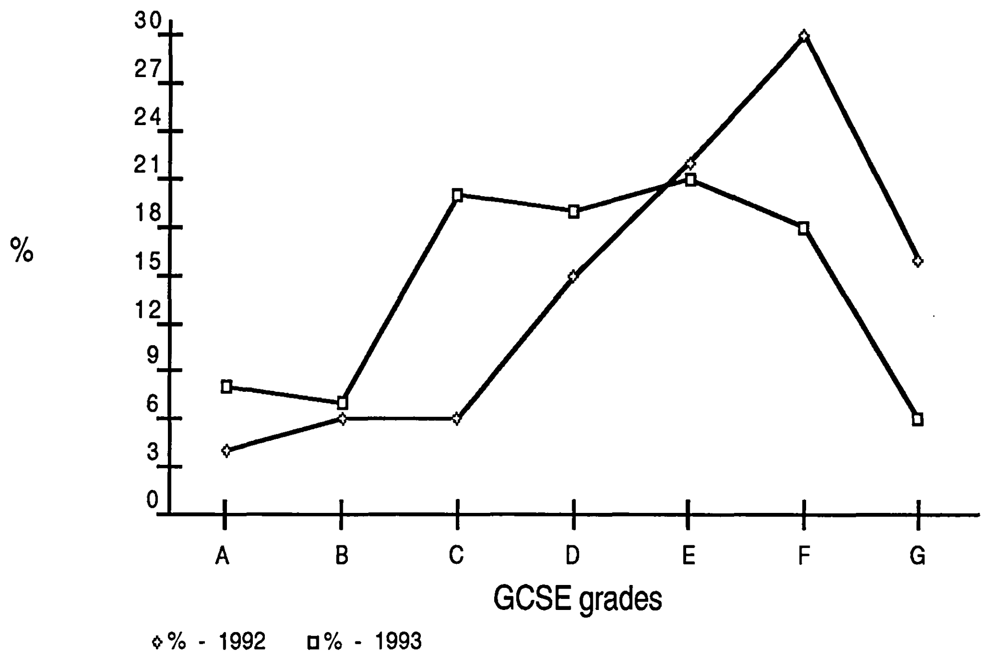
Table 9.1 Comparison of Suffolk GCSE pass grades in the two consecutive Suffolk cohorts. Figures are percentages.

	GCSE Pass Grades						
	A	B	C	D	E	F	G
1992 cohort	4	6	6	15	22	29	16
1993 cohort	8	7	20	19	21	18	6

Source: Department records

The GCSE performance in the research school improved, as noted above, from the first Suffolk cohort to the second. The grades are shown as percentages in Table 9.1. Figure 9.2 illustrates this improvement schematically using the GCSE grade data from Table 9.1.

Figure 9.2 Comparison of GCSE data from the two Suffolk science cohorts (1992 and 1993).



Source: Department records

Before these data are compared with those for the 1994 cohort it is necessary to consider the effect of the government interventions on the department in question. As described in Chapter 2 the schools catchment is skewed towards the less able and the achievements observed under the Suffolk scheme were very welcome. Both staff and students were pleased with their efforts and levels of motivation were high and increasing. When the department came to the unwelcome decision that they could no longer continue with the Suffolk scheme, for the reasons described in Chapter 8, there was immediate concern for the cohort who were mid-course.

It was necessary to take urgent steps to attempt to maintain the students' interest and motivation and to reassure them that they would not be penalised by the changeover. However, the subsequent changes in GCSE assessment and testing imposed by the government, through SEAC, made one crucial difference to this cohort.

When we changed syllabuses it was too late for any students to participate in the modular scheme of assessment and so, for this cohort, they were all to be certificated entirely by the terminal examination in conjunction with the 25% coursework component. The syllabus incorporates differentiation by offering three levels of entry, as does the Suffolk scheme. These tiers are designated basic, central and further and are related to National Curriculum attainment levels by MEG as shown in Table 9.3.

Table 9.3 Relationship between tiers and National Curriculum levels for GCSE science.

ENTRY TIER	LEVELS TARGETED	LEVELS AVAILABLE
Basic	4, 5, 6	3, 4, 5, 6, (7)
Central	7, 8	5, 6, 7, 8, (9)
Further	9, 10	7, 8, 9, 10

Source: MEG syllabus 1770/1771

Although specific levels are targeted, the data in Table 9.3 also show that additional levels can be awarded at each tier. The syllabus regulations indicated that the two higher levels available (level 7 for the basic tier and level 9 for the central tier) would only be awarded in exceptional circumstances. Table 9.4 indicates how these levels relate to the GCSE grades awarded.

Table 9.4 Relationship between GCSE science grade and National Curriculum level.

GCSE Grade	A	B	C D E	F	G
NC level	10 9	8	7 6	5	4

Source: MEG syllabus 1770/1771

Using the Suffolk software, deciding entry levels had been a relatively straightforward affair. Reading the computer records enabled the levels to be selected on the basis of previous performance, the nature of the unit and the students' points total. Students could safely be encouraged to aim high as the marking of the end-of-unit tests had an inbuilt safety net which allowed the award of a pass at a lower level subject to a specified mark being obtained. However, as Tables 9.3 and 9.4 illustrate, selection of tiers with the current syllabus is less specific.

With a series of end-of-unit tests there is the opportunity for students to make up for those tests on which they do not do so well or for those units which they find more difficult by performing well in other module assessments. This allows for entry levels to fluctuate between individual modules throughout the course. With a single terminal examination covering the three strands or disciplines the level must be selected with considerable accuracy and does not allow for student preferences in terms of interest or achievement. The syllabus recommends the tier of entry for a student on the basis of his or her expected National Curriculum attainment level. The recommended tiers are reproduced in Table 9.5.

Table 9.5 Recommendations for tiers of entry in relation to expected attainment level

Tier of entry	Basic			Central		Further	
Expected level	4	5	6	7	8	9	10

Source: MEG syllabus 1770/1771

This information suggests that it may be unwise to enter students for the further tier unless they are expected to obtain an A grade. This suspicion was actually confirmed by a colleague who is involved with setting GCSE science examinations. He also stated that the further tier questions were to be set purely on content from levels 9 and 10 of the National Curriculum and using language appropriate to those levels. He suggested that unless we were confident that students would obtain an A grade then it would be detrimental to them to be entered for the further tier.

This made decisions regarding level of entry extremely difficult for our more able students. We had the above information regarding level of difficulty of the further tier, in addition this cohort had been subjected to the change in syllabus and assessment methods. We decided that it would not be in their best interests to subject them to an examination which, in all likelihood, they would find difficult to understand and which they would certainly find difficult to answer. Consequently we entered no students at all for the further tier. We also had to exclude some students from the examination who would probably, had we still been following the Suffolk course, have been able to obtain an F or G grade.

The students were allowed to choose freely whether they wished to be entered for the double or the single award and which tier of entry (basic or central) they would prefer. Their choices were monitored by their teachers and some students were guided in their choice. The split was almost equal with 70 students being entered for the double award and 69 for the single.

However, when these figures are broken down by gender, of the 70 students entering for the dual award 45 were girls whereas only 30 of the 69 single award entries were for girls. The fact that such a large proportion of the girls had enough confidence in their ability in science to attempt the dual award is encouraging. This certainly suggests that the lessons we learned during the Suffolk course with regard to motivating the girls have been absorbed successfully into our normal teaching practice. Further discussion of these lessons and the resulting strategies is to be found later in this chapter and in Chapter 10.

Looking at the entries with regard to the tiers reveals a further pattern which relates to the choice of double/single award. The students entered for the dual award mainly attempted the central tier whereas the students entering for the single award generally did so at basic level. As it is generally the more able students who are attempting the double award then it is logical to expect them to attempt the higher tier. Table 9.6 gives a complete breakdown of the entry pattern for this cohort.

It was anticipated by the department that the GCSE results for this 1994 cohort would not be as high as those for the 1993 Suffolk cohort. The 1994 cohort had commenced their GCSE course by following the Suffolk scheme and were immediately subjected to two quite dramatic changes in assessment procedure. As a result of these the students were then subjected to a change of syllabus which necessitated radical changes in the framework for assessment and testing. The coursework component was to be assessed in a different way and its weighting was to be reduced. Additionally, due to the format of the National Curriculum, it proved to be virtually impossible for the majority of students to achieve the highest National Curriculum levels for the coursework element. The level statements for the coursework were vague and consequently open to different interpretations and neither did the structure of the levels allow the students to demonstrate progression.

Table 9.6 Breakdown of entry pattern, by gender, for 1994 GCSE science cohort

ENTRY	Double Basic	Double Central	Single Basic	Single Central
Boys	7	18	24	15
Girls	16	29	25	5

Source: Department records

Naturally, as there were no students entered for the further tier then we could not expect any A grades, the department was, however, also of the opinion that the more able students would be pushed to achieve B grades on the central tier examination. We were also conscious of the additional hurdle imposed by a terminal examination. For both the 1992 and 1993 cohorts all the testing had been based upon the end-of-unit tests. As explained earlier, the content of the tests was specified in the end-of-unit criteria in the Suffolk text books. In addition the content of the tests was based upon the teaching which had taken place in the lessons for the few weeks before the tests and were, therefore, testing short-term recall. For the 1994 cohort there were to be two written papers with the content being drawn from the entire National Curriculum which had been taught over the full two-year period making revision time and techniques more important than before.

Table 9.7 shows the percentage of students from the cohort at each GCSE pass grade for 1994. These figures are obtained from entries for both the double and single award in GCSE science.

Table 9.7 Percentage of students passing GCSE science, summer 1994.

GCSE Grade	A	B	C	D	E	F	G
% of entry	0	7	10	21	29	19	12

Source: Department records

Table 9.8 gives the complete data for the boys and the girls from the 1994 cohort for the double and single awards. These data clearly show that in the higher grades (B/C) the boys appear to have regained some of the ground they lost during the Suffolk course but in the intermediate (D/E) grades the girls are better represented. There appears to be an imbalance between the girls' perceptions of their ability as evidenced by their entry choices and their achievement as evidenced by the GCSE results.

Although the department's predictions of students' performance are now much less accurate than those made using the Suffolk software they can give some indication of expectations. These predictions were based on a trial examination, the questions for this examination being taken from sample assessment material provided by MEG and should, therefore, have been an accurate representation of the actual GCSE examination papers. The grade boundaries suggested by the department to predict grades could not be representative as this was the first time we were following this particular syllabus and we tended to err on the side of caution, particularly where it was apparent that the student needed some encouragement.

When the predicted grades are compared with the actual grades 44% of the students were awarded the grades we had predicted, 23% were awarded a higher grade and 33% a lower grade. If we consider those students entered for the double award we find that at the basic tier of entry 4 of the 7 boys and 5 of the 16 girls received a lower grade than we had anticipated. At the central tier of entry 5 of the 18 boys but only 6 of the 29 girls received a lower grade than the one we expected, of these 6, one developed attendance problems late in the course and two chose to enter for the central tier against our advice.

Table 9.8 Number of students at each GCSE science grade for 1994 cohort, by gender and award.

	BOYS		GIRLS	
GCSE GRADE	Double Award	Single Award	Double Award	Single Award
A	0	0	0	0
B	5	0	2	0
C	3	2	6	0
D	4	6	13	3
E	5	10	17	6
F	7	11	4	7
G	0	9	3	9
U	1	0	0	2

Source: Department records

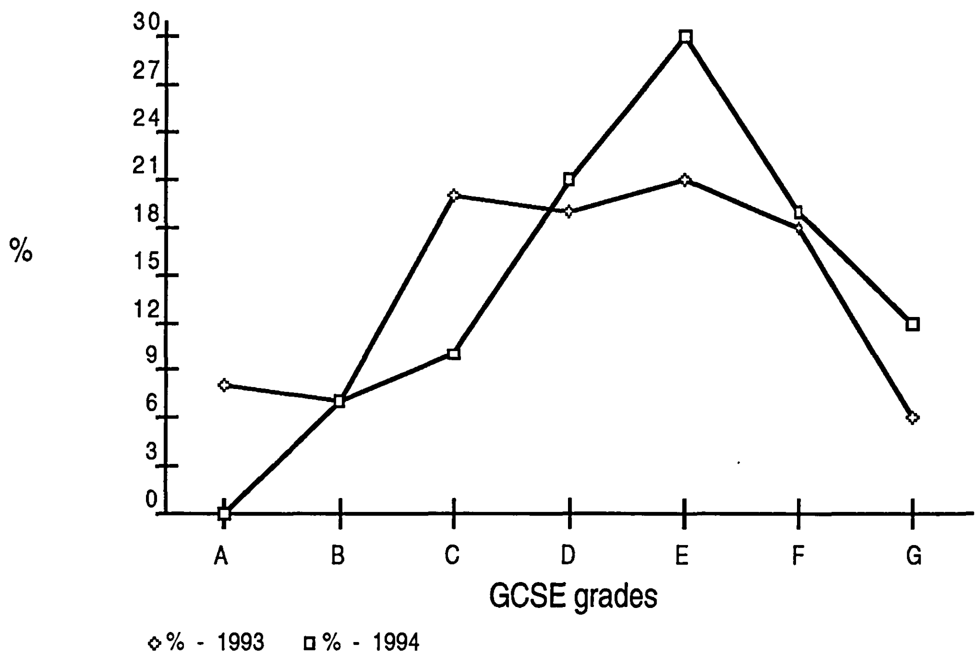
Table 9.9 lists the GCSE pass grades from each of the two Suffolk cohorts from 1992 and 1993 along with those from the 1994 MEG science for comparison. The Suffolk course was entirely double award but for the MEG course we entered students for both the double and the single award. The 1994 data arise, therefore, by counting the double award as two passes and the single award as one.

Table 9.9 Comparison of GCSE pass grades for the 1992, 1993 and 1994 cohorts. Figures are percentages.

	GCSE Pass Grades						
	A	B	C	D	E	F	G
1992 cohort	4	6	6	15	22	29	16
1993 cohort	8	7	20	19	21	18	6
1994 cohort	0	7	10	21	29	19	12

Source: Department records

Figure 9.10 Comparison of GCSE data from 1993 (Suffolk science) and 1994 (MEG science) cohorts.

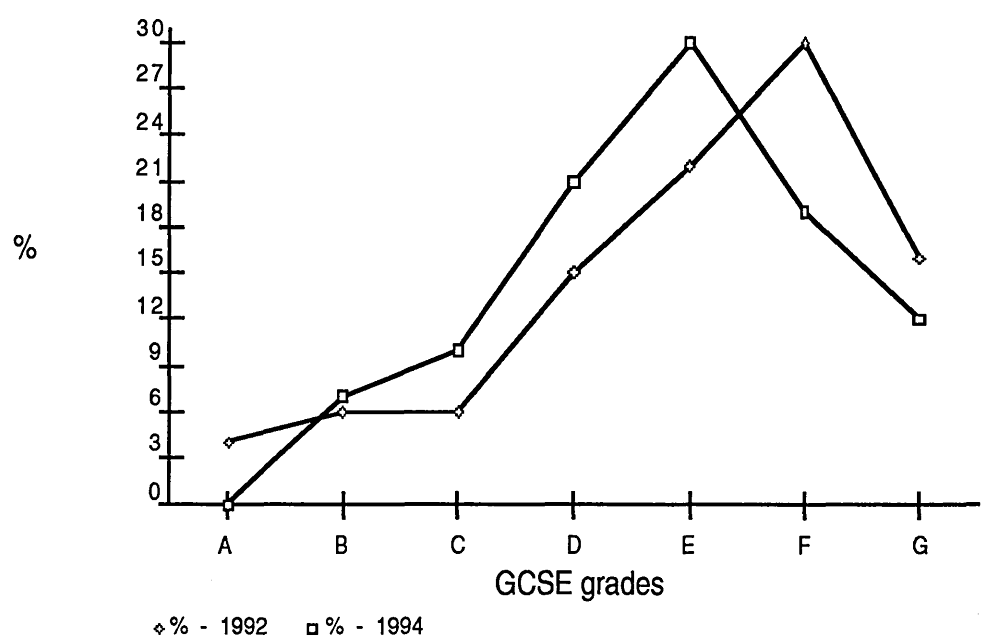


Source: Department records

Comparing the 1993 and 1994 data illustrates that, as expected, the overall performance deteriorated as the GCSE assessment moved away from the coursework-based Suffolk approach. Figure 9.10 presents these data in graph form to enable a direct comparison to be made. It can be seen that the overall differences are not large, certainly not as large as we originally expected, particularly as we were moving from the coursework-led Suffolk scheme to one which was based around a terminal examination.

Figure 9.11 compares the 1992 (Suffolk) and 1994 (MEG Science) data. This comparison is particularly interesting as it illustrates that the overall grade pattern appears to be better in 1994 when the students were subject to the assessment scheme based around terminal examinations rather than the coursework-led Suffolk scheme. This is in spite of the fact that, as explained earlier, no students were entered for the higher tier and could not, therefore, achieve an A grade.

Figure 9.11 Comparison of GCSE data from 1992 (Suffolk science) and 1994 (MEG science) cohorts.



Source: Department records

This research project has, during the period in which the Suffolk scheme was in operation, tried to identify those aspects of the course which contributed towards improving the attainment and motivation of our students. Comparing the students' performance prior to the introduction of Suffolk with the 1992 and 1993 GCSE results indicates a clear improvement, particularly by the girls. Therefore, when we moved from the Suffolk scheme to the MEG science course we tried not to disadvantage our students. We drew heavily upon the expertise we had gained in teaching Suffolk science over the previous few years, particularly those which appeared to have contributed most to the students' improvement, for example developing the students' contributions to the coursework elements of the Suffolk scheme.

In addition by 1994 we were also becoming more familiar and proficient with those teaching and assessment strategies which were proving to be effective in promoting our students general progress. Another way in which the improvement in the 1994 results can be explained, therefore, is by realising that, as a department, we had become more aware of our students' needs and more skilled in creating the opportunities to meet them. A more detailed consideration of the skills which we have acquired and developed during the period we have been teaching Suffolk can be found in Chapter 10.

Table 9.12 Comparison of GCSE grades from the 1992, 1993 and 1994 balanced science cohorts. Figures are raw scores.

GRADE	A	B	C	D	E	F	G	Mean
1992	10	16	16	40	60	78	44	5.02
1993	22	20	54	52	58	48	16	4.16
1994	0	7	11	26	38	29	21	4.81

Source: Department records

In Table 9.12 the GCSE pass data for the 1992, 1993 and 1994 cohorts (from Table 9.9) are presented as raw data. Each GCSE grade was allocated a score (A=1, B=2, etc) and these raw data were used to calculate a mean score for the cohort and this is included in the table.

From this rather crude calculation we can see that the mean grade obtained by the first cohort to follow the Suffolk scheme approximated to an E, scoring 5.02. The second cohort had improved to the extent that the mean grade was nearer to a D with a score of 4.16. The 1994 cohort, however, the first to follow the MEG syllabus under the revised GCSE regulations demonstrated, as expected, a drop in attainment from the 1993 cohort by scoring 4.81. Surprisingly, however, this cohort still bettered the performance of the first Suffolk cohort.

Statistically, the results are very surprising. Chapter 7 (Table 7.4) discussed how chi square calculations demonstrated no statistically significant difference between the boys' and the girls' GCSE performance in the first Suffolk cohort (1992). However, by 1993 there was a significant gender difference in favour of the girls which was measurable at the 1% level. A similar treatment of the 1994 data in Table 9.8, however, yields a chi square value of 15.8 in favour of the girls, which exceeds the critical value of 15.09 at the 1% level with 5 degrees of freedom (d.f = 5 as there were no A-grades possible). It is difficult to comprehend how, statistically, the 1992 and 1994 performance data are so wildly at variance. The expectations were that the 1994 results, based largely on a terminal examination, would be worse than the Suffolk results for both 1992 and 1993. The data suggests that our skills and strategies were effective at reducing the disadvantage created by transferring the emphasis of the assessment from coursework to terminal examination.

