A STUDY OF THE INFLUENCE OF SELECTED VARIABLES ON PUPILS' CHOICE OF SCIENCE SUBJECTS IN SIERRA LEONE SECONDARY SCHOOLS

A thesis submitted for the degree of
Doctor of Philosophy of the
University of Keele

Amos Lavaly

July 1985

VOL I

ABSTRACT

This thesis describes a study into selected factors affecting the choice of science subjects by Sierra Leone secondary pupils for study in forms 4 and 5 of the Secondary School.

The main focus in the present work was on factors and variables which relate directly and indirectly to the curricular influences to which pupils were exposed. An examination was made of the relationship between science choice patterns and science preferences on the one hand, and science learning environment variables and pupils' science learning experiences on the other. In addition, pupils' personality variables were also examined as possible correlates of science choice. All enquiries were conducted by means of written tests, inventories and questionnaires.

A particular feature of the study was that a parallel enquiry was conducted of pupils prior to their actual choice of subjects and pupils subsequent to their choice.

Among the findings derived from this study, the following are noteworthy:

i. The choice of science subjects by Sierra Leone secondary school pupils is strongly correlated with their declared interest in science and the satisfaction gained from previous science learning experiences. The nature of the home work demands made upon the pupils by their science teachers also appeared as a significant correlate of science choice and preference.

ii. There was considerable agreement between the correlates of intended and actual subject choice. This suggests that factors and variables which correlated significantly with science subject choice have an acceptable degree of predictive validity.

iii. No gender differences were found in the pattern of science subject choice in coeducational schools.

iv. There is a clear differentiation, in the choice of and preference for science subjects, between Biology and the two physical sciences (Chemistry and Physics). The choice of the latter is strongly associated with vocational and further education considerations.

ACKNOWLEDGEMENTS

I am extremely grateful to have had the privilege of being supervised by Professor Richard F. Kempa. To him I say a BIG THANK YOU for his advice, guidance and help in many ways throughout this research.

I wish to thank the British and Sierra Leone Governments for making it possible to do this research under the British Technical Assistance Scheme; the British Council, for the administration of the award; and the University of Sierra Leone, for granting me the study leave.

I am very grateful to all the Principals in Sierra Leone who responded to my questionnaire, and to those whose schools were used as sample schools, to their staff and pupils as well, for their cooperation during the conduct of my study in their schools.

I would like to express my gratitude to Professor Daniel A. Jonah of the Maths Dept. , Fourah Bay College, University of Sierra Leone and to Mrs Grace Jonah, for their help with the Principals' Questionnaire and during the administration of the tests, etc., in the schools.

Finally, I acknowledge with gratitude the invaluable contributions made by my wife, Millicent, and our children, Daniel-John, Simitie and Abraham, to my study by their support.

CONTENTS

CHAPTER ONE

Introduction

The study of school subject choices has caught the attention of researchers over the past years especially in countries operating educational systems in which early subject specialisation is allowed. England and Wales are a prominent example of such countries in that their educational system allows subject choices to be made as early as at age 14, and certainly not later than age 16. That such a momentous decision in the life of a pupil should be of concern for educationalists - and even for governments - cannot be overemphasised. Every pupil in a country where education is free and compulsory, or who goes through a secondary school, has to make this choice. For certain subjects, for example the sciences, it is very difficult once they have been dropped for some years, to start studying them at a later stage.

However, concern for the study of subject choices has emanated from different reasons. For example, in Great Britain, as a result of the Dainton Report (1968) which drew attention to the declining numbers of students studying science and mathematics in higher education, considerable attention was focussed on this study. Others have been as a result of the appallingly disproportionate number of girls choosing science subjects, or as a result of the desire to know what obtains in other countries for comparative purposes. Others, like Bardell et al. (1982), had arisen because of the difficulties of constructing successful option schemes by which third-year pupils selected their fourth-year options.