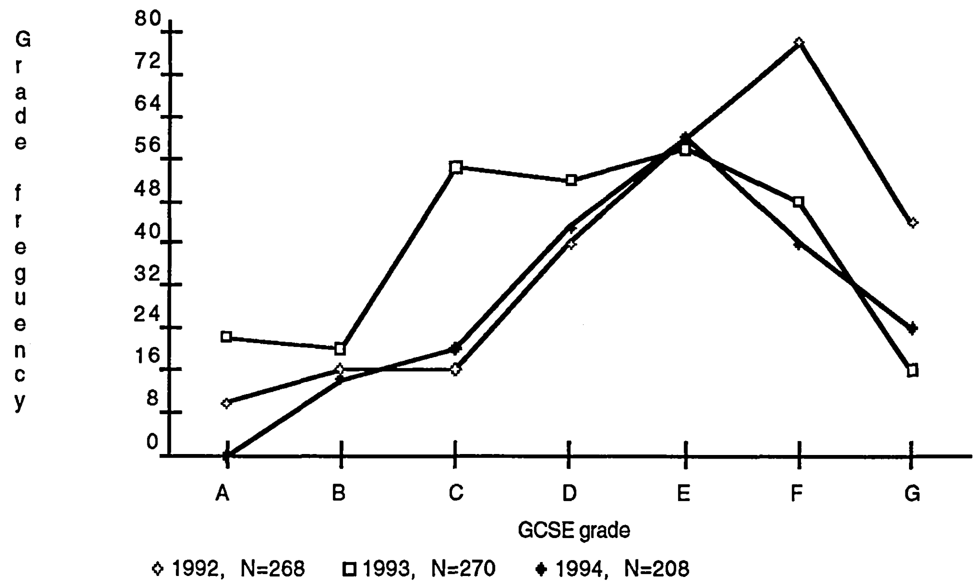
Another factor which could have contributed towards these observations is that the 1993 GCSE results may have been exceptionally high. We were pleased with these results and for our students the grades awarded represented a quite spectacular improvement. Within that cohort, however, we did have some exceptional students and the high-ability girls, for example, were very well motivated and had worked at consistently high levels throughout the course. Students, particularly those from the higher ability groups, were (as explained later in Chapter 10) given tutorial sessions during which their attainment levels were explained using the Suffolk software and individual targets were set to improve expected grades. As explained during the discussion of the Suffolk structure, each piece of assessment work added to the students' points score and consequently the assessments were given a high priority.

It had proved impossible for the Examining Board to monitor, on any rigorous basis, the huge body of assessment work collected during the Suffolk course. However, we had retained all our students' work and coursework details in order to ensure that our assessment procedures were accurate and available for scrutiny. This was an important procedure which we transferred to the newer course. Students' coursework for Sc1 was moderated at regular intervals by the whole department with detailed records being kept of the criteria for the award of levels, marking differences between teachers, context of the task and its place in the teaching programme and so on. These were retained along with all the students' work in order to facilitate the compilation of the portfolio for external moderation. Consequently we were able to give quite a high priority to the students' coursework in spite of the reduced emphasis given to it under the new GCSE regulations.

A brief review of the data presented earlier in this chapter can also add to an understanding of how the improvements may have come about. Figure 9.13 presents the same comparisons as those illustrated in Figures 9.2, 9.10 and 9.11 but using the raw data from Table 9.12 rather than the percentage of students at each pass grade.

The 1994 data can be seen to differ at both ends of the grade range. Firstly, as outlined earlier in this chapter, no students were entered for the further paper and, therefore, no A grades were possible. This cohort also shows reduced numbers of students at the F and G grades. This again was due to the changes the regulations controlling GCSE assessment having an effect upon our entry procedure.

Figure 9.13 Comparison of GCSE grades from the 1992, 1993 and 1994 balanced science cohorts. Figures are raw scores.



Source: Department records

Under the Suffolk scheme the coursework marks for the process skills were cumulative. Students were expected to complete two pieces of assessment work per unit and the points were totalled, grade boundaries being set and allocated using the software. Over the course of the two years of the GCSE (or three under the initial Suffolk format) even those students who had little ability or interest in science could be cajoled, persuaded, chased and so on to produce some pieces of work which would enable them to at least reach the minimum score necessary to be graded.

Under the GCSE regulations students now had to reach a level in each of the three strands of Sc1:
Strand i - ask questions, predict and hypothesise,
Strand ii - observe, measure and manipulate variables,
Strand iii - interpret results and evaluate scientific evidence.

These levels can be awarded in any number of pieces of work with only the highest needing to be recorded. However, as discussed elsewhere in this thesis, there is no opportunity for variety in the work or its presentation. For the less able students even reaching level 1 or 2 can be a major achievement but these are not recognised at GCSE and consequently many of the less able students did not bother with the coursework or did not reach basic level and so, were not entered for GCSE in 1994. A total of 17 of the cohort of 156 were not entered for the GCSE in 1994, 4 students were graded NR (no result) because their coursework was not completed by the deadline, 3 students were unclassified due to examination performance.

For many of the less able students who were entered and passed GCSE from this cohort the individual members of the department have given up much of their own time to help these students complete their coursework assignments to an adequate standard. In addition, revision sessions after school have been held to enable the students, of all levels, to revise such a large body of material and to cope with the rigours of the terminal examination. Consequently we have actively taken steps to try to ensure that the syllabus changeover was as smooth as possible and to reduce any damage caused by the changes in assessment procedure.

Additionally, and perhaps more importantly in view of the nature of this research programme, we have investigated both ourselves and our students. We have asked our students to indicate what they expect and need from us in order that they can firstly experience success and then make more progress by building upon this success. We have also shown that we can listen to and act upon what they have said. We have looked at the ways in which our students work in order to identify those areas and techniques which are the most suitable to enable them to demonstrate progress. We have used these to promote their confidence and interest within an open and informative assessment framework.

We have been able to develop the key skills (outlined in detail in Chapter 10) which were necessary in order to promote the GCSE achievement of our students. We have also been successful in transferring these skills to another system. The new GCSE course although it lacks the consumer-friendliness of the one in which we developed these skills still enables us to use them to the ultimate benefit of our students.

There have also been external moves which may lead to improvements in GCSE performance. The recent (January 1994) report by Sir Ron Dearing has highlighted many of the problems discussed elsewhere within this thesis which are seen to have been damaging to the education system within this country. The draft proposals for science in the National Curriculum published by SCAA (the School Curriculum and Assessment Authority) in May 1994 certainly point the way forward for some important and useful revisions of the policy changes of recent years.

The proposals as they affect this programme of research are a revision of Sc1 (the coursework element) in order to make it more flexible and manageable through meeting many of the criticisms expressed herein, for example, the work students submit does not necessarily have to be part of a full investigation and neither does the work have to provide evidence of all the strands. The number of areas (strands) becomes four instead of three for students in Key Stages 3 and 4 breaking down further the amount of work students need to complete in order to demonstrate competence at a level. The statements of attainment are replaced by more general Level Descriptions and there is a reduction in content which has been achieved by removing overlap between Key Stages and other subjects, in addition the remaining content has been reordered to facilitate progression.

CHAPTER TEN

Conclusions and the implications for further research

In the final chapter the author draws upon data from each of the three phases of the research to suggest ways in which the motivation and performance of GCSE science students may be promoted. Specific gender issues are considered as they are perceived to be applicable. Possible areas for further research are proposed in the light of the evidence and findings presented in this thesis.

In Chapter 1 the aims of this research programme were set within the framework of observations relating to gender differences in school science which were made by researchers during the late 1970s and early 1980s. Now, some 15 years later, very little appears to have changed as much of the data relating to the differential between boys and girls in secondary education seems to support inconsistencies and contradictions rather than answering questions.

It is currently possible to observe some differences in the ways in which girls and boys are treated within the secondary education system in order to try to redress the gender imbalance. Various career-oriented initiatives (similar to WISE, as discussed earlier in this thesis) have attempted to increase the profile and status of women in, for example, engineering, in an attempt to draw upon the wealth of female talent which has traditionally turned its back on such career areas. Some basic questions regarding the root of the gender issues in education still, however, remain unanswered.

Three crucial areas of concern have been identified which relate directly to this programme of research and these will be discussed in this concluding chapter. The first of these addresses the problems experienced in the dual role of teacher and researcher within the same institution. The second issue is concerned with the validity of those experimental observations made during the programme which demonstrated the promotion of achievement amongst the students. The discussion of validity then naturally leads to the problems of generalisation and the transferability of the findings. The third area relates specifically to gender issues and questions whether the observed gender differences, which relate to the differential achievements and attitudes of girls and boys in science, are sex-related or experiential.

The role of teacher and researcher

Some of the main problems facing a teacher carrying out research in their own school have been discussed in Chapter 2. Hopkins (1985) was quoted to illustrate how this project attempted to provide a base for the research whilst allowing the researcher to continue to fulfil the role of teacher/Head of Department. Questionnaires were used, in lesson time, to enable virtually 100% response to be obtained from the students. Additional research methods enabled more flexible approach/response mechanisms to be used which could provide deeper insights into the trends suggested by the questionnaire responses.

These investigations did not intrude unnecessarily into the teaching even though they sometimes used teaching time. The responses and findings were used to inform and evaluate the changes in teaching methods and contexts necessitated by new syllabuses, National Curriculum and so on. The research enabled teachers and students to consider their roles and actions in more depth and at the same time. The investigations supported the teaching rather than interfering with it.

There are certain constraints which can prevent a teacher adequately fulfilling the role of researcher. Time, energy, money and resources are valuable and limited commodities in schools. Consequently there is frequently little opportunity for teachers to develop elaborate designs and methods for research. This research programme has, however, demonstrated considerable success using quite basic research methods. The desire to carry out the task successfully would appear to be as important as the methodology by which the results are obtained. The validity of the findings from this research are discussed in more detail later in this chapter.

The teacher carrying out research also has to maintain standards and students' progress, he/she has to maintain control in the classroom and must also be careful not to compromise his/her position by making mistakes. The research methodology is crucial here, correct selection allows the teacher to function adequately and minimise risks. However, there is also the need to enable the students to see the researcher rather than the teacher from time to time. This is the point at which the role definitions become hazy and mistakes can be made. The students can also experience difficulty in recognising the teachers' role (teacher or researcher). Students' responses are frequently governed by a desire to please, but they may not be sure who they are trying to please.

Another factor in this equation is the students themselves. As teachers do not usually invite student opinion on their performance as teachers it is unlikely that he/she will able to obtain a clear picture of how the students view the new role of the teacher as researcher. The transition may or may not still leave the teacher as the authority figure and the students' responses may be coloured according to how they perceive the balance between teacher and researcher. It is, therefore, important that the teacher should seek to encourage relationships which can enable the students to feel that they have freedom of expression. This freedom may then spill over into the teaching situation, so the balance is a delicate one. However, the school situation is a familiar one to the teacher and as a researcher he/she should have room to manoeuvre enabling suitable and successful strategies to be developed.

In this research I explained to the students the nature and reasons for the Research Tasks and so on. I explained my role carefully and also discussed issues of confidentiality. I was quite specific as to who would (or would not) have access to individual responses. The various target groups appeared to respond positively and enthusiastically for the questionnaire-led opinion trawls. The smaller discussion groups and interviewees appeared quite happy to let me take on the role of researcher and spoke quite openly on a wide range of topics. When discussing teachers and teaching they were just as happy to criticise me to my face as criticising other staff and to discuss the reasons for their criticisms.

Consequently, it appeared that my transition from teacher to researcher was a relatively painless and, judging by the results of the research, reasonably successful.

The researcher who is a teacher also faces certain difficulties. Lieberman (1956, as cited in Farrell, 1971) described how for a teacher carrying out research, the aim is frequently to gather information which can then be used for specific purposes, for example, making policy decisions. Research, as described in Chapter 2, is more concerned with gathering data which is then used for proposing and testing hypotheses. The working environment makes it difficult to control variables, for example, changes in the staff and student populations, variable student attendance, motivation and so on. These variables can affect both the validity and reliability of findings. In addition there is the researcher's need to check findings, assumptions and interpretations which may prove to be difficult for reasons discussed earlier. The researcher also sees confusion between the teachers' subjective opinions and objective data.

This research tried to avoid many of these problems by using the students' achievement in GCSE science as a measure of the students' progress and of the overall success of the programme. The GCSE data stands quite independently of teachers' subjectivity and is capable of analysis without the need to return to the cohort for additional data. The earlier Research Tasks investigating attitudes and so on were not used for analytical purposes but to inform larger policy decisions made within the science department.

The researcher and the teacher often find it difficult to communicate for a variety of reasons. The teacher often lacks the wider knowledge of the researcher being unaware of what is actually known at any particular time. The teacher also often lacks the opportunity and/or the desire to keep up with the changing knowledge base. In addition, the terminology used by the researcher may frequently be technical and abstract, the teacher's terminology, although technical tends to reflect more upon the specific situation and this can lead to difficulties in communication.

The researcher tends to reflect upon a situation or model. This reflection will consider the focus of the research, the methodology, an analysis linked to the focus and an evaluation. The teacher, however, will tend to reflect more upon his/her practice. The analysis considers changes in practice asking questions in the form 'What happens if I...?', 'How can I...?' and so on. The evaluation looks at the results of these changes but generally in overall terms and with an eye on future changes where the focus of the research may also change.

These last two points have been avoided to a certain extent by approaching the research from a teacher/researcher's viewpoint. The research has concentrated on changing situations and practice in order to achieve the aims of the research. The thesis has tried to discuss the research, communicating the methodology and the findings in terms of the educational framework. The resulting changes to situations and practice have then been evaluated in terms their implications for teaching.

Experimental validity and transferability

The second area of concern relates to the nature and importance of the improvements in attainment observed amongst the students within the author's school. The time scale of this research has made it impossible to determine whether the observed improvements on the part of the girls can be maintained or whether we have simply seen short-term gains within the period of the research.

If the improvement on the part of the girls has only been effective for those cohorts who were taught during the period of the action research then the programme has not been particularly valid in the long-term. If, however, the department has learned from the research, by developing strategies and techniques to improve the position of girls in science and by developing teaching contexts which increase the motivation and interest of girls then we are more likely to see a lasting change. The discussion in Chapter 9 suggests that this learning process may, in fact, be the case as we appear to have evidence of skills being acquired and then transferred from their original context (the Suffolk scheme) in order to improve the effectiveness of teaching within another, different assessment framework. These strategies and techniques are discussed in more detail later in this chapter.

As described earlier, the introduction of the Suffolk science course was a major initiative for the department. It required a major input of teacher time and effort into developing schemes of work, assessment skills and lesson resources. A great deal of time was spent explaining to the students how the course was different, what they would be expected to contribute, the nature of the assessment and so on.

Consequently the first Suffolk cohort were, within the science department, given very special treatment. In addition, they were aware that they were being given this special treatment. Ball (1988) notes that '...the 'Hawthorne Effect' is a potential threat to the validity of educational experiments' (p491). The Hawthorne Effect has been noted and discussed since the 1920s. Basically, it is a reactive effect which involves some form of positive behaviour modification in favour of the initiative by the subjects of an investigation. It can be difficult to determine whether the improvement is actually due to the initiative or whether it occurs as a result of the fact that the subjects are aware of their involvement in the investigation.

Ball suggests that, in order to reduce this effect and prevent it clouding the results of an investigation, positive steps should be taken to reduce the emphasis of the experiment. This could involve playing down the importance of the initiative, using control situations or, presumably, not informing the subjects that they are part of an experiment. In the situation described in this research programme, however, the aim was to improve the attainment of the students. The Hawthorne Effect, in contributing to this attainment could be viewed as a desirable, positive effect.

However, when the GCSE data from the 1992 and 1993 Suffolk cohorts are compared the observed differences suggest that this effect was not a contributory factor. The second Suffolk cohort were not exposed to the same build-up to the course as the first cohort. Naturally, the students' responsibility for their own progress through the assessment programme was stressed, they were chased up for late or missing work, they were made to sit module tests they had missed, and so on. These are, however, normal teaching procedures. The second cohort were not given the 'pre-launch' treatment, which had included for the first cohort, parents meetings, special talks for the students in tutor time and the like. Whereas the assessment and module tests in Year 9 were given special emphasis by the teachers for the first cohort, they were, for the second cohort treated as routine. By this time we were repeatedly testing and continually assessing both a Year 9 and a Year 10 cohort and consequently we had much less time available in order to give the second cohort of Suffolk students the same special treatment.

The second cohort would, according to the Hawthorne Effect, be less likely to match the achievements of the first cohort as they were not being given the same attention. Ball suggests that a reduction in emphasis may be necessary in order to counter the Hawthorne Effect thereby increasing the validity of the experiment. A reduction in emphasis on the innovative nature of the course took effect for the second cohort. Although we did not specifically aim to reduce the emphasis on the Suffolk course the very fact that it was no longer new affected both the way in which the teachers perceived it and the way in which it was presented to the students. However, as the data from Phase Two illustrate, the second cohort outperformed the first cohort. In addition, the differential between the boys and the girls which favoured the girls in the first cohort was seen to widen considerably in the second cohort. Consequently the Hawthorne Effect appears not to have been a contributory factor to the success of this programme and thus we can reasonably conclude that the observed improvements were due to the initiatives introduced by the department and this strengthens the validity of the observations.

Research by O'Brien and Porter (1994), who initiated a series of interventions designed to improve girls' attitudes in physics, illustrates the Hawthorne Effect in action. Their findings also appear to provide some justification for a crucial decision made by this author earlier in the current research programme. I had decided that no initiatives would be introduced which would intentionally give rise to 'girl-friendly' science or policies. This decision was made for three reasons. Firstly I wanted to enable the girls to experience success without creating an artificial environment for this to take place within the school. Watts and Bentley (1994) recognised this point suggesting that the creation of 'feminine' science may well act against the interests of women who may later wish to pursue science. Secondly, earlier research (for example GIST) had demonstrated equal benefit by all students, boys and girls, in response to interventions made in order to improve the position of girls within normal school situations. Finally, I had no desire to reverse the problem by creating situations in which the boys became disadvantaged.

O'Brien and Porter's (1994) intervention projects involved providing visiting teachers for secondary schools where there had previously been <u>no</u> physics. Equipment was also to be provided in some cases. The establishment of the visiting teacher programme involved an initial presentation in the school for people directly and indirectly involved. The researchers commented:

> There is also usually an interest from the local press, a fact which helps to give the 'new' subject a high profile, not only among the students but also among their parents. (p330)

The research described how a more positive attitude in relation to girls' ability in physics was observed in the project schools whereas other attitudes were similar in both project and control schools. However, the project evidenced a tendency for the attitudes relating to girls' ability to become less positive with time. The Hawthorne Effect would have predicted this decline as the project gradually lost its high profile. This loss of momentum would appear to justify my decision to target an entire cohort with the various Research Tasks and other interventions.

Bassey (1990) approaches the question of validity from another direction by considering the findings in terms of whether a study of a singularity can realistically be transferred into a generalisation. He defines a singularity as '...an account of particular events.' (p39). He uses this definition to describe a generalisation as '...a statement which collates evidence of particular events,...' and further extends this argument to specify that the statement '...extrapolates that evidence to predict the occurrence of similar events.'

Bassey's discussion positions the singularity firmly within local boundaries of space and time which are defined by the nature of the study but sees the generalisation as being capable of making predictions which extend beyond these boundaries. He also points out that the generalisation includes far less detail than the more specific singularity. He suggests that where a singularity is concerned the goal is that the audience can find sufficient similarities to enable them to relate the findings to their own situation. A generalisation is described as being representative and the goal is that the audience can transfer the findings directly to their own situation.

It was intended from the outset that this programme of research would be aimed at the students in the research school. It was hoped that the performance of all students would be improved and that the motivation and attainment of girls in science would increase. The mechanisms of the research were detailed and specific and consequently fall within Bassey's notion of a singularity. However, some of the Research Tasks were extended to include a wider audience and some of the data comparisons were made on quite a large scale. Consequently there is the opportunity for other teachers to be able to extend the arguments put forward in this thesis to their own situation. The transferability is not so specific and direct as Bassey intends can be obtained from a generalisation. The cohorts investigated were fairly normal representatives of the secondary school population in this country and although there are obvious demographic and intellectual variations within the larger picture individual teachers in individual schools may reasonably reflect upon this research and the implications for their own schools and practice.

The research has suggested that one of the ways in which the girls' motivation and attainment in GCSE science can be increased is by using an assessment system which includes a substantial amount of coursework. As discussed in Phase Three, government policy has actively reduced the coursework component in GCSE in favour of terminal examinations.

The data in Chapter 9 have shown how the GCSE performance of all students, particularly the girls, has deteriorated on moving to a GCSE course with a reduced coursework component. The remaining coursework component provides only 25% of the marks towards the final GCSE grade. In addition this component is based in the Sc1 strand of the National Curriculum and simply requires students to record their plans and observations for investigative work and relate the two for the evaluation. This is quite restrictive in that it gives students little freedom to pursue those topics which interest them in any greater depth. In addition, there is little opportunity or incentive for the students to report creatively and imaginatively within this framework. Any individual research is restricted purely to the area of the actual investigation.

Earlier evidence obtained from girl students (Chapter 7) has illustrated how they appreciated the opportunity to pursue individual topics within a range of contexts. The work produced by all students, but particularly the girls, for the assessment for Suffolk science has shown imagination, thought, interest and concern. The resulting materials have been of very high quality which in turn allowed the students to be given more credit for their work further increasing student motivation.

In planning, carrying out and evaluating an investigation there is much less opportunity for students to be creative in their presentation as, in order to award National Curriculum levels certain criteria have to be met. This makes the written work simply another impersonal task to be completed. The criteria themselves make little sense to students and do not allow them to access the upper levels without considerable effort on the part of both teacher and student.

In addition, the current (1994) position regarding Sc1 assessment for GCSE requires the assessments to be made within the context of a full investigation and that the three strands of Sc1 are assessed within that investigation. This imposes a further restriction upon the individual students' framework for response. Hopefully, this situation will be remedied when the proposals for the changes in National Curriculm science (as reported in Chapter 9) take effect.These recommendations made as a result of the Dearing Report (1994) address both the issue of continuity of levels and context of assessment task. These are both positive moves and suggest that some of the ground lost when the coursework component was reduced may possibly be regained in the future.

Gender differences in attitude and achievement

In relation to the third question it must be acknowledged that there are certainly some differences between boys and girls which are still difficult to explain without one accepting that there are innate differences between the sexes. This has, in the past, been seen as a rather disturbing statement as it has been perceived in certain areas as implying that one sex is inferior to the other.

Research into the development of cognitive abilities (Thurstone and Thurstone, 1941) identified three areas of ability or intelligence. These centred upon verbal, numerical and spatial skills. Halpern (1992) discussed how it was very difficult to differentiate between ability and achievement in the three skill areas. The students under investigation will have different perceptions of the desirability, under social and peer pressures, of demonstrating superiority in any particular skill area. Linguistic skills may, for example, be allocated a low priority by a linguistically talented boy because it may not conform to his peers' norms and he may, therefore, perform at a lower level on tests of linguistic ability. Similarly a girl with high level mathematical skills may underperform on numerical tests because these skills are perceived by her peers as 'masculine'. Whitehead (1994, p74) suggested that for an able girl:

> ...conformity to sex-appropriate norms is incompatible with [her] developing competencies and abilities, thus producing 'gender-role strain'. The incompatible demands of femininity and academic success provide such a conflict.

Previous research quoted elsewhere in this thesis has indicated that girls are superior to boys in certain skill areas and boys are superior in others. The IEA data (Chapter 1), for example, illustrated that when compared at age 14, the boys were at a great advantage in physical and practical science, at a lesser advantage in chemistry and biology and at a disadvantage in reading, language and literature tests. It has also been noted how these differences fluctuate according to age, environment and experiences.

In Chapter 3 the expression of gender typical behaviour was discussed in relation to the findings from Research Task 6, which probed students' attitudes towards different aspects of the sciences. Saraga and Griffiths' comments (1981) comparing the personal nature of biology as opposed to the more impersonal subject matter of physics further illustrated this point in relation to girls' choices in science.

If all these factors are taken into account then it is possible to consider and discuss biological differences in ability simply as differences without implying that they give rise to any superiority or supremacy.

Biological differences have been considered variously as being brain-centred, chromosomal or hormonal in nature. However, within the body these three are interlinked and it is virtually impossible to allocate a specific importance to one of these three areas in developing cognitive abilities. That is not to say, however, that the importance of some of these areas cannot be reduced.

The various sex-linked recessive gene theories, for example, Gray (1981) and others, as discussed in Chapter 1, currently appear to be given as little support as they did at the time. Hormonal causes are less easy to discount although they are not, as yet, positively identified as contributing to cognitive skills. Several theories have been proposed relating spatial skills to the level of certain hormones in the body. Halpern (1992) discusses how women's cognitive abilities have been shown to vary (albeit slightly) throughout the menstrual cycle. She refers to the work of Hampson and Kimura (1988) to illustrate that, for example, women's verbal and manual skills are at their highest when oestrogen and progesterone levels are also high (mid-cycle), these skills reducing as the levels of these hormones reduce reaching a minimum during menstruation. It must be noted that these changes are simply changes observed amongst women, no comparisons with men are intended or implied.

Hormones tend to be classed as male and female hormones, suggesting that the hormones themselves may be responsible for the differences and this can also help to promote ideas relating to superiority/inferiority. It is in fact the levels of these hormones which vary according to gender and age. The human body quite happily accommodates and uses certain specific hormones irrespective of any gender tag.

Discussions regarding brain differences between the sexes can prove to be even more emotive. The fact remains that neither male nor female brains demonstrate differences in size, weight or complexity. Sex differences in the way the different areas of the brain are organised have been proposed but as yet it is impossible to allocate gender differences to brain function in isolation.

The Cognitive Acceleration through Science Education (CASE) project (Adey and Shayer, 1990) attempted to promote the cognitive level of students through a series of tasks and exercises and demonstrated success with a significant number of boys. Very few of the girls evidenced any benefit from this intervention. This difference was attributed by Adey and Shayer to the fact that the girls had a growth spurt in brain activity approximately one year earlier than the boys and thus were unable to gain the same benefit from the project.

As discussed earlier, males and females are biologically different in several ways. Sex-role characteristics can combine with these differences under the influence of peer and parental expectations to produce individuals who adhere perfectly to the gender-norms of their particular environment. This combination can equally result in an individual who differs widely from these norms. The degree of conformity will in turn promote varying degrees of attitude and behaviour reinforcement. For girls, however, academic success is not always seen to be relevant so that improved performance and/or attainment on the part of girls may well be at odds with their stereotypical image. Whitehead (1994) suggested that:

> The more rigidly stereotypical the gender schema the more conforming the behaviour is likely to be. Girls whose gender schema are less stereotyped are much more likely to be academically successful and to see themselves as having a career. (p53)

No matter how important or relevant biological differences are perceived to be it is essential that environmental factors are included in the equation. Rennie and Dunne (1994) observed:

> ...there is now compelling evidence that social and cultural factors, rather than innate factors, explain the differential participation of males and females in science. (p285)

Whitehead (1994) noted that the occupation of a girl's father had little relation to the tendency to stay on at school and, when investigating working-class girls of high ability, observed that:

> ...coming from a working-class background and having parents who themselves have no experience of post-school education does seem to contribute significantly to [their] under achievement and low aspirations. (p73)

O'Brien and Porter (1994) acknowledged the current under-representation of girls within physics but suggested that this was:

> ...more a function of society's expectations than a reflection of girls' inherent abilities and interests. (p327)

They observed that their research had indicated that this situation was seen as more of a problem by physicists and physics teachers than it was by the girls themselves (see also Jorg and Wubbels, 1987). Interestingly, their research discovered that more negative attitudes were found in the larger and the smallest schools within the survey. The findings also suggested that the negative attitudes towards physics were more predominant in the mixed schools which agrees with earlier research discussed in Chapter 1. Young (1994), however, suggested that student achievement in physics within girls' schools is also a function of social class rather than purely its single-sex nature.

It is immaterial who perceives the problem, the fact remains that the problem exists and continues to disadvantage a large proportion of our students. Watts and Bentley (1994) reconsidered the argument for restructuring the system of science education. They discussed how the system of science education is a social construction and is, therefore, potentially capable of some modification. This would enable us to create some other model which fits the nature of science as closely as the current model. They argue for some 'humanizing' process within school science in order to enable the students to visualise a role for themselves and to participate more actively within the structure of the entire science education experience.

The term 'experience' is not used lightly. What we set out to provide for our students was an environment in which it was possible for them to experience science. We aimed to enable them to learn to think in a scientific way, to understand the nature of science and be comfortable within that structure. Throughout the experience and the teaching we wanted our students to be successful, to be aware that they were being successful and to want to build upon the success.

We also wanted our students to feel the need to succeed and in order to do this we had to encourage the students to recognise their individual status and worth. It proved to be possible to move a long way in this direction by the simple but effective method of talking to the students, either individually or in small groups, and acknowledging their worth. Personal discussions with science teachers, as explained below, were used as a tool to promote motivation and achievement amongst the students. However, free discussion with a student, not necessarily about their work or progress, says a great deal to a student about how other people perceive their worth and can add greatly to their sense of identity and individual status.

One of the main ways in which we created that awareness within the GCSE framework was by using the Suffolk assessment framework in a thorough and effective fashion. As explained earlier in Chapter 4 the assessment scheme and the software made it possible to inform, to encourage and to counsel our students. In the later stages of the course the teachers took on the role of tutor, taking responsibility for a number of students and holding meetings at regular intervals to review the students' progress in relation to meeting pre-determined targets. The students who were in a critical position near grade boundaries and so on had, effectively, a personal tutor for science who advised and encouraged them. This tutor was not necessarily their science teacher at that particular time and so the student could actually be taught and helped in areas where they were experiencing problems without necessarily having to expose their weakness or insecurity in a group situation.

The strategies and techniques which appear to have been influential in creating the desired environment for promoting 'science' can be grouped into three separate but not clearly-defined areas. These can be summarised according to their contributions to the overall science experience and relate to the nature, the quality of the experience and the effect of the experience. The role of the teacher as counsellor described above, for example, relates to both the quality and the effect of the experience. The quality aspect is inherent within the personal treatment of the students, acknowledging their status as individuals within the cohort and recognising their needs. The effect was, hopefully, the promotion of the student's attainment in GCSE science.

Improving the nature of the experience included, for example, introducing interesting contexts and enlivening the teaching environment. It was also necessary to encourage more active student participation in science by, for example, promoting group work, developing clear but challenging investigational opportunities, recognising and valuing students' contributions. Alternative methods of communication were encouraged in order to enable students to make a more personal contribution. Providing an atmosphere in which the girls felt safe was also important in this area, for example, enabling them to express opinions and have them valued rather than ridiculed; to investigate, research and report back in their own way and not having to 'fight' for laboratory equipment. The constraints which were observed to be acting upon girls in science lessons have been discussed in more detail in Chapters 1 and 6. It was necessary for us to prevent the boys from dominating the teaching environment whilst still encouraging them to actively involve themselves within the teaching and learning cycle.

Some of those activities which were intended to improve the nature of science also improved the quality of the experience by promoting positive attitudes amongst the students. Active participation and recognition of contribution were effective here. Differentiated activities were promoted in order that students could feel confident that they could actually make contributions to the various tasks and investigations. The gender-related improvements noted above must have greatly improved the quality of the experience for the girls and although they did not contribute to promoting a feminist notion of science they certainly helped create an environment which was more welcoming to girls without being overtly 'girl-friendly'.

After the school's inspection (1993) the department was criticised to a certain extent for not taking enough chances in pushing the students. This may have been a valid criticism by an inspector viewing isolated incidents with unfamiliar students but we were working towards specific targets for students we knew quite well. We aimed to encourage our students individually to gradually improve their attainments. We were not 'holding their hands' but neither were we prepared to actively invite their failure. Our departmental results appear to have vindicated our approach and contributed to the benefit of the experience.

The other factors which relate to the nature and quality of science will have combined in different ways for students of different abilities and of both sexes. This will have produced an overall experience which was, hopefully, tuned to the needs of the individual allowing everyone to be free to achieve, given the constraints applied by the situation and the individual differences, to their best possible level.

Areas for further research

During the period of this research there have been a series of rapid and radical changes in government education policy which have had considerable bearing on the nature of the work. There has been little evidence of informed decision-making. Change has rapidly followed change with little opportunity for assimilation or consolidation. In fact, within the GCSE science framework, we have seen changes being made so rapidly that the preceding changes have had little time to be properly introduced, much less to be evaluated. The entire system of education in this country has been subject to a series of 'innovations' which have left the profession and the consumers reeling. The effects of these changes need to be carefully monitored over the next few years in order that we can attempt to identify any benefits and drawbacks.

The National Curriculum working party for science had proposed that 'control of the science curriculum should rest firmly with teachers' (T.E.S., 18.12.87, p7). It was also stipulated that the teachers 'must not be dictated to by rigid assessment demands.' The report suggested criteria which were intended to serve as guidelines for teachers but stressed that 'the selection of specific learning experiences is a matter for schools and teachers' and that this should be based on factors including availability of resources and the students' prior science experience. In addition to the areas of knowledge, skills and understanding the working party also considered the role played by the students' attitudes towards science. These proposals and recommendations appear to have been generally ignored by successive Secretaries of State for Education with policy changes often taking an opposing line. The Dearing Report does show evidence of having listened to what teachers and other professional bodies have had to say, hopefully the resulting changes, as outlined in the draft proposals, will build upon this.

This research programme has identified that coursework has a pivotal role in promoting the success of girls in GCSE science as they appear to benefit from the opportunity to carry out their own research and respond freely. Both the role of coursework within the GCSE assessment programme and the nature of the coursework tasks can provide powerful motivational factors leading to increased student success, particularly on the part of the girls.

Bousted (1992) commented on the rapidly increasing numbers of girls achieving A-C grades in GCSE English. She discussed how the extended coursework tasks were proving to be beneficial by promoting student involvement increasing the level of the students' skills and the quality of their work. Bland (1993) discovered that in mathematics, boys from the full range of abilities, preferred an examination-only approach to GCSE assessment. A headteacher observed (T.E.S., 30.9.94, p14) that at GCSE 'ongoing assessment seems to appeal to girls, who work very diligently at coursework'.

The evidence suggests that it is necessary to further investigate the importance of coursework in increasing the motivation and attainment of the girls. There appears to be little evidence of any comparative studies which could confirm the importance of GCSE coursework. The existing research appears to be mainly concerned with coursework in GCSE English, although there are some studies in mathematics. This research would suggest that there is urgent need for researchers to investigate in more depth the importance of coursework in GCSE science. Additional research is also necessary to identify ways in which the assessment framework could be amended in order to include a larger proportion of coursework but in a more rigorous and controlled fashion. HMI has recommended (Chapter 8) that the Examining Boards need to be seen to be playing a more active and innovative role in this area.

In 1993 SEAC prepared a code of practice for GCSE which detailed in Section 4 how GCSE coursework should be assessed and moderated by the Examining Boards. The code outlined how the coursework tasks should be set, marked, supervised and standardised. It specified:

> The examining group must provide a substantial portfolio of exemplar tasks and mark schemes which meet the defined parameters and criteria. Where an examining group does not set all the coursework tasks itself, it must ensure that the portfolio has sufficient range and depth to give teachers firm and explicit direction. Para 73.

The mechanisms of attitude formation have not been adequately explained by this research but some clues to their origins and operation have been suggested. It can be seen that irrespective of how and what we teach the attitude of the students towards the teachers, the teaching and the content is of paramount importance. Ultimately, however, it appears to be not the actual experiences which matter but the attitudes students develop towards these experiences. The teaching experience will, for the student, be influenced by both the teacher and the context. Individual students within a single teaching group will perceive the experience in different ways, other students' opinions may be absorbed to a greater or lesser extent, and the perceptions will be likely to change with time. This area of perception and attitude formation remains a crucial area of research in science education because we can still see considerable evidence of 'turning off' at all levels.

The President of the ASE (Blin-Stoyle, 1993) identified the problem of '...the continual decrease in the take-up of science and technology studies post-GCSE and in higher education.' (p3). He observed that at A-level the proportion of students in the physical sciences and mathematics had dropped when compared with, for example, arts subjects. The uptake of biology had, however, shown little change. A similar pattern was recorded in higher education with the proportion of engineering and technology applications dropping. He also commented that there was no evidence of an increased interest by girls in either the physical or engineering sciences. OFSTED (1994) observed that although the overall numbers of students taking A-levels was increasing, the actual proportion of those students taking science and mathematics courses had decreased quite dramatically since the early 1980s. The report also highlighted a drift away from physics.

The ASE (1994) also carried out a survey of balanced science provision in 178 schools in England and Wales. Some interesting observations were made possible by the different approach to the double science option, some students being directed into this option, others being given a choice. The results of the survey showed that '...where choice exists the numbers doing double science go down and that this decrease is greater for girls than for boys.' (p24). In spite of the improvements in attainment in GCSE science it appears that there is still some problem with our students' perceptions of science in both education and career terms.

A further worry which has been expressed is that the girls, although having made excellent progress in GCSE are still behind in A-level achievement. As noted elsewhere in this thesis, for example in Chapter 6 there is increasing dissatisfaction with the traditional academic structure of the A-level courses in this country in that the structure does not permit equality of opportunity.

Strong support for the apparent mismatch of the traditional A-level approach with those factors which motivate students was observed in a report on the 1994 A-level results of girls in Northern Ireland (T.E.S. 30.9.94). The 1993 GCSE results showed that the proportion of students being awarded 5 or more A-C grades was greater in the girls' schools, slightly ahead of the mixed schools and well ahead of the boys' schools. At A-level, however, this was reversed, the proportion of students gaining 3 or more A-C grades was similar in boys' and mixed schools and greater than in the girls' schools.

This illustrates that the A-level performance of the girls had not matched the promise shown by their GCSE results, with the gap reported as being quite large in certain curriculum areas. Subject choice and size of sixth form were identified as contributory factors although the mixed/single-sex question was inconclusive. As noted earlier in this chapter, Young (1994) suggested that social class was also a factor in this equation. The evidence discussed elsewhere in this thesis, as provided by this research, would suggest that the assessment structure and the coursework factor are both crucial elements in this problem. The T.E.S. article (30.9.94) also reports that Dr. Morgan from the University of Ulster believes, as a result of her own studies into gender bias, that the amount of coursework may be a contributory factor.

These observations suggest that two important areas in which further research can be of benefit are in both the uptake of and performance in A-level courses. This research programme has shown that it is possible to improve students' performance, motivation and self-esteem within GCSE science. The improvements were greater for the girls than for the boys. The post-16 pattern with the author's students follows that described above. Feedback from the local colleges indicates that very few of our students go straight from school to A-level courses in the sciences and of those few the proportion of girls is minimal. Some of our students will take further education courses which are to some extent science-related but this appears to be because of a necessity to study the science in order to follow a career rather than a desire to study the science and then select a related career. The discussions and proposals described in Chapter 6 all focus on the 14-19 age range identifying that a problem still exists within the secondary area and that this problem first begins to take effect at the 'option choice' phase in Year 9. Career and option choices at age 14 remain, therefore, prime areas for further research in the form of intervention and counselling, particularly with regard to student attitudes and perceptions.

The Rotherham Careers Service ('Where did they go?', R.C.S. bulletin to schools, December 1991) recorded that of 261 school-leavers entering employment by December of that year 52 were in science-related occupations (classified as technical, practical, scientific skill). Of these 52, 51 were boys. Of 746 students entering Youth Training Schemes for that year 169 were recorded for science-related training, 6 of these were girls.

The DFE Statistical Bulletin (1992) illustrated a decline in the numbers of students with A-levels in science-based subjects and an increase in arts-based subjects. The gender pattern also proved to follow the traditional bias with boys outnumbering the girls in physics, chemistry and mathematics passes, the pattern being reversed in biology where the girls were ahead of the boys.

This suggests that the whole area of careers choices, student ambitions and expectations may also provide a profitable area for further research, particularly when these factors are combined with the changing gender roles and characteristics of the students between the ages of 14 and 18.