1.1 Historical Background of School Structure

Sierra Leone has a similar educational system as England, as a result of their former colonial linkage. Pupils start school at age 5, take a Selective Entrance Examination for entry to secondary school at 11+, take

the GCE O-level/SC at the end of the fifth form which qualifies them either to enter the sixth form or college. Nevertheless, unlike Britain, education is neither free nor compulsory and the 11+ exam is retained not to decide which type of secondary school to attend, but as the name suggests, it is there to select pupils who are to attend secondary school, as passing this exam is a requirement for entry into secondary school. So labels like grammar school, secondary modern school, technical school, comprehensive school, do not have the same meaning as they had or have in England. Promotion, too, from one class to another is not automatic or by age, but by achievement according to standards set by individual schools.

Since schools are a reflection of the countries in which they exist, there are bound to be major differences too: England is an affluent Western country and Sierra Leone is a Third World country.

Besides technical and vocational schools there are only two types of secondary schools: single sex schools and mixed sex schools. Schools that were founded long before Sierra Leone gained her Independence from Britain in 1961, were almost all single sex schools. Most of the schools that were founded either prior to or after our Independence, were mixed sex schools. For example, of the 13 secondary schools founded before 1940, 7 were all-boys schools and 5 were all-girls schools. Of these 13 schools only 3 were founded by the government. The rest were founded by Christian Missions mainly from Great Britain and the United States of America.

In a way Sierra Leone had played a leading role in Education in West Africa. The first institution of higher learning in West Africa, Fourah Bay College, now one of the colleges of the University of Sierra Leone, was founded in Sierra Leone in 1827 by the Church Missionary Society. For a long time - up to the late 60's - it was affiliated to the University of Durham in England, and produced graduates who played prominent roles in various sectors of the community in West Africa, especially in the English speaking countries. Yet, not until the early 60's did it turn out its first

science graduates! In an article in the 'West Africa' Magazine of 12 April 1958, reproduced in the 11 April 1983 issue, the following was written: "At the other end of the country's educational ladder, a report on Fourah Bay College has expressed grave concern in the students' lack of interest in science, as Latin continues to be the most popular subject." It is worth noting, however, that the first secondary schools too, one for boys and one for girls, were opened by the Church Missionary Society in 1845, and they started teaching science in that same year in the boys' school but not until in 1930 did they start teaching science in the girls' school (Sawyerr, 1967).

1.2 Nature of Subject Choice

Schools in general, with perhaps the exceptional case, require all their pupils to study all the subjects they offer, for the first two or three years of a pupil's secondary school education. The total number of subjects that are offered depends on the school, the facilities they have and the expectations of their society. The reasons for this initial common curriculum vary from school to school as well as from country to country. Broadly, it is necessary to give a base or foundation essential for future study and learning, and for continuing personal development. Also, it is argued that if a pupil is going to make a choice, then it is only reasonable for the pupil to be exposed to those subjects before making the choice. There are also the essential subjects which a certain society feels they should be studied because they are important for cultural, economic, political, group, family and inter personal life in society.

A former Headmaster and a teacher (Smith and Matthew, 1970) have given three reasons why pupils have to make choices. First, because of time. As a pupil studies a subject, his/her knowledge of it grows as well as the time required to pursue it. The more thorough a subject is studied the more time it will require, hence there is just not enough time for everybody to do

everything. Secondly, because of ability. Beyond a certain level most pupils find it difficult to excel at everything. Since some pupils have the ability for certain subjects and not for others, it is better to develop their abilities in those subjects they can excel at while mindful at this stage to avoid narrow specialisation. Thirdly, it is a matter of personal preference. As pupils grow older they become more conscious of their personal likes and dislikes. Also pupils are more likely to do well in subjects they are interested in. Therefore it is better for them to spend more time on subjects they prefer, if these preferences have already been discovered.

1.3 Purpose and Justification for this Research

The purpose of this research, therefore, is to find out the factors and variables that influence subject choice, with special emphasis on the choice of science subjects, in secondary schools in Sierra Leone.

Unlike the British situation, there has been no investigation (or detailed study) done for Sierra Leone into factors affecting subject choice. In fact the only investigations known to have been done so far in Sierra Leone and indeed in West Africa, were those of Ferron (1965) who investigated into the likes and dislikes concerning the various subjects of the school of pupils in Freetown; Sawyerr (1967), who attempted to look into the Science subjects as taught in secondary schools of Freetown (Western Area of Sierra Leone); and Adejumobi (1976), who investigated into the subject preference of students in the then Western State of Nigeria Grammar Schools, stressing on gender differences. The review of literature in Chapter 2 will point to a number of factors and variables influencing subject choice in countries like U.K. and U.S.A. These have been found to fall into three groupings: educational factors, socio-economic factors and psychological factors.