Although we have managed to improve attainment for our students there still appears to be a lack of interest in science and little or no desire to continue science studies post-16. Obviously to simply increase the students' attainment is not enough and there appears to be a fundamental area within science education where we are failing to meet the needs of our students and this in turn leads to the knock-on effects described by the ASE. The fact that so many are turning-off suggests that it is actually the science education which is failing to attract the children. This recalls a point made earlier in the thesis in relation to girls and physics, questioning which of the two is actually doing the failing.

This failure may be due to the fact that we are actually turning the students off science, or that we are failing to capitalise on the interest in science displayed by the younger students. The students entering secondary school are generally seen to be interested in many different aspects of science (see Chapter 3). The younger students frequently have a natural curiosity regarding themselves and their environment but during Key Stage 3 this curiosity gradually diminishes. We appear to be either failing to capitalise upon this curiosity early on in the secondary system, or failing to adequately meet the needs of the students in terms of their desire to know and to find out.

As we become increasingly concerned with the progress of our students during the early secondary years we begin to focus more and more on National Curriculum levels and attainment and this must to a certain extent, be destroying the magic which surrounds science for many students. This is not to say that we should be ignoring the attainment levels of our students, we should be continually concerned with promoting their achievements. One of the ways in which we can do this, however, is by encouraging those positive aspects of science education which our students bring with them into the secondary school. Our students have expectations of science in the secondary school and if we can meet these expectations and harness their interest and enthusiasm we can begin to translate this into real achievement. The introduction of the unfamiliar and often meaningless National Curriculum-related assessment criteria may well be actively contributing to the turning-off process.

There remains vital work to be carried out in this area before the observed trend becomes the normal pattern of events with the knock-on effect for industry, both manufacturing and engineering.

OFSTED (1994) supported many of the research issues raised earlier in this chapter, highlighting several areas of science and mathematics education where they felt there were currently inadequacies. Among these areas they identified that research was necessary in determining the ways in which students learn in order to improve the quality of both teaching and learning. They also suggested that future studies should focus on the mechanisms of student choice looking particularly at student attitudes towards and career choices in science and mathematics. It was also recommended that further moves were made to make these subjects more attractive to girls.

Conclusion

This thesis opened with a quote from the EOC from 1985 which expressed two major areas of concern with the structure of our educational system, suggesting that its structure did not allow the girls freedom of opportunity. These areas of concern were:

> ...1. within a largely co-educational system different patterns of education and different educational experiences are identifiable for girls and for boys,
> 2. the outcome of the education system is unequal and is generally less favourable for girls regardless of their ability and aptitude. (p1)

A decade later the evidence provided by this thesis suggests that both these areas of concern have been successfully addressed by this programme of research. Firstly, we succeeded in providing patterns of education and educational experiences which were essentially identical for both the boys and the girls but which allowed all students the opportunity to achieve freely. More importantly, we succeeded in this area without discriminating against or favouring either sex. Secondly, we discovered that the outcomes were still somewhat unequal, although in the opposite way to that suggested above because our initiatives allowed the girls the opportunity to make full use of their abilities and aptitudes.

During this discussion of the research a great deal of attention has been devoted to the analysis of the Suffolk science scheme and its assessment. There is no intention to suggest that the Suffolk scheme is perfect, it does have its faults and these have been identified and highlighted. It serves, however, as an excellent and successful example of a coursework-led assessment framework for GCSE science. It appeared to encourage and motivate students, both boys and girls. In view of the observed successes, the modification and regulation of Suffolk and other similar courses with a successful coursework component may have been a preferable alternative to process of dismantling and dilution imposed by the government.

This research has also demonstrated that it is possible for our under-achieving students to improve their performance in science to the point where they are demonstrating success at GCSE level. Our more able students have also been able to demonstrate increased attainment. Both of these gains appear to have been achieved mainly through an improvement in the quality of the students' science education with an emphasis on the mechanisms of assessment. However, this thesis was initially aimed at promoting achievement within a gender framework and it would appear to have succeeded by demonstrating that, within this pattern of general improvement, it is possible to promote the achievement of girls.

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<u>APPENDIX 1</u>

Concluding suggestions and recommendations from the ASE consultative document 'Alternatives for Science Education'. (ASE, 1979, pp 52-54)

The committee noted positively:

(a) that science education, particularly at the secondary school level and for the more able pupil, has improved considerably during the last two decades, and we should acknowledge our debt to all those who have contributed to the curriculum renewal movement;

(b) that many teachers have sought, often under difficult circumstances, to adapt existing resources designed for academically oriented pupils to meet the needs of the average and below average pupil;

(c) that the science teaching profession has in so many ways sought to adapt theory and practice to the changing context of comprehensive education for all, new examination systems and, in many respects, the hopes and aspirations of ordinary pupils, their parents and their reference groups.

The following problems were also highlighted:

(d) that science syllabuses have become more heavily content laden, to the extent that at A level they contain much that previously would not have been encountered outside the confines of an honours degree in science;

(e) that at the primary school level, which we regard as an essential building block in the total edifice of science education for all, we have, as a nation, failed to convert the hopes of the early 1970s into a reality for the 1980s;

(f) that school science has, both overtly and covertly, become more pure, conceptually demanding and complex, and less concerned with the everyday reality and experience of our youngsters, their parents and their employers: it has, in so many ways, become a complex symbolic system accessible to the few, and we do not believe that there is anything intrinsic in science, or science studies, that necessarily forces our subject in this direction;

(g) that while the needs of future scientists *may* be met within current provision, we have done little to relate science studies to other legitimate goals, particularly those related to education for life, for work, for citizenship or for leisure;

(h) that the important cultural aspects of science, its history, philosophy and contribution to the way twentieth-century man conceptualizes his

environment, have not been adequately considered in the construction of examination syllabuses and courses at all levels of schooling;
(i) that science teaching, particularly at secondary school level, too often appears as a highly specialist and capital-intensive activity outside the general curriculum of the school. It appears, like modern languages, as a difficult but high-status adjunct to general education which, in the main, fails to create effective links with other subjects.

The committee recommended:
1. That science studies have a key role to play in general education but that radical changes in the content and nature of school science must be made if obligations are to be effectively discharged.
2. Young people, of all abilities and aspirations, have the right of access to the world of science, and it is incumbent upon all teachers and administrators to ensure that ways are found whereby science studies can become accessible to all.
3. That science education programmes and courses must be broadened at all levels to enable teachers and pupils to explore more flexibly and creatively the wider implications of science in society. This must mean a marked reduction in content and a more flexible and imaginative use of resources including the laboratory, the environment and the literature of science.
4. While experimental work and the detailed study of the conceptual proceses that characterize science must remain central to all work undertake, an equal, and balancing, emphasis must be placed on developing an understanding of the usefulness of scientific knowledge and processes in society and in everyday life.
5. As a direct consequence of the above assertion we recommend that substantial resources be allocated to a major programme of research and development that seeks to evaluate alternative definitions of school science; that develops and effectively evaluates curricula proposals in the areas of applied science, earth sciences and the history and philosophy of science; and which develops a series of small-scale and intensive studies of the nature of young people's conceptualizations of science and scientific processes.
6. That every opportunity is taken during the normal processes of

curriculum review to move gradually in the directions suggested in this report. In particular we recommend that the introduction of a common examination system at 16+ should be seen as a major opportunity to to realize some of the implications of our often repeated slogan, 'Science education for all'. Similarly we urge that irrespective of the N and F debate, efforts will be made to improve A-level syllabuses.

Finally we urge the Association and all concerned with science education to consider in detail the implications of the HMI report 'Primary Education in England' and reconsider the basis upon which resources are allocated to this sector of educational provision.

7. That the Association, in cooperation with LEAs, the Schools Council and the DES, responds as a matter of great urgency to the very considerable need to review science teacher training provision and the training of primary/middle school teachers at the initial and in-service levels. We feel that science teachers can respond to the repeated challenges referred to earlier only if realistic and practical provision is made for the further improvement of the teaching force, the resources available to it, and the conditions under which it works. While we do not wish to specify these matters in terms of teaching loads, class size, capitation allowances and study leave, we remain convinced that these factors must be constantly reviewed in the context of any proposals to change the curriculum.

8. Finally, we recommend that this consultative document is regarded by all who read it as a basis for discussion and not a prescriptive recipe for a brave, or frightening, new world.

APPENDIX 2

Summary of recommendations and proposals from the ASE policy statement 'Education Through Science'. (ASE, 1981, pp 3-6)

Part I The place of science in the school curriculum

1. Education through science is an important component of general education and as such should continue to be recognized as part of the core, or protected, element of the curriculum.
2. All pupils should have the opportunity to benefit from a full and effective programme of science education through their period of compulsory schooling.
3. All schools should have a strategy that enables aspects of the aims for science education to be achieved through appropriate work in science and other subject areas.
4. All schools should develop an approach to science studies based on the notion of science across the curriculum which sees science as essential in the development of a common core or curriculum at the primary and secondary levels of schooling.
5. The science curriculum should incorporate a reasonable balance between the specialist and generalist aspects of education through science and should reflect the range of contexts and aims specified.
6. Current provision at the primary and secondary levels suffers from a number of important weaknesses and the Association believes that a strong case exists for the further development of school science teaching

Part II The development of the school science curriculum

7. In the short term, the Association urges schools and local education authorities to prevent any erosion of present levels of provision.
8. The Association remains fully committed to the development of effective provision of science education in the early years of schooling.
9. At the lower secondary level, schools should provide a broad general introductory course of science studies for all pupils.
10. A strong case exists for the redefinition and restructuring of introductory courses at the lower secondary level.
11. In the final years of compulsory secondary education, the Association accepts that the present subject option system across the curriculum is inadequate for future education and social needs.
12. In considering alternative strategies, the Association stresses the need

for a rigorous review of current syllabuses; the establishment of school science curriculum development plans; and the active exploration of integrated, modular and extended courses for the 13-16 age group.

13. The Association supports the establishment of regular LEA reviews of curriculum provision at the secondary level and the provision of national programme of research and development.

14. The Association in the long term, sees the necessity for a fundamental review of 16-19 curriculum provision but urges that such a review should take account of curricular changes lower down the secondary school.

15. In the short term, the Association recommends a review of all A-level and H-grade syllabuses in the light of the emerging criteria for the Common Examination System at 16+; the development of new A-level and H-grade science courses for students who do not wish to specialize in biology, chemistry or physics; and the creation of wider opportunities for science studies in the 16-19 stage of formal education.

16. The Association believes that further studies in science and technology should be made available to the full range of boys and girls who leave school at 16+.

17. TheAssociation urges institutions of higher education to review their entrance procedures and assumptions carefully, in order to increase educational opportunity at the tertiary level.

18. TheAssociation considers it important that discussions are held with representatives of higher education on ways of improving transistion arrangements between school and higher education.

19. The Association believes that greater resources should be allocated to science related courses in adult education.

Pedagogic implications of Science for All

20. The Association accepts that a policy of science education for all has many pedagogic implications and strongly recommends increasing the levels of self-evaluation on the part of science teachers.

21. In the above context, the Association regards it as critical that teachers of science should adopt a wider and more flexible range of teaching styles in their science education programmes.

22. The Association attaches great importance to the role of written and spoken language in effective science teaching.

23. The Association also attaches importance to the careful definition of the relationships between mathematics and science in the school curriculum.

The assessment of the outcomes of teaching and learning

24. The Association welcomes the decision to implement a common system of examining at 16+ and attaches great importance to the creation of a system that increases educational opportunity and leaves schools free, within nationally agreed criteria and orgnizational frameworks, to measure student performance against their own detailed criteria and across the full ability range.

25. In the long term the Association supports the development of criterion-referenced examinations and profile reporting systems.

Resources for the effective teaching of science in schools

26. The Association urges the new Advisory Committee on the Supply and Education of Teachers to give urgent attention to the problem of the supply of qualified teachers of the physical sciences.

27. The Association believes that all initial training courses for primary teachers should contain a compulsory course in the teaching of science.

28. The Association recommends the establishment of special courses of initial training designed to produce advisory teachers at the primary level with expertise in methods involving young children in scientific work.

29. The Association urges training associations and validating bodies to review the content and organization of courses of initial training in order to achieve a number of stated aims.

30. The Association attaches the greates importance to the development of a more effective programme of in-service training and support for teachers of science. To facilitate such a programme, the Association is establishing an In-service Validating Committee.

31. The Association notes with concern that resource provision in maintained primary and secondary schools is in many cases inadequate to meet the demands of the present curriculum. Guidelines for the provision of resources are incorporated in Part II of the document. In particular the Association recommends that for practical work all classes should be restricted to a maximum of twenty pupils.

Part III Implementation

32. It is recommended that the Association should create a structure for the implementation of this, and future policy statements.
33. It is recommended that the Association should establish a Standing Policy Review Group; an Advisory Committee; and seek formal reciprocal representation with other educational bodies.
34. It is recommended that the Association should review the role of its existing journals and consider the possibility of a further publication devoted to discussion and dissemination of matters of policy. It should also review its internal management and organization and the role of the Secretariat.
35. It is recommended that this policy statement should serve as a focus for national, regional and sectional meetings and conferences in the immediate future.

APPENDIX 3

Questionnaires issued to students in 1987 Year 7 cohort to investigate science-related activities and interests (Task 3).

First name..

Surname..

Please tick one box for each question

DO YOU ???????????????????	OFTEN	SOMETIMES	NEVER
Wash the dishes			
Look after animals			
Read books about science			
Take photographs			
Change a plug			
Watch TV programmes on science			
Hoover and dust			
Play with Lego/Meccano			
Play with remote control cars			
Play with plasticine			
Play with paints/crayons			
Collect rocks			
Collect flowers/plants			
Watch TV programmes on animals			
Watch 'Transformers'			
Watch 'Jem'			
Repair a bicycle			
Cook			
Use the washing machine			
Iron			
Use a screwdriver or other tools			
Use a microwave			

First name..

Surname..

Please tick to show which of the following you would like to learn more about in your science lessons.

	YES	NO
Eyes and seeing		
Animals as pets		
Cameras and photographs		
Trees and flowers		
Stars and planets		
Electrical models		
Muscles and movement		
Acids and chemicals		
Volcanoes and earthquakes		
How motor cars work		
Computers		
Microscopes		
Science in sport		
Plants we can eat		
How children develop		
Looking after our bodies		
How a television works		
Building models		
Animals in the jungle		
Measuring		
Food and our diet		
Making a record		
Rainbows		
Ears and hearing		
Our bodies		

APPENDIX 4

Questionnaires issued to parents to investigate curriculum preferences for their children in 1987 Year 7 cohort (Task 4).

1. PUPIL'S NAME ______________________________

2. TUTOR GROUP __________ 3.TEACHING GROUP ______________

4. PLEASE READ THROUGH THE FOLLOWING LIST OF SCHOOL SUBJECTS AND TICK THE BOX TO SHOW WHETHER YOU THINK EACH ONE IS VERY IMPORTANT, QUITE IMPORTANT OR NOT IMPORTANT FOR YOUR CHILD TO STUDY.

	VERY IMPORTANT	QUITE IMPORTANT	NOT IMPORTANT
ART			
BIOLOGY			
CAREERS EDUCATION			
CHEMISTRY			
COMPUTER STUDIES			
COOKERY			
DRAMA			
ECONOMICS			
ENGLISH			
FRENCH			
GEOGRAPHY			
GERMAN			
HEALTH EDUCATION			
HISTORY			
MATHS			
MUSIC			
NEEDLEWORK			
PHYSICAL EDUCATION			
PHYSICS			
RELIGIOUS EDUCATION			
SEX EDUCATION			
TECHNOLOGY			
WOOD/METALWORK			

5. PLEASE TICK WHICH OF THE FOLLOWING REASONS HELPED YOU TO DECIDE WHICH SUBJECTS ARE IMPORTANT FOR YOUR CHILD.

(i) Your child likes it

(ii) Your child is good at it

(iii) It will be useful for a job/career

(iv) It will be useful for life

(v) It is interesting

(vi) It will benefit your child as a person

(vii) Any other reason ______________________________

____

____

6. ARE THERE ANY SUBJECTS WHICH YOU FEEL ARE MORE IMPORTANT FOR BOYS?

____

____

OR MORE IMPORTANT FOR GIRLS? ____________________

____

____

OR ANY SUBJECTS WHICH YOU FEEL ARE IMPORTANT FOR BOTH BUT WOULD BE BETTER STUDIED IN SINGLE-SEX GROUPS?

____

____

7. ARE THERE ANY ASPECTS OF SCHOOL LIFE, OR ANY SUBJECTS, WHICH YOUR CHILD HAS TOLD YOU THAT THEY HAVE PARTICULARLY ENJOYED?

____

____

OR THAT THEY HAVE PARTICULARLY DISLIKED? ____________________

____

____

8. HAS YOUR CHILD TAKEN PART IN ANY EXTRA-CURRICULAR ACTIVITIES E.G. SPORTS TEAMS, INSTRUMENT LESSONS, ETC.?

____

____

9. ARE THERE ANY ACTIVITIES WHICH YOU WOULD LIKE THE SCHOOL TO PROVIDE SO THAT YOUR CHILD CAN TAKE PART?

____

____

10. ARE THERE ANY AREAS OF YOUR CHILD'S EDUCATION OR DEVELOPMENT TO WHICH YOU DO NOT FEEL THAT THE SCHOOL CONTRIBUTES ADEQUATELY?

____

____

11. ARE THERE ANY WAYS IN WHICH YOU FEEL THAT YOU WOULD LIKE TO CONTRIBUTE TO THE WORK OR THE LIFE OF THE SCHOOL?

____

____

APPENDIX 5

Pilot questionnaire for option choice survey, issued to 1987 Year 11 cohort (Task 5).

QUESTIONNAIRE

THIS QUESTIONNAIRE IS DEISGNED TO GIVE INFORMATION ABOUT OUR SCIENCE COURSES AND OPTION SYSTEM. PLEASE COMPLETE THE INFORMATION ABOUT YOURSELF AND THEN ANSWER ALL THE QUESTIONS BY TICKING THE CORRECT BOX OR BY ANSWERING IN YOUR OWN WORDS WHERE REQUIRED.

TUTOR GROUP __________ AGE __________ MALE [ ] FEMALE [ ]

1. WHICH SCIENCE SUBJECTS HAVE YOU STUDIED FOR GCSE IN YEARS FOUR AND FIVE?

   BIOLOGY [ ] CHEMISTRY [ ] PHYSICS [ ] MODULAR SCIENCE [ ]

2. WHEN YOU MADE YOUR OPTION CHOICES IN YEAR THREE, DID YOU HAVE A FUTURE CAREER IN MIND?

   YES [ ] NO [ ] NOT SURE [ ]

   IF YOUR ANSWER IS YES, WHAT CAREER WERE YOU THINKING OF?

   ____

3. DO YOU NOW HAVE A CAREER IN MIND?

   YES [ ] NO [ ] NOT SURE [ ]

   IF YOUR ANSWER IS YES, IS IT THE SAME AS IN QUESTION 2?

   YES [ ] NO [ ]

   IF YOU HAVE CHANGED YOUR MIND, WHAT CAREER ARE YOU NOW THINKING OF?

   ____

4. DO YOU THINK THAT YOU WILL NEED SCIENCE FOR YOUR CAREER?

   YES [ ] NO [ ] NOT SURE [ ]

5. DID YOUR CAREER CHOICE HAVE ANY EFFECT ON YOUR OPTION CHOICES?

   YES [ ] NO [ ]

6. WHICH OF THE FOLLOWING DO YOU THINK INFLUENCED YOUR CHOICE OF OPTION SUBJECTS?

	YES	NO
YOUR PARENTS		
YOUR TEACHERS		
YOUR FRIENDS		
YOUR RELATIVES		
SUBJECTS YOU LIKED		
SUBJECTS YOU DISLIKED		

7. WHICH IS YOUR FAVOURITE SCIENCE SUBJECT?

BIOLOGY [ ] CHEMISTRY [ ] PHYSICS [ ]

8. WHAT DO YOU LIKE MOST ABOUT YOUR FAVOURITE SCIENCE SUBJECT?

CARRYING OUT EXPERIMENTS	
DOING CALCULATIONS/PROBLEMS	
DRAWING DIAGRAMS	
WRITTEN WORK	
DRAWING GRAPHS/CHARTS	
ANY OTHER	

IS THERE ANYTHING ELSE YOU LIKE ABOUT SCIENCE?

YES [ ] NO [ ]

IF YES, WHAT ELSE DO YOU LIKE? ______________________________

____

____

____

9. WHAT DO YOU LIKE LEAST ABOUT SCIENCE?

CARRYING OUT EXPERIMENTS	
DOING CALCULATIONS/PROBLEMS	
DRAWING DIAGRAMS	
WRITTEN WORK	
DRAWING GRAPHS/CHARTS	
ANY OTHER	

IS THERE ANYTHING ELSE YOU DISLIKE ABOUT SCIENCE?

YES [ ] NO [ ]

IF YES, WHAT ELSE DO YOU DISLIKE? ______________________________

____

____

____

10. HOW DO YOU RATE YOUR ABILITY IN THE FOLLOWING SCIENCE SUBJECTS?

	BIOLOGY	CHEMISTRY	PHYSICS
VERY GOOD			
GOOD			
AVERAGE			
BELOW AVERAGE			

11. DO YOU THINK YOU USE SCIENCE IN ANY OTHER SUBJECTS?

YES [ ] NO [ ]

IF YES, WHAT ARE THE SUBJECTS?

____

WHAT TYPE OF SCIENCE?

____

____

12. THERE HAS BEEN A LOT OF TALK RECENTLY ABOUT HOW WELL GIRLS AND BOYS DO IN SCIENCE SUBJECTS. DO <u>YOU</u> THINK THERE ARE ANY DIFFERENCES?

YES [ ] NO [ ]

IF YOUR ANSWER IS YES, WHAT ARE THE DIFFERENCES AND IN WHICH SUBJECTS?

____

____

____

HOW DO YOU NOTICE THEM?

____

____

____

HOW DO YOU THINK THEY COME ABOUT?

____

____

____

13. YOU HAVE NOW ALMOST COMPLETED YOUR GCSE SCIENCE COURSES AND KNOW WHAT IS EXPECTED OF YOU. IF YOU HAD THIS INFORMATION IN YEAR THREE WOULD YOU HAVE MADE THE SAME OPTION CHOICES IN SCIENCE?

YES [ ] NO [ ]

IF YOUR ANSWER IS NO, HOW WOULD YOUR CHOICES BE DIFFERENT?

____

____

____

WHY WOULD YOUR CHOICES BE DIFFERENT?

____

____

____

14. *WOULD YOU WISH TO CHANGE ANY OF YOUR NON SCIENCE OPTIONS?*

YES ☐ *NO* ☐

IF YES, WHICH SUBJECTS WOULD YOU WISH TO CHANGE?

____

____

____

WHY WOULD YOU WISH TO CHANGE?

____

____

____

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APPENDIX 6

Responses to Task 5 (pilot for option choice survey) from 1987 Year 11 cohort.

What else do you like about science? (Q8)

BOYS' RESPONSES

Sorting things out by myself.
Working in groups.
I find it very interesting and I think science(s) required for future employment. Physics is also useful for knowledge required in the home.
It is taught in a good manner and can be learnt easily without a lot of revision of all the course work.
Finding out about things I previously didn't know. Finding out why things work, what makes them work and how that is useful to us.
Discovering things for myself and working things out.
Solving problems.
Doing our own little topics (Modular Science).

GIRLS' RESPONSES

Watching videos and using hearts of animals to get a better look at it.
The way girls are treated against boys because usually it is thought that only boys are good at science and want to go into a career involving science.
Very interesting and enjoyable.
Learning other things that are new because everything that is learnt help a little bit when you leave school to get a job.
Finding things out about nature.
Interesting, finding out about how things work etc.
Finding out all the things I already didn't know.
Learning about your body and the things around you.

What else do you dislike about science? (Q9)

BOYS' RESPONSES

The teacher.
Listening to teacher.
I dislike the fact that not enough experiments are carried out which appear

to be required in experiencing the true facts of the sciences.
Teacher talking for too long.
Too much to remember.

GIRLS' RESPONSES

The fact that it is usually boring.
It is too complicated and I think the course should have been longer.
Carrying out experiments where you cut up a heart or something.
Watching boring videos.
The teacher.
We don't do enough practical work.

<u>What are the differences between girls and boys in science and how you notice them? (Q12)</u>

BOYS' RESPONSES

Girls find solving problems hard in science. The girls sit about doing nothing during experiments. Some girls are very good at written work and learning equations etc but cannot think for themselves when there are no books or equations.
No difference. A few girls in our class do quite well and others don't do quite as well as the boys.
Girls do better at biology, boys do better at physics and chemistry.
Girls are rubbish at unpleasant jobs in biology.

GIRLS' RESPONSES

Girls do better at biology and chemistry while boys mainly like physics which I can't stand. More boys go for physics than girls.
Boys enjoy physics more than girls because they tend to choose it as an option because of their career (engineering etc). They are nearly all boys in our physics lessons.
Not many girls are interested in things like electronics so all the girls do science about the body.

Boys tend to do well in science and more boys do science than girls.

Boys (majority) tend to like physics and chemistry whereas girls tend to like biology. Different sexes are interested in different things.

I think some girls may lack self-confidence, because they have a negative attitude towards sciences they don't do as well.

More boys opt for physics while there are more girls opting for biology. Boys are more interested in machinery, girls are more interested in animals.

Physics seems to appeal to boys because it has a lot to do with machinery which is what they USUALLY aim for when looking for a job. Boys are more mechanically minded.

In physics boys seem to take it more as it is mainly a mechanical sort of subject. Boys are more suited and interested in the subject.

Girls take biology and boys take physics. When told to choose boys go for physics and girls to biology. This is because girls think that boys are better at physics than they could be.

Girls go more for the biology and the boys go more for physics. Chemistry is neutral. When given a choice girls seem to be set against doing electronics and things like that mainly because they think boys are better at it than them.

APPENDIX 7

Revised questionnaire for option choice survey issued to 1988 Year 11 cohort (Task 8).

QUESTIONNAIRE

SCIENCE OPTIONS AND CAREER CHOICES

This questionnaire is designed to provide information about our options system and how you feel about your option choices.

Please fill in the following information about yourself and then answer all the questions on the following pages.

Last name ______________________________

First name ______________________________

Tutor group ________________ *Age* ________________

Sex ________________ *Date* ________________

Please be honest and open in your answers to the questions, your responses will not be seen by your teachers or friends.

PLEASE ANSWER ALL THE QUESTIONS

Q1. Please tick to show which science subjects you are studying for GCSE

BIOLOGY ☐ *CHEMISTRY* ☐ *PHYSICS* ☐ *MODULAR SCIENCE* ☐

Q2. When you made your option choices in year three, did you have an idea of what you would like to do on leaving school? Please tick.

YES ☐ *NO* ☐ *NOT SURE* ☐

If your answer is YES, what career did you have in mind?

____

What career do you now have in mind?

____

Q3. Please tick the BOX OR BOXES to show which of the following helped you to decide which SCIENCE options to choose.

YOUR PARENTS ☐

YOUR FRIENDS ☐

YOUR TEACHERS ☐

YOU FELT THAT YOU WERE GOOD AT THE SUBJECT ☐

YOU LIKED THE SUBJECT ☐

YOU LIKED THE TEACHER ☐

YOU THOUGHT YOU WOULD NEED IT FOR A CAREER ☐

Which of these influenced you the most?

____

Q4. Please tick one box to show how you rate your ability in BIOLOGY

GOOD [ ] AVERAGE [ ] BELOW AVERAGE [ ]

Q5. Please tick one box to show you you rate your ability in CHEMISTRY

GOOD [ ] AVERAGE [ ] BELOW AVERAGE [ ]

Q6. Please tick one box to show how you rate your ability in PHYSICS

GOOD [ ] AVERAGE [ ] BELOW AVERAGE [ ]

Q7. Which subject do you like best? Please tick.

BIOLOGY [ ] CHEMISTRY [ ] PHYSICS [ ]

Q8. Please tick the BOX OR BOXES to show what you like most about your favourite science subject.

DOING EXPERIMENTS	[ ]
DOING CALCULATIONS/PROBLEMS	[ ]
DRAWING DIAGRAMS	[ ]
WRITTEN WORK	[ ]
LEARNING ABOUT SCIENCE IN OUR EVERYDAY LIFE	[ ]
LISTENING TO THE TEACHER	[ ]
TALKING TO THE TEACHER	[ ]
TALKING TO OTHER PUPILS/GROUP WORK	[ ]
BEING ASSESSED IN PRACTICAL EXPERIMENTS	[ ]

Q9. Please tick the BOX OR BOXES to show what you dislike about science.

DOING EXPERIMENTS	[ ]
DOING CALCULATIONS/PROBLEMS	[ ]
DRAWING DIAGRAMS	[ ]
WRITTEN WORK	[ ]
LEARNING ABOUT SCIENCE IN OUR EVERYDAY LIFE	[ ]
LISTENING TO THE TEACHER	[ ]
TALKING TO THE TEACHER	[ ]
TALKING TO OTHER PUPILS/GROUP WORK	[ ]
BEING ASSESSED IN PRACTICAL EXPERIMENTS	[ ]

Please write down anything else you particularly dislike about science.

____

____

____

Q10. Do you think BIOLOGY is

QUITE DIFFICULT [ ] AVERAGE [ ] FAIRLY EASY [ ]

Q11. Do you think CHEMISTRY is

QUITE DIFFICULT [ ] AVERAGE [ ] FAIRLY EASY [ ]

Q12. Do you think PHYSICS is

QUITE DIFFICULT ☐ AVERAGE ☐ FAIRLY EASY ☐

Q13. Do you think boys do

BETTER THAN ☐

ABOUT THE SAME AS ☐

NOT AS WELL AS ☐

girls in science? Please tick.

Why do you think these differences exist?

____

____

____

____

Q14. A fourth year pupil said that "SOME SCIENCE SUBJECTS ARE MORE SUITABLE FOR BOYS THAN FOR GIRLS." Tick the box to show how you feel about this statement.

AGREE ☐ DISAGREE ☐ NOT SURE ☐

If you agree, please write below which science subjects you think are

MORE SUITABLE FOR BOYS ______________________________

MORE SUITABLE FOR GIRLS ______________________________

SUITABLE FOR BOYS AND GIRLS ______________________________

Please try to explain why you feel that some science subjects are more suitable for boys than girls.

____

____

____

____

Q15. You have now completed one year of your GCSE science courses and know more about the subject and what is expected of you. If you had this information in year three do you think that you would have made the same option choices in SCIENCE?

YES ☐ NO ☐

If your answer is NO which subject or subjects would you wish to change and what would you like to take instead?

____

____

Why would you wish to change this subject or subjects?

____

____

____

APPENDIX 8

Questionnaires for attitudes surveys issued to 1987 year 9 cohort to investigate student perceptions of interest, ability and gender issues in (i) biology; (ii) chemistry; (iii) physics (Task 6).

		STRONGLY AGREE	AGREE	DISAGREE	STRONGLY DISAGREE	UNDECIDED
1.	Once I've left school, I won't think about most of my BIOLOGY any more.					
2.	When I do well in a BIOLOGY test I consider myself lucky.					
3.	Most of my friends think BIOLOGY is boring.					
4.	It's not really important for girls to do well in BIOLOGY exams at school.					
5.	We go on to new work in BIOLOGY far too quickly for me to follow it.					
6.	I don't find much use for BIOLOGY out of school..					
7.	I find BIOLOGY lessons interesting, whatever we are doing.					
8.	BIOLOGY teachers seem to pay more attention to the girls in the class.					
9.	I can't remember half the things we are taught in BIOLOGY.					
10.	I find it difficult to understand BIOLOGY even when the teacher explains it to me.					
11.	I enjoy the fact that there's always something new for me to learn in BIOLOGY.					
12.	I would like to spend more time learning about the BIOLOGY of things in and around our homes.					
13.	Boys are always trying to get the teacher's attention in BIOLOGY lessons.					
14.	Learning about BIOLOGY is helpful in understanding how things around us work.					
15.	When we do experiments in BIOLOGY the boys always seem to get the apparatus first.					
16.	I am quite good at BIOLOGY.					
17.	I enjoy doing the graphs and charts in BIOLOGY.					
18.	The experiments in BIOLOGY are usually fairly easy.					
19.	Girls don't often ask questions in BIOLOGY lessons.					
20.	I can use BIOLOGY to solve some everyday problems.					
21.	Doing experiments in BIOLOGY is more for boys than for girls.					
22.	I have more trouble understanding BIOLOGY than any other subject.					

	STRONGLY AGREE	AGREE	DISAGREE	STRONGLY DISAGREE	UNDECIDED
23. A lot of the topics we do in BIOLOGY make no sense to me.					
24. Boys do BIOLOGY experiments better than girls.					
25. I find drawing the diagrams in BIOLOGY really boring.					
26. When you're thinking of a career BIOLOGY is more important for boys than for girls.					
27. I find it difficult to make conclusions from the results of my BIOLOGY experiments.					
28. I would rather have BIOLOGY lessons just with pupils of my own sex.					
29. I'm scared of it going wrong when we do BIOLOGY experiments.					
30. I think that girls concentrate better in BIOLOGY than boys.					
31. I can get so interested in a BIOLOGY experiment that I don't know what's going on around me.					
32. I usually understand a new idea quickly in BIOLOGY					
33. I like having to think things out in BIOLOGY					
34. I think BIOLOGY is more relevant for girls than for boys.					
35. When the BIOLOGY teacher asks a question it's always the girls who try to answer first.					
36. I only want to learn useful things in BIOLOGY.					
37. I would rather work on my own in BIOLOGY experiments.					
38. I think BIOLOGY is the most important of the sciences if you are a boy.					
39. I think that we should use BIOLOGY to learn how to help other people.					
40. I enjoy working on the mathematical problems in BIOLOGY.					
41. The teachers seem to think that the boys are more important in BIOLOGY.					
42. Each term, BIOLOGY gets harder for me to understand.					

		STRONGLY AGREE	AGREE	DISAGREE	STRONGLY DISAGREE	UNDECIDED
1.	Once I've left school, I won't think about most of my CHEMISTRY any more.					
2.	When I do well in a CHEMISTRY test I consider myself lucky.					
3.	Most of my friends think CHEMISTRY is boring.					
4.	It's not really important for girls to do well in CHEMISTRY exams at school.					
5.	We go on to new work in CHEMISTRY far too quickly for me to follow it.					
6.	I don't find much use for CHEMISTRY out of school.					
7.	I find CHEMISTRY lessons interesting, whatever we are doing.					
8.	CHEMISTRY teachers seem to pay more attention to the girls in the class.					
9.	I can't remember half the things we are taught in CHEMISTRY.					
10.	I find it difficult to understand CHEMISTRY even when the teacher explains it to me.					
11.	I enjoy the fact that there's always something new for me to learn in CHEMISTRY.					
12.	I would like to spend more time learning about the CHEMISTRY of things in and around our homes.					
13.	Boys are always trying to get the teacher's attention in CHEMISTRY lessons.					
14.	Learning about CHEMISTRY is helpful in understanding how things around us work.					
15.	When we do experiments in CHEMISTRY the boys always seem to get the apparatus first.					
16.	I am quite good at CHEMISTRY.					
17.	I enjoy doing the graphs and charts in CHEMISTRY.					
18.	The experiments in CHEMISTRY are usually fairly easy.					
19.	Girls don't often ask questions in CHEMISTRY lessons.					
20.	I can use CHEMISTRY to solve some everyday problems.					
21.	Doing experiments in CHEMISTRY is more for boys than for girls.					
22.	I have more trouble understandingCHEMISTRY than any other subject.					

		STRONGLY AGREE	AGREE	DISAGREE	STRONGLY DISAGREE	UNDECIDED
23.	*A lot of the topics we do in CHEMISTRY make no sense to me.*					
24.	*Boys do CHEMISTRY experiments better than girls.*					
25.	*I find drawing the diagrams in CHEMISTRY really boring.*					
26.	*When you're thinking of a career CHEMISTRY is more important for boys than for girls.*					
27.	*I find it difficult to make conclusions from the results of my CHEMISTRY experiments.*					
28.	*I would rather have CHEMISTRY lessons just with pupils of my own sex.*					
29.	*I'm scared of it going wrong when we do CHEMISTRY experiments.*					
30.	*I think that girls concentrate better in CHEMISTRY than boys.*					
31.	*I can get so interested in a CHEMISTRY experiment that I don't know what's going on around me.*					
32.	*I usually understand a new idea quickly in CHEMISTRY.*					
33.	*I like having to think things out in CHEMISTRY.*					
34.	*I think CHEMISTRY is more relevant for girls than for boys.*					
35.	*When the CHEMISTRY teacher asks a question it's always the girls who try to answer first.*					
36.	*I only want to learn useful things in CHEMISTRY.*					
37.	*I would rather work on my own in CHEMISTRY experiments.*					
38.	*I think CHEMISTRY is the most important of the sciences if you are a boy.*					
39.	*I think that we should use CHEMISTRY to learn how to help other people.*					
40.	*I enjoy working on the mathematical problems in CHEMISTRY.*					
41.	*The teachers seem to think that the boys are more important in CHEMISTRY.*					
42.	*Each term, CHEMISTRY gets harder for me to understand.*					

		STRONGLY AGREE	AGREE	DISAGREE	STRONGLY DISAGREE	UNDECIDED
1.	Once I've left school, I won't think about most of my PHYSICS any more.					
2.	When I do well in a PHYSICS test I consider myself lucky.					
3.	Most of my friends think PHYSICS is boring.					
4.	It's not really important for girls to do well in PHYSICS exams at school.					
5.	We go on to new work in PHYSICS far too quickly for me to follow it.					
6.	I don't find much use for PHYSICS out of school..					
7.	I find PHYSICS lessons interesting, whatever we are doing.					
8.	PHYSICS teachers seem to pay more attention to the girls in the class.					
9..	I can't remember half the things we are taught in PHYSICS.					
10.	I find it difficult to understand PHYSICS even when the teacher explains it to me.					
11.	I enjoy the fact that there's always something new for me to learn in PHYSICS.					
12.	I would like to spend more time learning about the PHYSICS of things in and around our homes.					
13.	Boys are always trying to get the teacher's attention in PHYSICS lessons.					
14.	Learning about PHYSICS. is helpful in understanding how things around us work.					
15.	When we do experiments in PHYSICS the boys always seem to get the apparatus first.					
16.	I am quite good at PHYSICS.					
17.	I enjoy doing the graphs and charts in PHYSICS.					
18.	The experiments in PHYSICS are usually fairly easy.					
19.	Girls don't often ask questions in PHYSICS lessons.					
20.	I can use PHYSICS to solve some everyday problems.					
21.	Doing experiments in PHYSICS is more for boys than for girls.					
22.	I have more trouble understanding PHYSICS than any other subject.					

	STRONGLY AGREE	AGREE	DISAGREE	STRONGLY DISAGREE	UNDECIDED
23. A lot of the topics we do in PHYSICS make no sense to me.					
24. Boys do PHYSICS experiments better than girls.					
25. I find drawing the diagrams in PHYSICS really boring.					
26. When you're thinking of a career PHYSICS is more important for boys than for girls.					
27. I find it difficult to make conclusions from the results of my PHYSICS experiments.					
28. I would rather have PHYSICS lessons just with pupils of my own sex.					
29. I'm scared of it going wrong when we do PHYSICS experiments.					
30. I think that girls concentrate better in PHYSICS than boys.					
31. I can get so interested in a PHYSICS experiment that I don't know what's going on around me.					
32. I usually understand a new idea quickly in PHYSICS.					
33. I like having to think things out in PHYSICS.					
34. I think PHYSICS is more relevant for girls than for boys.					
35. When the PHYSICS teacher asks a question it's always the girls who try to answer first.					
36. I only want to learn useful things in PHYSICS.					
37. I would rather work on my own in PHYSICS experiments.					
38. I think PHYSICS is the most important of the sciences if you are a boy.					
39. I think that we should use PHYSICS to learn how to help other people.					
40. I enjoy working on the mathematical problems in PHYSICS.					
41. The teachers seem to think that the boys are more important in PHYSICS.					
42. Each term, PHYSICS gets harder for me to understand.					

APPENDIX 9

Year 10 (1988 cohort) student comments from snowball discussion groups (Task 9).

Student responses from snowball discussions (Research Task 9).

GROUP 'A'

1. More interesting practical work.
2. More teaching from the teacher and not the book.
3. Equal amount of attention to both sexes.
4. Teacher not giving 100% attention to the group he is taking.
5. The work wasn't fully explained so that we could understand.

GROUP 'B'

1. The lessons are too boring.
2. Seems to be more for boys than girls.
3. Teacher didn't pay much attention to the work we were doing.
4. Work wasn't explained enough so we didn't know what to do.
5. Teacher was away a lot so we missed a lot of work, then the stand-in teacher didn't know how to help us.

GROUP 'C'

1. Physics is mostly for boys.
2. Technological side was difficult to understand.
3. Moved on too quickly.
4. Lighting a bunsen was more interesting than physics.

GROUP 'D'

1. Make the subject more interesting for girls especially.
2. The teacher should make us do more practicals and less writing.
3. The teacher should explain in more detail about the work we do.
4. The teacher should talk to the girls more because the boys understand more than the girls.
5. Physics is more about mechanical things so the subject is really for boys.

GROUP 'E'

1. The teacher talked to the boys more than the girls.
2. The girls worked harder than the boys but we didn't get much help, even though the boys got more help they messed about.
3. All we did was answer questions out of books, we did a lot of writing. He did all the practicals and all we did was watch him.
4. If we did a practical it was playing with Lego.
5. The teacher didn't explain about what we were doing. He wasn't a very good teacher.

APPENDIX 10

Materials unit, teacher modification (carrier bags)

One of the units in the Introductory Year of the Suffolk course (Materials) outlined a teaching sequence which was designed to be assessed under the process skill Planning and Designing. The lesson notes outlined two alternative routes to meet the assessment criteria, one of which involved a study of concrete, the other a study of paint. This was facilitated in the Suffolk Authority by the cooperation of a cement manufacturer and a paint manufacturer who had provided both materials and expertise.

Neither of these were readily available for my own school and alternatives were sought. I wanted to use both materials and contexts which were familiar to the students so that the assessment focussed entirely on their planning and designing skills and not on introducing them to using unfamiliar materials. The planning and designing exercise had to involve an element of product testing and I intended that these testing procedures should be devised by the students.

I produced three alternative approaches to occupy this lesson sequence. The first of these involved a comparison of carrier bags obtained from a variety of stores in the local town centre. The students were left to decide which aspects of carier bag design and manufacture they felt were important and then devise tests to enable comparisons to be made.The students completed the task by assessing the suitability of the bag for the goods likely to be sold by that store.

The second and third experiments were very similar but used different materials and contexts. The first of these involved testing five carpet samples, the students had to decide as a result of these tests which carpet would be most suitable for each of five specified areas. The alternative to this involved the students in attempting to match the suitability of five clothing fabrics for manufacturing clothes for people to wear in five different working environments.

The experiment designs and testing procedures developed by many of the students were innovative and rigorous. The lesson sequence allowed the assessment criteria to be matched and the students appeared to enjoy their work.

APPENDIX 11

Questionnaire relating to science lessons and interests issued to 1988 Year 9 cohort (Task 10).

SCIENCE LESSONS: QUESTIONNAIRE

We are trying to find out what you like and don't like about science lessons in general so that we can make some alterations in what we teach and how we teach it. Please read through each of the following questions carefully and answer each one as best you can. You may have noticed that there is no space for you to write your name; this is so that you can be completely honest in your answers without being identified. Your thoughts are important and will help us and other pupils. Thank you for your help.

PLEASE TICK BOY ☐ GIRL ☐

QUESTION 1. We all accept that there are times when we do have to write notes in science lessons but the way in which we do it can make a big difference to the lesson. Look at the following ways of note making and decide which one you like best. Put a number 1 in the box next to it. Give the one you like second best a 2, the next one a 3, and so on, until all 8 are numbered. Number 8 will be the one you like least.

A. COPYING NOTES FROM THE TEXT BOOK ☐

B. COPYING THE TEACHER'S NOTES FROM THE BOARD ☐

C. MAKING NOTES FROM THE TEXT BOOK BY PUTTING IT INTO YOUR OWN WORDS ☐

D. ANSWERING QUESTIONS FROM A BOOK OR WORKSHEET IN FULL SENTENCES ☐

E. COPYING QUESTIONS FROM A BOOK OR WORKSHEET THEN PUTTING ONE WORD ANSWERS ☐

F. COPYING A PASSAGE FROM A BOOK OR WORKSHEET FILLING IN MISSING WORDS ☐

G. WRITING DIRECTLY ONTO A WORKSHEET ☐

H. THE TEACHER DICTATING NOTES ☐

QUESTION 2. Experimenting is what Science should be all about. In order to ensure that you work safely and accurately and complete the work successfully, the teacher has to give you instructions. Read through the following ways of giving instructions and put a number 1 in the box next to the one you like most, a number 2 next to the one you like next, and so on, until you have numbered all 7. Number 7 will be the one you like least.

A. THE TEACHER EXPLAINS HOW TO DO THE EXPERIMENT ONCE ☐

B. THE TEACHER EXPLAINS HOW TO DO THE EXPERIMENT THREE OR FOUR TIMES ☐

C. THE TEACHER DEMONSTRATES HOW TO DO THE EXPERIMENT AND THEN LETS YOU GET ON WITH IT ☐

D. THE TEACHER GETS SOMEONE FROM THE CLASS TO DEMONSTRATE THE EXPERIMENT AND HELPS THEM TO DO IT THEN LETS YOU GET ON WITH IT ☐

E. THE TEACHER GIVES YOU A WORKSHEET WITH WRITTEN INSTRUCTIONS ONLY ☐

F. THE TEACHER GIVES YOU A WORKSHEET WITH WRITTEN INSTRUCTIONS AND DIAGRAMS OF THE APPARATUS ☐

G. THE TEACHER WRITES/DRAWS INSTRUCTIONS ON THE BOARD ☐

QUESTION 3. If the teacher demonstrates an experiment, demonstrates with another pupil, or simply explains the experiment, would you prefer to have written information to refer to during the experiment? Please tick one of the boxes below.

YES ☐ NO ☐

QUESTION 4. The way in which you are grouped can affect the way you do the experiment and your enjoyment of the work. When you do experiments do you prefer to work

A. ON YOUR OWN? ☐

B. IN PAIRS? ☐

C. IN THREES OR FOURS? ☐

PLEASE TICK ONE BOX ONLY.

QUESTION 5. How do you feel about working with pupils of the opposite sex when you do experiments?

A. I HATE IT ☐

B. I DON'T MIND ☐

C. I LIKE IT ☐

PLEASE TICK ONE BOX ONLY.

QUESTION 6. There are several different designs for experiments. Read through the alternatives below and put a number 1 in the box for the one you like most, a number 2 for the one you like next, and so on, until you have numbered all 5. Number 5 will be the one you like least.

A. AN EXPERIMENT WHERE YOU ALREADY KNOW THE ANSWER ☐

B. AN EXPERIMENT WHERE YOU DON'T KNOW THE ANSWER ☐

C. AN EXPERIMENT WHERE THERE IS NO "CORRECT" ANSWER ☐

D. AN EXPERIMENT WHERE YOU HAVE TO TAKE READINGS OR MAKE OBSERVATIONS AND RECORD THEM ☐

E. A PROBLEM-SOLVING EXPERIMENT WHERE YOU HAVE TO DECIDE ON YOUR OWN METHOD ☐

QUESTION 7. Would you rather

A. WORK ON YOUR OWN TO WRITE UP AN EXPERIMENT? ☐

B. WORK IN PAIRS TO WRITE UP AN EXPERIMENT? ☐

PLEASE TICK ONE BOX ONLY.

QUESTION 8. The list below is a series of topics which could be studied in a PHYSICS course. Place a number 1 in the box next to the one you think you would find most interesting, a 2 against the next most interesting, and so on, until you have numbered all 9 topics. Number 9 will be the one you think is least interesting.

A. ENERGY INVESTIGATIONS

B. SPORTS SCIENCE

C. MICROELECTRONICS

D. MACHINES AND WORK

E. USING ELECTRICITY

F. USING LIGHT

G. STRUCTURES AND FORCES

H. FORCES AND MOVEMENT

I. CHOOSING MATERIALS

QUESTION 9. The list below is a series of topics which could be studied on a BIOLOGY course. Place a number 1 in the box next to the one you think you would find most interesting, a 2 against the next most interesting, and so on, until you have numbered all 9 topics.

A. FOOD AND DIGESTION

B. CELLS AND LIFE

C. MICROBES

D. PATTERNS OF REPRODUCTION

E. USE OF ENERGY

F. PLANTS

G. LIFE AROUND US

H. ANIMAL BEHAVIOUR

I. CONTROLLING OUR BODY

QUESTION 10. The list below is a series of topics which could be studied on a CHEMISTRY course. Place a number 1 in the box next to the one you think you would find most interesting, a 2 against the next most interesting, and so on, until you have numbered all 9 topics.

A. RAW MATERIALS

B. GASES

C. ELEMENTS

D. CHEMICALS WE EAT

E. CONTROLLING REACTIONS

F. METALS

G. STRUCTURE AND PROPERTIES

H. CHEMISTRY IN THE HOME

I. ENERGY AND CHEMISTRY

PLEASE MAKE SURE THAT YOU HAVE TICKED THE BOY/GIRL BOX AND ANSWERED ALL THE QUESTIONS. THANK YOU AGAIN FOR YOUR HELP.

APPENDIX 12

Basic descriptors used for survey of Suffolk units with 1988 Year 8 cohort (Task 11).

Suffolk Units with 'basic' descriptors (Task 11).

BIOLOGY UNITS

FOOD AND DIGESTION

1. Identifying a healthy diet.
2. Meal analysis.
3. Starch in basic foods.
4. Feeding mechanisms.
5. The structure of the gut.

MICROBES

1. Examples of microbes.
2. Factors affecting the growth of microbes.
3. Microbe colonies.
4. Food preservation.
5. The spread and control of disease.

CELLS AND LIFE

1. Types of cells.
2. Investigating microstructure.
3. Biological organisation.
4. Characteristics of life.
5. Conditions needed for life.

PATTERNS OF REPRODUCTION

1. Types of reproduction - asexual and sexual.
2. Reproductive methods in plants.
3. Reproductive methods in animals.
4. Flower structure and human reproductive organs.
5. Dispersal methods.

CHEMISTRY UNITS

EXTRACTING MATERIALS

1. Separating using differences in properties.
2. Identifying by measuring boiling point.
3. Making water.
4. Water survey.
5. Chromatography.

GASES

1. The uses of gases.
2. The effects of gases.
3. Collecting gases.
4. Identifying gases.

ELEMENTS

1. Investigating elements.
2. Making new substances.
3. Making and breaking compounds.
4. Properties of elements.
5. Looking at one element in detail.

MATERIALS

1. Classifying the properties of materials.
2. Identifying plastics.
3. Preparation of polymers.
4. Environmental problems.
5. An industrial investigation.

PHYSICS UNITS

BIOPHYSICS AND SPORTS SCIENCE

1. Senses - stimulus and response.
2. Exercise and fitness.
3. Sports and body measurement.

ENERGY INVESTIGATIONS

1. Forms of energy.
2. Sources of energy.
3. Changing energy.
4. Using energy.
5. Constructing a device to convert energy.

MICROELECTRONICS

1. Making circuits.
2. Sensor circuits.
3. Problem solving.
4. Industrial applications.

MAKING THE BEST OF FORCES

1. Making a lifting machine.
2. Machines to save energy.
3. Increasing forces by using machines.
4. Drive systems.
5. Gears.

APPENDIX 13

Enhanced descriptors of Suffolk units used with 1988 Year 8 cohort (Task 11).

Suffolk Units with 'enhanced' descriptors (Task 11).

BIOLOGY UNITS

FOOD AND DIGESTION

1. The things we need in our daily diet.
2. What did your family eat yesterday.
3. A simple look at basic foods.
4. How different animals eat.
5. What happens to our food once we swallow it.

MICROBES

1. Mouldy bread and rotten apples.
2. Making yoghurt and booze.
3. Growing a family of germs.
4. How to stop germs eating our food before we do.
5. How to stop germs making us ill.

CELLS AND LIFE

1. Looking at living things.
2. Using microscopes to look at our cells.
3. Making microscope slides.
4. How cells work inside a body.
5. Keeping things alive.

PATTERNS OF REPRODUCTION

1. Why don't potatoes get married?
2. Why do apples grow on trees?
3. Why (and how) are girls and boys different?
4. Where did I come from?
5. Why don't tree trunks touch each other?

CHEMISTRY UNITS

EXTRACTING MATERIALS

1. How to make a substance pure.
2. Which liquid is this.
3. Making pure water (or whisky).
4. How a waterworks works.
5. How to identify the murderer.

GASES

1. Lots of gases to keep us alive.
2. What do these gases do?
3. What is in Andrew's Liver salts?
4. Making and collecting gases.
5. Stop the air killing our planet.

ELEMENTS

1. Elements in our world and our lives.
2. Making elements change.
3. Making copper rivets (to hod your blue jeans together) from rocks.
4. Why does it do THAT?
5. You are a research chemist.

MATERIALS

1. Why does my yoghurt container melt in the microwave?
2. I know it's plastic but which plastic?
3. Make your own clothes.
4. Why does my Big Mac box last longer than me?
5. Who wants to be the Managing Director?

PHYSICS UNITS

BIOPHYSICS AND SPORTS SCIENCE

1. How fast does Boris Becker serve?
2. Could I get out of the way in time?
3. Exercise and fitness, how does it help ME?
4. Measuring my body.

ENERGY INVESTIGATIONS

1. How does my kitchen work?
2. Using energy to make life easier.
3. Devices to change one energy form into another.
4. Working together to create your own energy changes.
5. Energy in the future (changing our world)

MICROELECTRONICS

1. Making your own burglar alarm or fire alarm.
2. Making an automatic light switch or window opener.
3. Microelectronics at YOUR service.
4. Making a device to solve a problem of your own.
5. Microelectronics we use every day.

MAKING THE BEST OF FORCES

1. Working together to lift more easily.
2. Machines to make life easier.
3. Measuring push and pull.
4. The human body machine.
5. Explaining the simple machines in our home.

APPENDIX 14

Schedule used as basis for interviews with upper band Year 9 students, 1988 cohort (Task 12).

PART 1

Students asked to respond agree/disagree/not sure

1. Most of my friends think science is boring.
2. I think that science is boring.
3. It's not really important for girls to do well in science tests.
4. I don't find much use for science out of school.
5. I find it difficult to understand science even when it has been explained to me.
6. I enjoy the fact that there is always something new for me to learn in science.
7. Science is more a boys' subject than a girls'.
8. I find it difficult to make conclusions from the results of my experiments.
9. I like having to think things out in science.
10. I find the end-of-unit tests easy.
11. I find the language used in the tests difficult to understand.

PART 2

Students asked to respond yes/no/don't know when asked

i) do you do much.....?

ii) do you like doing.....?

1. Individual reading to obtain information.
2. Reading instructions from the board.
3. Reading instructions from a text-book.
4. Personal research.
5. Reading one another's work.
6. Reading your own work.
7. Reading, then explaining in your own words.

PART 3

Students asked to respond yes/no/don't know when asked
i) do you do much.....?
ii) do you like doing.....?

1. Copying from books/the board.
2. Making notes from a book/video.
3. Writing dictated notes.
4. Expressive writing involving personal views/opinions.
5. Creative writing (use of imagination).
6. Answering writen questions.
7. Completing blanks in worksheets.
8. Collating material from different sources.
9. Map work, labelling, copying or creating diagrams.
10. Summarising/shortening written material.

PART 4

Students asked to respond yes/no/don't know when asked
i) do you do much.....?
ii) do you like doing.....?

1. Answering teacher-directed questions.
2. Asking questions.
3. Asking one another for help.
4. Discussing work-in-hand informally.
5. Chatter off-task.
6. Discussing work-in-hand in groups.
7. Arguing a point.
8. Asking for help.
9. Silent work.

PART 5

Students asked to respond yes/no/don't know when asked
i) does the teacher do much.....?
ii) do you like the teacher doing.....?

1. Giving instructions to class verbally.
2. Demonstrating.
3. Explaining.
4. Dictating.
5. Reading to class.
6. Questioning.
7. Encouraging.
8. Praising.
9. Criticising.
10. Relating work to everyday issues.
11. Recapping.
12. Disciplining.

PART 6

Would you recommend me to use this particular science course with the students in my own school?

PART 7

Are there any comments you wish to make in support of any of your answers or any general comments regarding the course, your teachers or their teaching methods?

APPENDIX 15

Schedule used as basis for interviews with lower band Year 9 students, 1988 cohort (Task 14).

PART 1

The students were asked to respond to the following questions.

1. Do you think the end-of-unit tests are easy or hard?
2. Do you like having tests at the end of each unit?
3. Are the words on the tests too long or too difficult to read?
4. Are the questions clear, do you understand what they are asking?
5. Do the tests make you want to work hard to get a good result?
6. How do you feel when you get the results of a test?
7. What was the best thing about the last unit?
8. What was the worst thing about the last topic?
9. How could the last topic have been improved for you?

PART 2

The students were asked to give each of the following activities a score from 1 to 10 according to how much they like it. A score of 1 being low, a score of 10 high.

1. Experimenting.
2. Drawing.
3. Copying.
4. Filling in blanks.
5. Sticking and pasting activities.
6. Watching a video.
7. Listening to the teacher.
8. Sitting the tests.
9. Getting the test results

The students were given the opportunity to revise individual scores on having scored all 9 activities.

PART 3

The students were aske to respond yes or no when asked:

Do you enjoy.....?

1. Working in small groups of 3 or 4.
2. Being given a problem and having to decide for yourself what experiments to do.
3. Being given different activities to do in the same lesson and having to go from one to the other (as on the Science/Music Day).

The responses to these were discussed at length where students wished to enlarge upon their answers.

APPENDIX 16

Unit specifications for 3 of the Units of Accreditation written to accompany the Suffolk Science Scheme (Task 16).

UNIT ACCREDITATION SUBMISSION PRO-FORMA

CODE NO.
DATE:

SCHOOL COMPREHENSIVE L.E.A.

UNIT TITLE ECOLOGY

CURRICULUM AREA(S) SCIENCE

UNIT DESCRIPTION

The student will carry out a series of laboratory based practical investigations through which she/he will gain an awareness of the influence of the environment on living organisms, adaptation, the effect of humans on their environment; food chains and webs. This unit is written to accompany the MEG Coordinated Science syllabus.

PROCEDURES FOR MAKING AND RECORDING ASSESSMENTS

Assessed by the teacher through inspection and recorded on an Assessor's Summary sheet (1,3,4).
Assessed by the teacher through inspection and recorded on an Assessor's Summary sheet (2,5,6,7,8,9)

UNIT SPECIFICATION

All outcomes must be demonstrated.

Outcomes to be accredited	Evidence to be offered
In successfully completing this unit the student will have	
demonstrated the ability to 1. use a key to identify living organisms; 2. use a biological sampling technique e.g. quadrat, line transect; 3. take measurements of at least two of the following in a specified environment: pH, temperature, moisture, oxygen content, using simple measuring techniques; 4. work as a member of a group; 5. display data obtained from a habitat sample using one or more of the following: posters, graphs, tables.	Teacher completed checklist (1,3,4). Written account (2,5,6,7,8,9).
shown knowledge of 6. food chains or webs; 7. the effect of the physical environment on the life of an organism; 8. two ways in which humans control their environment.	
acquired an understanding of 9. how an organism has adapted to its environment.	

UNIT ACCREDITATION SUBMISSION PRO-FORMA

CODE NO.
DATE:

SCHOOL COMPREHENSIVE L.E.A.

UNIT TITLE CHEMISTRY IN THE HOME (1)

CURRICULUM AREA(S) SCIENCE

UNIT DESCRIPTION

The student will carry out a series of laboratory based investigations through which she/he will gain an awareness of the use, storage and manufacture of some household chemicals.
This unit is written to accompany the MEG Coordinated Science syllabus.
This unit is the first in a series of two units.

PROCEDURES FOR MAKING AND RECORDING ASSESSMENTS

Assessed by the teacher during practical work and recorded on a checklist(1-10).

UNIT SPECIFICATION

To gain accreditation the student must successfully complete
1. Outcomes 1,2,3,4.
2. Two outcomes from the following group of outcomes (5,6,7,8,).
3. Outcomes 9 and 10 are optional.

Outcomes to be accredited	Evidence to be offered
In successfully completing this unit the student will have	
demonstrated the ability to 1. identify a solution as being acid, alkali or neutral by using an indicator; 2. identify the pH of a solution using Universal Indicator paper or solution; 3. identify the pH of a solution produced by mixing together solutions of acid and alkali; 4. produce a neutral solution by mixing together solutions of acid and alkali; 5. accurately measure a volume of liquid using a pipette; 6. accurately measure a volume of liquid using a burette; 7. release liquid from a burette in a controlled way; 8. accurately determine the volume of liquid released from a burette; 9. carry out a titration to produce a neutral solution; 10. carry out a titration to soften a sample of hard water.	Teacher completed checklist (1-10).

UNIT ACCREDITATION SUBMISSION PRO-FORMA

CODE NO.
DATE:

SCHOOL COMPREHENSIVE L.E.A.

UNIT TITLE USING ELECTRICITY

CURRICULUM AREA(S) SCIENCE

UNIT DESCRIPTION

The student will carry out a series of laboratory based practical investigations through which she/ he will gain an awareness of series electrical circuits, electrical measurements and electrical safety. This unit is written to accompany the MEG Coordinated Science syllabus.

PROCEDURES FOR MAKING AND RECORDING ASSESSMENTS

Assessed by the teacher during practical work and recorded on a checklist (1,4).
Assessed by the teacher through inspection and recorded on an Assessor's Summary sheet (2,3,5,6,7,8,9,10).

UNIT SPECIFICATION

To gain accreditation the student must successfully complete
1. Outcomes 1,2,4,6,7,8,9,10.
2. Outcomes 3,5 are optional.

Outcomes to be accredited	Evidence to be offered
In successfully completing this unit the student will have	
demonstrated the ability to 1. make a series circuit containing a minimum of three components; 2. read a voltmeter or ammeter scale correctly; 3. calculate the resistance of a component using an ammeter and voltmeter; 4. correctly wire a three pin plug; 5. take accurate readings from a domestic electricity meter; 6. cost the running of different appliances;	Teacher completed checklist (1,4). Written account (2,3,5,6,7,8,9,10)
shown knowledge of 7. how domestic electrical equipment can be made safe;	
acquired an understanding of 8. the differences between series and parallel circuits; 9. the way in which a fuse works;	
experienced 10. the three effects of an electric current.	

APPENDIX 17

Postal questionnaire issued to first Suffolk science cohort.
November, 1992.

Dear

I am currently attempting to evaluate our GCSE science course, particularly in the light of the National Curriculum and the changes which have been forced on us by Government education policy.
I would be grateful if you could take the time to respond to this questionnaire in order that I can discover what the course was like on the receiving end. Most of the questions require you to tick a box for your response but any additional comments you wish to make will be extremely valuable. All your responses will be treated with the strictest confidence and will not be made available to any of your former teachers. I do hope that you can find the time to help.
Someone will call to collect your completed questionnaire on

it would be helpful if you could have the questionnaire ready for when they call, if you are not likely to be in please leave it where it can be given to the collector by another member of your family.
Thankyou again for your help and cooperation

****

1. NAME

2. ADDRESS

3. GCSE PASSES 1992

SUBJECT	GRADE	SUBJECT	GRADE

4. If you are now in further education please complete the following section;

NAME OF COLLEGE

COURSE/SUBJECTS (include level)

4. If you are now in full-time employment please complete the following section;

NAME OF EMPLOYER

BRIEF DESCRIPTION OF JOB

5. If what you are doing this year does not fit into question 4 or 5 please explain below what you are doing.

The rest of this questionnaire is about your final years at comprehensive school, particularly your GCSE courses. Please answer the questions as accurately as you can, your comments will be treated in the strictest confidence. Most of the questions simply require ticks in boxes but it would be extremely useful if, as you are answering , you note down any thoughts or recollections which occur to you. These notes may then form the basis for any comments you wish to make at the end of the questionnaire.

6. How do you feel about your performance in the GCSE examinations? Please tick one box.

I WORKED TO THE BEST OF MY ABILITY ☐

I SHOULD HAVE WORKED HARDER ☐

7. How do you feel about your GCSE results?
Please tick one box.

BETTER THAN I EXPECTED

MORE OR LESS WHAT I EXPECTED

WORSE THAN I EXPECTED

8. Which do you feel were your favourite subjects in your GCSE courses (please name no more than three)?

9. Which of your GCSE subjects did you enjoy the least (no more than three)?

10. Which of the following do you prefer as a structure for assessing GCSE courses? Please tick one box only.

100% COURSEWORK WITH NO FINAL EXAM

A FINAL EXAM WITH NO COURSEWORK

SOME COURSEWORK AND A FINAL EXAM

11. Which of your GCSE courses were based on?

100% COURSEWORK WITH NO FINAL EXAM

A FINAL EXAM WITH NO COURSEWORK

SOME COURSEWORK AND A FINAL EXAM

12. Which of your GCSE subjects had a series of tests throughout the course which counted towards the final grade?

13. Your science course was assessed over three years instead of two. Did you prefer this more extended assessment?

YES ☐ NO ☐

14. Did you enjoy your science course? Please tick one box.

VERY MUCH ☐

YES ☐

NOT REALLY ☐

NOT AT ALL ☐

15. How well did you do overall in the end-of-unit tests?

VERY WELL ☐ AVERAGE ☐ NOT VERY WELL ☐

16. How well did you do overall in the process skills?

VERY WELL ☐ AVERAGE ☐ NOT VERY WELL ☐

17. Which units did you prefer? Please tick one box only.

BIOLOGY ☐ PHYSICS ☐

CHEMISTRY ☐ NO PREFERENCE ☐

18. Did you enjoy your science work more with some teachers than with others? Please tick one box.

VERY MUCH ☐ A LITTLE ☐ NOT AT ALL ☐

19. Were your marks better with some teachers than with others?

VERY MUCH ☐ A LITTLE ☐ NOT AT ALL ☐

20. In general, did you get better marks with the teachers you liked

YES ☐ NO ☐

and did you get poorer marks with the teachers you didn't like?

YES ☐ NO ☐

21. Did you ever intend to aim for a science-related career?

YES ☐ NO ☐

22. Has your school science affected your career choice at all?

YES ☐ NO ☐

23. Has your school science made you more interested in science?

YES ☐ NO ☐

24. Has your school science turned you off science?

YES ☐ NO ☐

25. Do you feel that the type of assessment in your science course helped you to achieve a higher grade?

YES ☐ NO ☐

26. Do you feel that the nature of the assessments in your science course reduced your science grade?

YES ☐ NO ☐

27. Do you feel that your assessments were affected at all by the teacher you had for a particular unit?

YES ☐ NO ☐

As you may remember, your year group was the first one to follow that particular science course and we are anxious to evaluate its success and popularity. It would be extremely useful if you would look back over your responses to questions 14-27 and then use the following space to explain your responses or make any additional comments you feel would be useful, continuing over if necessary.

APPENDIX 18

Transcripts from two of the paired discussions held with Year 11 girls, May 1993.

PAIRED DISCUSSION 1

The author is M, the students are girl H and girl J, both from the most able science group. The author is talking informally to the students, initially about estimated GCSE grades in science. Author's notes in italics.

M. I asked J if she had got A's (*in science*) and if she had got A's right across the board. She said no. Have you got A's right across the board?

H. No.

M. ...and J said she'd got them in science because it was so easy.

J. Mm yes.

M. so I said... which others have you got A's in?

H. erm languages.

M. Is that because you want to do languages?

H. No that's because...do we do coursework in languages? No, no I just find it easy... Art then the rest are sort of like B's it's just the way science is.

M. What about you J, what are you getting A's in?

J. Art and an A or a B in French, Maths, Geography, RS.

M. With the Art or the languages, they seem to be things that people have a flair for in which case they do well at them...but J said (*science*) it's dead easy.

J. Yes.

M. So tell me again for the tape why you think its so easy.

J. Because its coursework, because you don't have to learn everything...in one go.

M. No big exam at the end.

J. Yes.

H. Yes, that's what I thought it's...it's short term recall like you said and you don't have to...you don't have to think of all these... you don't have to remember all these...these facts and everything for one big exam.

J. That's the worst thing about it, you might not remember a lot of the stuff.

H. Yes. It panics me doing exams, you sit there with it all in front of you thinking ohh...

J. Yes.

M. Do you think that it's also easier in terms of the assessments, not the tests, because we ask you to simply go away and write something and you've got freedom to do it how you want? Because in the tests you've got to... you've got to respond in a certain way haven't you?

H. Yes.

M. Do you like multiple choice questions?

J/H. No.

H. Well it's not A and it's not B, which one is it? I don't know. I mean, I like to go away and write things in my own time whereas with the exams you're pressured to do it, you've got to do so much in a certain time whereas with these assessments and everything you can do it how you want, spend how long you want on it (J. Yes.) and depending on whether you like the subject or not it depends on how much effort you put in whereas exams...you're forced to do it and you end up coming out with worse things. Just the pressure of it.

M. ...so do you think overall, because really it's the end of an era now, you're the last people who are doing this course. It's changed completely for next year. Do you think it's been worthwhile?

H. Yes, cause I've ended up with A's.

M. What about the individual sciences, the biology, chemistry and physics...have you been quite happy doing bits of each?

J. I like doing them all.

H. I like doing them all...I find physics more difficult than biology but at least it's not easy all the time.

M. But that also means that because we've got to give everybody the best possible deal that you've got to change teachers as well...

H. I don't mind that.

J. Yes.

H. I think that's great because...what happens if you get a teacher that you just don't like, you just end up completely ruining everything...

M. Mmm...

H. ...whereas if you get teachers that you like and teachers you don't like you see what you can do and how it affects you.

M. So what about the teachers you had this year, has it been OK?

H. Humm (*laughs*).

J. Who have we had this year, [A]?

H. [A],[B], [C], yes.

J. I like you and [C] best.

H. Yes [A] rambles on and on.

J. You don't do any writing with [A] so you can't revise for the tests, you just have to er...

H. You've got to listen to [A] and you've got to take it in, but because [A's]... [A] tends to take one tone while [A's] teaching all the time, it's really difficult to pick up on [A's] voice and you just lose interest. [A's] like...isn't [A]?

J. Mmm yes.

H. [A] just like talks on one tone all the time and you're thinking I'm falling asleep (*J laughs*) and I've said to [A], can we have some more notes?...and you try criticising [A] and you'd know what [A] gets like, and I said to [A] "Just...I'd just...can we just have a few more notes, cause even if the class doesn't do it can I? Is it all right if I take some?"
"Oh I don't think you'll need to do that, no it's always worked before like this"

J. Yes.

H. "No, you shouldn't do this, just look at your results, you've never needed it before."
"But I'd feel better if you did that [A]."
"No, no, it's all right."
"All right, [A]."
You know.

M. Yes [A's] got these same phrases that [A] uses over and over again, mind you, I do as well, I suppose all teachers do don't they?

H. It's just the attitude that you and [C] have, it's easier to get on with.

J. I find it interesting.

H. Yes, I mean I'm always laughing at you and [C]. Because [C's]...no offence but...because [C's] younger than you [C] seems to understand how we think and [C] tries to make [C's] lessons more interesting. And [C's] not afraid to tell us things, whereas, like... [B] shies away from it, especially doing reproduction with [B]. Oh God how embarrassing.

J. I can't remember that.

H. Not this year but a couple of years back.

J. I didn't have [B].

H. I did reproduction with [B] and [B] was...[B] didn't want to say anything to us, [B] didn't want to tell us. We need to know these things.

M. Oh you do...now, in terms of the coursework, the science is different because you've got two aspects to it. In English you've got your assignments, geography your fieldwork, but we've got the two parts, the tests and the process skills...(*explains change in syllabus, different structure of MEG science syllabus*)...now what about the tests do you think it's better having the tests in or not? Because the structure has been dictated, there has got to be an end-of-year test. There has to be an end-of-year test in English, in geography, in maths and everything else, the government has said that, but we can we could build up to that final test by doing tests each term during the fourth and fifth year... now do you think that's useful?

H. Mmm definitely.

M. Because we don't have them for the current fourth year, or we didn't have them at first, they've sent some now. They were supposed to arrive in September and they actually came in November.

H. The more you get used to doing these tests the easier it becomes and it's a way of keeping track of what you're learning and you can see...you can see with which teachers and what subjects you're better at...by looking at the tests that you did for that topic.

M. Right, but in the long run you prefer the process skills to the tests. Would you rather...

J. The tests are two different things though aren't they...

M. You liked them both?

H. Yes.

J. Yes because with coursework you can do what...do as much as you want.

M. Yes?

J. With the tests...it's like the facts you've got to know to say that you understand the unit.

H. Yes.

M. Do you think the tests actually tested what you know, because there has been criticism that the tests are too easy?

H. They're not too easy, are they? Well, they can be harder.

J. They don't test a lot of stuff that you've learned, it's just...if you learn everything, because you don't know what's going to come up, but it doesn't test a lot of things that you've learned.

M. I think that's probably because you've mainly done the special level, if you'd done the foundation ones you'd find that it was just testing the facts but for the special you...the intention was that you've learned it and have to apply that.

H. Yes, I find that a lot of the questions you can't... you can't put them back to what you've done because they've...they test more like your common sense than they do your science.

J. Some have nothing to do with science.

H. That's what irritates me. Because they don't...they don't test your science ability, they test your thinking ability or your maths sometimes. My common sense in some of the things that I think of they're like (*laughs*)... stupid, but whereas my science...the way that I think about science that seems better. I think they ought to test you more on your science knowledge than your ability to think straight.

M. Right...J are you going to carry on with sciences when you've left school do you think?

J. I don't know.

M. You've got no idea what you're going in for?

J. I want to do geography and maths but I don't know what else...I'd like to do science but...if you take an A-level...I was thinking about biology but then you've got to take A-level chemistry, I think, as well to give you the chemistry knowledge that you need for the biology which is like two A-levels in science...there's that many things that I like I don't know which to go for.

M. You'll have to do four A-levels.

J. No thanks.

M. Are you going to do languages?

H. No, I want to do psychology. They keep telling me I ought to do biology at A-level but there's that many other things I want to do that I just can't cram them all in. I'll probably end up just having to do psychology with art and history I think.

M. Were there some units that you er...hated?

J. Definitely, microelectronics, I hate that.

H. Oh no, it's horrible...electronics, energy...they keep going over this energy. We do it about three times and every time we do what we've done before and a little bit extra. I don't understand why we can't just do it all at once and get it out of the way er...I did that with [B], microelectronics...and physics, some areas of physics I didn't like, I can't remember what they were.

M. So do you think with the 33 units you've had a really good spread? Was there some of it you've hated

H/J. Yes

M. ...in terms of easiness, do you think it's easier to achieve or easier to cope with or...dare we say it, easier to cheat... because that's been another criticism? Not on your part but on our part, because obviously if I'm getting a load of A's it looks great.

H. Mmm...[B] made a point about that didn't [B]...we'd had...we'd had some teachers before [B] and [B] was very suspicious that we were getting A's and so [B] really did clamp down on us and [B] was like...went to the extremes that [B] was making it more difficult, the work that [B] was doing because [B] just didn't believe that we were capable of doing that...and [B] said, "The other teachers might think that you are capable of getting specials without you having to do any work but I want to see proof"

PAIRED DISCUSSION 2

The author is M, the students are girl K and girl D, both from upper-ability science groups. The author is talking informally to the students about estimated GCSE grades and how close the two students are to an A grade. Author's notes in italics.

K. I'm about this far off (*indicates small distance with finger and thumb*).

M. Off an A?

K. Off an A.

M. Right, how much is that far? Do you want me to have a look and see? (*Author checks K's current points total on computer printout*). OK, so you're probably going to get an A in science, what others do you think you're going to get an A in?

K. I've got A/B in history and I might do in business studies.

M. Right, what about you D?

D. I've got an estimated A in maths, business studies and history and B/A for art.

M. So do you think you're going to make it in science?

D. I'll just be on the borderline, I think I should get it er... hope.

M. Right, and K, you're definite now?

K. Yes, I should say so.

M. I meant to ask the others this and didn't, do you think you deserve an A in science?

K. Yes I do.

M. Do you?

D. Yes.

M. Do you think it was easy to get an A in science? J said she thought it was easy...

K. That's J though, how many A's has she got?

M. Well, not that many but she'll probably end up with more than she's estimated. So why do you think you've got your A, or are likely to get yours?

D. Because its continuous, all the time and if you put it in from the start and you work...

M. So what's so different about the assessment, continuous assessment, instead of doing just one exam at the end?

D. It's not as...

K. No it's a lot better, cause if you put it in as you're going along it's much easier than having to remember everything. I mean, you still get tested on it so you still have to know it but it's not like at the end...you have to do mass revision and stuff.

D. Because a lot of people will just panic.

K. Yes cause in the exams you just...I go...

D. I go to pieces.

M. There are people who say that we shouldn't allow coursework as part of your GCSE because...there are a variety of reasons...because it is too easy and it enables you to get much higher grades than you're actually worth...

K. It's not, it's not that it's too easy, no. You're supposed to work for it, it's just that there's so much stress on you... you don't work to what you could in the exams... because if you took your exam and put it into a classroom you'd do loads better... just because of the fact you're like in a hall and being watched and stuff.

M. I'd go along with that, yes? What about the tests, are you happy with actually having the tests as part of the assessment?

K. Yes I think you should...

D. Yes.

K. ...because you've got to do some way of knowing if people know it and like what level you've learnt it.

M. Right, so you'd prefer regular tests throughout the course rather than just one at the end of each year?

K/D. Yes.

M. Now what about the assessment pieces of work, the process skills, were you happy about those?

K/D. Yes.

M. I read in a paper this morning, a Head of a girls' school said that she thought the courseworkwas better for girls because girls like to write. I don't mean write indiscriminately but... like to research and like to put it down so people can see what they know. Would you have been happy...?

K. Not always.

M. No not always but...

K. I don't particularly like writing.

M. Don't you? But given the choice between a paper of 100 multiple choice questions or going away and finding out about it yourself and writing about it, doing a few diagrams...

D. I'd rather do it like that especially if it's stuff you're into...it's interesting, you get your books and go for it.

M. Yes?

K. But not just for girls, just depends who it is doesn't it?

M. So what about the bits you liked and the bits you didn't like. You did 33 units over the 2 years. Were they all alright... or were some garbage or some brilliant?

D. Some were, some were er...

M. Garbage?

D. Yes.

K. I can't remember which...

D. That structures [unit] was stupid.

M. Didn't you like that?

D. No.

M. I've not taught that one so I don't know. What about microelectronics?

K. No I didn't like that at all.

D. I failed both of them [*microelectronics units*]... no, in the 3rd year I didn't do it. The last one I failed miserably.

M. What about brilliant ones, were there any brilliant ones?

K/D. *Silence*

M. Are you going to do sciences next year?

K. I was thinking about biology, maybe.

D. Art, maths, history.

M. Would you like to have had one exam at the end of your 5th year?

K/D. No!

M. Do you think there's anything we got wrong in the way we did the course, the way we structured it? Were you happy changing round?

K. Yes I think that was good because you can... if... like you draw the short straw and get somebody who's boring then it's good to be able to change to somebody else.

D. I've got [E] now and [E] does like biology and chemistry but [E] doesn't know anything about physics so it's better that way. [E's] like a specialist.

<u>APPENDIX 19</u>

Letters to Suffolk Science schools explaining the changes in the operation of modular syllabuses, 1992.

Midland Examining Group

East Midland Regional Examinations Board
Oxford and Cambridge Schools Examination Board
The West Midlands Examinations Board
University of Cambridge Local Examinations Syndicate

19 JUNE 1992

NATIONAL CURRICULUM KEY STAGE 4 1994

NOTICE TO TEACHERS

MODULE TESTS AND STAGE ASSESSMENTS ADMINISTRATIVE ARRANGEMENTS

MEG is aware that many Centres are concerned about the arrangements for administration of **module tests** in

SCIENCE (1770/1771)

CO-ORDINATED SCIENCE (THE SUFFOLK DEVELOPMENT) (1777)

and the **stage assessments** in

MATHEMATICS (SMP GRADUATED ASSESSMENT) (1666)

The GCSE groups nationally have been engaged in discussions to formulate a Standing Agreement on the administration of module tests. The agreement is designed to increase the security of module tests whilst retaining a reasonable degree of flexibility in their use. The following arrangements have been produced on the basis of the outcome of the inter-group discussions and may need to be amended once the Standing Agreement has been finalised and approved by the School Examinations and Assessment Council (SEAC).

1. **Module Tests in Science Syllabuses (1770, 1771 and 1777)**

   (a) **Number of Versions of Each Module Test**

   Within each tier there will be at least two versions of each Module Test for use in a given academic year.

   (b) **Distribution, Receipt, Storage and Examination Arrangements for Module Test Papers**

   (i) Copies of Module Test papers for use in the academic year 1992 - 1993 will be despatched to Centres by the beginning of October 1992 in sufficient quantities to meet the needs of Centres as indicated on provisional entry documents.

   (Tests will be provided for the start of the Autumn Term in future years but this will not be possible in 1992.)

(ii) Module Test papers will be despatched to Centres, in sealed envelopes. The arrangements for their receipt and storage should be as specified in the Handbook for Centres for other confidential material.

(iii) Module Test papers and candidates' scripts must be offered at all times the same degree of security and confidentiality as all other examination papers and scripts of the Midland Examining Group.

(iv) Module Tests should be given to candidates under examination conditions in accordance with MEG's regulations covering the conduct of the examination as stated in the Handbook for Centres.

(v) If only some of the papers for a given Module Test are required on a given occasion, the remaining papers should be resealed and kept secure until needed.

(vi) Candidates' scripts and used question papers must at all times be regarded as confidential material and must be kept secure until despatched to the external examiners.

(c) **Arrangements for Candidates to take a Module Test**

(i) Centres may choose when their candidates will take each Module Test. Where tests are given to different groups of candidates within six weeks of each other, **alternative** versions of the test must be used. No test may be re-used within a Centre within six working weeks.

(ii) A candidate will not normally be allowed to be re-tested on a module during the course except where a request for special consideration has been accepted by the Home Board.

(iii) For candidates who miss a Module Test through no fault of their own, for example because of illness, and who are unable to take a version of the test on another occasion, MEG's part absence procedures should be followed.

(iv) Candidates who, for no good reason, absent themselves from a Module Test will be given a mark of zero for that test.

(d) **Marking of Module Tests**

All Module Tests which contribute towards a GCSE Level will be externally marked by MEG using the normal co-ordination and standardisation procedures as for any other written papers.

2. **Stage Assessments in Mathematics (SMP Graduated Assessment)**

(a) **Number of Versions of Each Stage Assessment**

There will be at least three versions of each Stage Assessment.

(b) **Distribution, Receipt, Storage and Examination Arrangements for Stage Assessments**

The arrangements will be as in 1 (b) (i)-(vi) above except that order forms will be used in place of provisional entry documents and materials provided upon receipt of those order forms.

(c) **Arrangements for Candidates to take Recaps and Aural Tests**

(i) Centres may choose when a candidate will take each Recap or Aural Test. Where tests are given to different groups of candidates within six weeks of each other, **alternative** versions of the test must be used. No test may be re-used within a Centre within six working weeks.

(ii) A candidate may be re-tested on a given module using a different version of the test. A re-test may not be administered within two weeks of the sitting of the previous test.

(d) **Marking of Recaps and Aural Tests**

All tests which contribute towards a GCSE Level will be externally marked by MEG using the normal co-ordination and standardisation procedures as for any other written paper.

Further details of the administrative arrangements, including those concerning the registration of candidates, will be issued as soon as possible.

Any enquiry about this notice should be addressed, in writing, to the Secretary of your Home Board.

28 August 1992

NOTICE TO TEACHERS

GCSE/KEY STAGE 4 SYLLABUSES: THE OPERATION OF END-OF-MODULE TESTS

After consultation with the Joint Council for the GCSE, the School Examinations and Assessment Council (SEAC) approved at its Council meeting early in July procedures for the operation of end-of-module tests in GCSE/Key Stage 4 examinations.

It was because the procedures had not been agreed at the time of their preparation that the published GCSE/KS4 syllabuses for 1994, which include modular assessment, make no detailed reference to the operation of the end-of-module tests. The MEG syllabuses concerned are as follows:

Mathematics (SMP Graduated Assessment) (1666)
Science: Double Award (1770)
Science: Single Award (1771)
Co-ordinated Science (The Suffolk Development) (1777)

The main features of the procedures are:

- End-of-module tests must be timetabled either on a single fixed date or in accordance with a schedule produced by the Group. Such a schedule will allow for the timetabling of different tests on the same module at different times.
- Tests taken at different times on the same module will be parallel, different tests to ensure comparability and security.
- Test scripts must be sent immediately after the test to external examiners for marking.
- Groups will report test scores to Centres within a month of the completion of marking.
- Candidates will not normally be permitted to re-take an end-of-module test .

MEG has applied the procedures to the syllabuses listed above and details of the arrangements for each of the syllabuses are given in two separate notices, one for Mathematics and one for Science, copies of which are being sent to Centres at the same time as this notice.

Any enquiry about this notice should be addressed, in writing, to the Secretary of your Home Board.

Midland Examining Group

East Midland Regional Examinations Board
Oxford and Cambridge Schools Examination Board
The West Midlands Examinations Board
University of Cambridge Local Examinations Syndicate

28 August 1992

NOTICE TO TEACHERS

GCSE/KEY STAGE 4 SCIENCE SYLLABUSES: THE OPERATION OF END-OF-MODULE TESTS

This notice refers to the following Science syllabuses:

SCIENCE: DOUBLE AWARD (1770)
SCIENCE: SINGLE AWARD (1771)
CO-ORDINATED SCIENCE (THE SUFFOLK DEVELOPMENT) (1777)

After consultation with the Joint Council for the GCSE, the School Examinations and Assessment Council (SEAC) approved at its Council meeting early in July procedures for the operation of end-of-module tests in GCSE/Key Stage 4 examinations.

The main features of the procedures are:

- End-of-module tests must be timetabled either on a single fixed date or in accordance with a schedule produced by the Group. Such a schedule will allow for the timetabling of different tests on the same module at different times.
- Tests taken at different times on the same module will be parallel, different tests to ensure comparability and security.
- Test scripts must be sent immediately after the test to external examiners for marking.
- Groups will report test scores to Centres within a month of the completion of marking.
- Candidates will not normally be permitted to re-take an end-of-module test.

MEG will apply the procedures as follows:

1. **Science: Double Award (1770) and Science: Single Award: (1771)**

   - Tests on each of the nine modules will be available on a series of dates towards the end of each school term. For each module a parallel but different test will be set each term. This will mean that the Double Award candidates will have five opportunities in Years 10 and 11 to take each of their nine end-of-module tests and Single Award candidates five opportunities to take each of their five end-of-module tests.
   - All end-of-module tests will be marked externally on completion of tests each term.
   - Individual candidates' marks for each module test will be reported to centres within one month of the completion of the marking.

Further details about the collection of entries and the dates of the tests will be sent to Centres during September.

2. **Co-ordinated Science (The Suffolk Development) (1777)**

The syllabus has been changed as follows:

- The Year 10 modules will be examined in an end of Year 10 examination contributing 25% towards the overall GCSE assessment. The examination will be in the form of a one and a half hour paper for each of the three tiers (Foundation, Merit and Special) with each paper divided into sections corresponding to Sc2, Sc3 and Sc4.

- A set of one copy of each test for the units in Year 10 specified in the syllabus will be provided free of charge to all Centres registered to use the course. These tests can be used by Centres in an unrestricted way to enable regular monitoring of achievement and feedback to candidates. Thus, although the marks on these tests will not count towards the overall GCSE grades, their provision will preserve the formative and diagnostic nature of the course.

The published syllabus is being revised to reflect the changes which have been made and revised syllabuses and sample assessment materials will be sent to Centres during October.

Further details about the collection of entries and the date of the examination will be sent to Centres during September.

NB This notice supersedes the notice to teachers dated 19 June 1992 entitled "Module Tests and Stage Assessments Administrative Arrangements".

Any enquiry about this notice should be addressed, in writing, to the Secretary of your Home Board.

Midland Examining Group

East Midland Regional Examinations Board
Oxford and Cambridge Schools Examination Board
The West Midlands Examination Board
University of Cambridge Local Examinations Syndicate

Your ref:

In reply please quote:

If telephoning please ask for:

Please reply to: Oxford and Cambridge Schools Examination Board
Purbeck House
Purbeck Road
Cambridge CB2 2PU
Telephone: Cambridge (0223) 411211

9 September 1992

Dear Head of Science,

THE OPERATION OF MODULAR SYLLABUSES
COORDINATED SCIENCE (THE SUFFOLK DEVELOPMENT)
SYLLABUS CODE 1777

You will be aware that SEAC and the Joint Council for the GCSE Groups have been involved in discussions concerning regulations for the administration and security of module tests. As a consequence, when the syllabus for 1777 was sent to centres earlier this year details of test administration could not be included.

A Standing Agreement for the operation of module testing which meets with the approval of the SEAC is now in place and you will recently have received details in a Notice to Teachers.

The main principles of the Standing Agreement can be summarised as follows:

1. The scheduling of module tests.
A module test must be administered on a single fixed date or, if the test is to be offered more than once, on a defined schedule of dates. Where it is decided to offer a schedule of dates a parallel but different test must be used on each date.

2. Marking of module tests.
Tests should be marked by external examiners immediately after they have been taken. Standardisation procedures similar to those used with terminal examinations should be adopted and standardised marks should be communicated to Centres within a month of completion of marking.

3. Security of scripts.
After marking, scripts should be sent to the Examination Group and retained until after the appeals period for that cohort of candidates.

The advantages of the modular assessment of Coordinated Science : The Suffolk Development are seen to include:

a. flexibility of organisation and teaching sequence;

b. the identification of specific, short-term targets;

c. feedback to candidates and teachers which is both formative and diagnostic;

d. assessment very close to the point of learning which contributes to the final GCSE grade.

In order to comply with the SEAC requirements it was felt to be important to retain as many of these features as possible.
To allow for flexibility in teaching sequence, a module test would need to be offered more than once. Consequently, it would be necessary to have three, or possibly four, published dates during Year 10 of the course with each module offered on two or three different occasions. However, the effects of maximising flexibility in this way would be to increase disruption of the school timetable and to create severe administrative and financial difficulties particularly in maintaining a programme of standardisation of marking. Also significant would be the problem of writing increasing numbers of parallel and comparable module tests.

Administering module tests on fixed dates would also remove the advantage of assessing close to the point of learning; module tests might be taken 9 weeks after a module had been taught and feedback to the candidate (and teacher) might not be received until 15 weeks after completing a module. An additional observation is that half the modules might need to be assessed on the third published date requiring about 2.5 hours of examining time.

After careful consideration of the issues raised above, and after discussion with teachers from a number of Centres, it has been decided to adopt the following strategy.

1. A set of one copy of each test for units in Year 10 will be provided free of charge to all Centres registered to use the course. These tests can be used by Centres in an unrestricted way to enable regular monitoring of achievement and feedback to occur. In this way the first three benefits of a modular course listed above are retained. Tests for Units B1, B2, C1, C2, P1, P2 will be despatched to Centres by the beginning of October, 1992; tests for the remaining units will follow as soon as possible. Candidates' marks for these tests will not count towards the overall GCSE grade.

2. The Year 10 modules will be examined in an end of year examination. This will contribute 25% towards the overall GCSE assessment. There will be a 1.5 hour paper for each of the three tiers (Foundation, Merit and Special) with each paper divided into sections corresponding to Sc2, Sc3 and Sc4.

The date for this examination will be released to centres as soon as possible but it is likely to be during the week beginning 28th June 1993 for students to be entered for GCSE in 1994. Entries for this Year 10 examination will be required by Home Boards during February 1993.

It is felt that this strategy will preserve the formative and diagnostic nature of the existing course and, at the same time, enable candidates to approach the terminal examination in Year 11 with the knowledge that up to 50% of the overall assessment is secure. Thus, Coordinated Science (The Suffolk Development) will have retained many of the features which made the original course successful. It is supported by a comprehensive range of high-quality publications produced by Collins Educational and Centres will continue to receive support from MEG. It is hoped that you will wish to maintain your involvement in the scheme.

Yours sincerely

J. Noel

John L Noel
Assistant to the Secretary

APPENDIX 20

Letter to Examining Board from Suffolk Science school complaining about late changes in assessment procedures, March 1994

Extract from letter to Exam Board from Headteacher of a Suffolk school

A meeting of our local Suffolk Science Cluster Group was held at [this] school on [date]. The cluster secretary reported significant changes to the assessment of AT1 which would cause unaceptable amounts of extra work to teachers and, more worrying, result in our more able pupils being penalised. We have attended courses put on by the Board at [two towns]. The Science Departments in the Cluster have worked hard together to implement the Board's rules on assessment.

The Board cannot change the rules with only 6 weeks to go before the final exam. All schools in the Cluster agreed they were not going to change their assessments - they were after all following the Board's instructions. If there is error in the way in which assessments in AT1 have been carried out, then the responsibility lies with the Board and not with schools.

I enclose comments from our Head of Science which cover in detail our concerns.

I look forward to a prompt reply on this matter.

Additional comments from Head of Science

1. [School] submitted a candidate's work to the last cluster meeting. After discussion, the meeting agreed that it should award the following levels:

1.1 level 10

1.2 level 10

1.3 level 10

1.4 level 10

This work was sent to the regional moderators' meeting where it was down -graded, the following levels being awarded:

1.1 level 6

1.2 level 6

1.3 level 6

1.4 level 9

The reason for this change was given - "because the work did not consider the relative effects of the variables it could not be awarded above level 6".

Many of our candidates with similar scores are likely to suffer in a similar way.

Our comments

(i) Meetings organised by the examination board and cluster meeting information have always made it clear that Operational Performance Indicators (OPI) are not hierarchical. Up to this cluster meeting you have not had to satisfy Operational Performance Descriptor (OPD) 7 (or any other lower descriptor) before a candidate's work could be awarded a level 8 or 9 or 10. A candidate's work was awarded the highest level descriptor it satisfied.

(ii) The reason for this change appears to be that it is contained in Statements of Attainment (SoA) - "use scientific knowledge, understanding of theory to predict the relative effect of a number of variables (1.7a)". Again both examination board meeting and local cluster meetings have always made it clear that candidate's work must be assessed against the OPI and not against the SoA.

(iii) We accept that under some circumstances candidates must explain the likely relative effects of variables to be awarded (1.1) 7.

(iv) A large amount of staff time has been expended in marking candidate's work to a set of conditions laid down by the examination board. Candidates who produce level 7 to 10 standard work put a lot of effort into their investigations and total assessment time is usually 15 to 25 minutes. This excludes discussion with other colleagues about assessment difficulties and the time needed for internal moderation.

It seems to us to be totally unreasonable to "change the rules" some six weeks before the final date for A.T.1. assessment marks to be submitted. Such a step is grossly unfair to both candidates and staff. It would appear that we have all wasted our time. We are particularly concerned about our more able candidates who have put a lot of extremely hard work into their A.T.1. assessments. It would appear that they will now get scant reward for ther efforts.

2. It would appear that failure to discuss the relative effects of variables in (1.1) disqualifies candidates from achieving higher than level 6 in (1.2) and (1.3)

Our comments

(i) We are unable to find any reference to the "relative effects of variables" in the OPI for (1.2). Even in the SoA, it states "manipulate or take account of the relative effect of two or more independent variables (1.7b)". We assume that candidates who successfully manipulate two independent variables should attain Level 7. (This is ignoring the fact that only OPIs have been used for assessment purposes up to now.)

(ii) We accept that (1.3) levels 6 and 7 contain statements about the relative effect of variables. Given that OPI are not hierarchical this should not disqualify candidates from the award of levels 8 to 10.

3. We were also informed at the cluster meeting that the regional moderators meeting was "looking for evidence of the candidate extending the original idea" if levels 8 to 10 were to be awarded.

Our comment

(i) We cannot find any basis for this statement in either the OPIs or the

SoAs.

(ii) We feel that there is need for written clarification of this matter including exemplary material.

(iii) We feel that it is far too late in the course for any change in assessment procedure to be made.

4. We were informed at the cluster meeting that candidates may submit work which has been completed at home if we are satisfied that the candidate has not received outside assistance.

Our comment

Although we welcome this move, it again comes rather late in the day. The Science staff at [school] have worked numerous lunchtime and evening sessions supervising candidates who required more time than could be allowed in lessons.

General Comments

(i) We have been far from happy about the way the Science Investigation section of the Suffolk Coordinated Science course has been handled. We do appreciate that these are not easy times for anybody connected with education. Having said this, we have endured two years of confusion and uncertainty. It is completely unacceptable that the rules governing Science Investigation are changed at this late stage for our present Y11 candidates. Of particular concern is the change in emphasis from OPDs to SoAs to justify the changes.

(ii) How does the course hope to discriminate between more able and less able candidates? If the "new rules" are applied most candidates cannot achieve above level 6. With suitable experience and practice, quite ordinary candidates can achieve level 6.

(iii) If the "new rules" are applied, more able candidates will have wasted a great deal of valuable and irreplaceable time. They could have got to level 6 quite quickly. It is achieving higher levels which takes time.

(iv) Candidates should not be penalised because of inefficiency at examination board level. The candidates and their school put Science 1 assessment into practice given the framework supplied to them by the board.

Many of the earlier surveys during Phase One of the research were intended to be used in order to build up a general picture of the school and the students. Trends in attitudes were sought with the intention that these be used to stimulate further areas for research. There was no intention that any rules be sought in order to inform the development of theories and hypotheses. Consequently little effort was made to attempt to assign any statistical significance to these observations.

However, the data yielded by Research Task 6 (the attitude surveys) as described in Chapter 3 were interesting. They indicated gender differences which were themselves, apparently, related to the separate science disciplines. Consequently these data (included in Tables 3.8, 3.10 and 3.12) were analysed for statistical significance.

The Mann-Whitney U test was selected as a suitable non-parametric test to compare the distributions of these uncorrelated data, obtained by assigning scores to the Lickert scale responses. This test is also particularly suitable when comparing populations with similar distributions. Three tests were carried out, one for each question field i.e. interest/relevance, perceived ability and gender issues. In each case N was 14 which gives critical values for U of 55 at the 5% level and 42 at the 1% level. The U-score was calculated using the formula:

$$U = N_1N_2 + \frac{N_1(N_1+1)}{2} - R_1$$

Where N is the group population and R is the score of the group ranks. The calculated U-scores are shown in the following table:

Question area	Interest/relevance	Ability	Gender issues
BIOLOGY	41*	69	96.5
CHEMISTRY	62.5	60.5	95.5
PHYSICS	57.5	33.5*	83.5
* indicates significance at 1% level.			

The data obtained from the computer-generated performance analysis (see Chapter 5) were analysed to determine any statistical significance using a t-test. The formula used to calculate the t-scores was:

$$t = \frac{M_b - M_g}{\sqrt{\frac{SD_b^2}{N_b} + \frac{SD_g^2}{N_g}}}$$

where Mb and Mg are the boys' and the girls' mean scores respectively, SDb and SDg are the boys' and the girls' standard deviations respectively and Nb and Ng are the respective numbers of boys and girls in the cohort.

The comparative research data (performance analysis and GCSE results, see Chapters 5 and 7)) were also tested for statistical significance. The data were, in each case, in the form of frequencies comparing the numbers of students at each GCSE grade and the chi square test was, therefore, selected for the analysis. The formula used to calculate chi square was:

$$X^2 = \sum \frac{(O - E)^2}{E}$$

where O and E are the observed and expected frequencies respectively.