Hence it cannot be assumed that findings in U.K. about factors

influencing subject choice can automatically be translated into the Sierra Leone situation, as these factors are also dependent on economic, social, and educational conditions which are not the same in both countries. For example, the investigation already mentioned (Ferron, 1965), when compared with a similar work done by Pritchard (1935) in England, the findings were markedly different for the two countries, especially in the Science subjects and some cultural subjects like Art, Handicrafts and Music.

Such a study will obviously take up and concern with variables already studied elsewhere. With regard to the pupil being studied, previous work can be classified into internal and external factors. The internal factors concern the pupil's psychological make-up (inner state). The external factors concern the pupil in his/her environment and the pupil in the school setting. Emphasis in this study will be on school-related issues, as these are external factors that can be changed, and no work has been done in this area for Sierra Leone, with respect to subject choice for the GCE O-level/SC.

If some factors can be identified in the school setting that influence subject choice, explanations may be sought for these factors in the hope that it will be within the scope of the school to do something about them, as far as they concern those pupil-related variables resulting from their participation in or exposure to educational influences. Whereas there is very little that can be done about the socio-economic factors other than to know their influences, and for the school to make the necessary changes as the socio-economic conditions change.

1.4 Structure of the Thesis

In this Chapter 1 a brief historical background has been given about the school system in Sierra Leone, the reasons for subject choice and why this study is undertaken. Chapter 2 will be concerned with a comprehensive review of literature relevant to this study and as already outlined in this

chapter. How the tests, questionnaires, inventories, etc., were developed and what they were intended to measure, as well as the strategy used for their sample selection and their administration, are given in Chapter 3. In Chapter 4 the method of factor analysis employed in the series of factor analyses performed is given and also why it was necessary to perform each factor analysis. The factors extracted in each analysis are discussed, and in most cases a discussion of the deviations from these factors by the boys' and girls' samples of the third form is made. Chapter 5 is concerned with what actually obtains in schools in Sierra Leone with regard to the curriculum before subject choice and the subject choice process itself. Chapters 6 and 7 deal respectively with analysing the results for the Form 3 and the Form 5 samples, as to how the variables measured relate to the number of Sciences intended to be chosen (Form 3 sample) or actually chosen (Form 5 sample). Science Preference is also often used as a dependent variable in these analyses, but Sex and School Type are used as moderating variables. The comparison between the findings for the two samples is done in Chapter 8, and in Chapter 9 general conclusions are drawn and the study as a whole is evaluated.

CHAPTER TWO

Review of Related Literature

As already pointed out in the introductory chapter, previous work on factors and variables influencing pupils in their choice of subjects can be classified into three broad areas:

(i) The Pupil in the School Setting

This refers to influences that are brought to bear on the pupil as a result of the school situation. In other words, they are school-related influences, which will be called "educational influences". They include the curriculum, teaching method, learning activities, school policy and facilities.

(ii) The Pupil and the Environment

Here, environment does not include the school environment but refers to the pupil's home background and society. These are influences coming from the pupil's own home, the society's economic, educational and vocational opportunities; society's expectations of the roles to be played by the two sexes, her values and the status attached to certain careers and subjects. These influences are referred to as "socio-economic influences".

(iii) The Pupil's Psychological Make-up (inner-state)

The psychological variables relate to the pupil's intellectual make-up, motivation, thinking biases, cognitive styles and orientation, and to his/her personality. These influences coming from the pupil's inner state are called "psychological influences".

These classifications are not meant to be mutually exclusive since pupils are influenced by the society they live in as well as by the conditions that obtain in the school. The school and the society too do influence each other. The classification has been done in order to help understand how, for instance, the educational variables interact with the pupils' psychological make-up and sex, as a result of their participation

in or exposure to school, resulting in their being influenced to choose certain subjects.

As this research is concerned primarily with pre-GCE O-level/SC subject choice with special emphasis on science subjects, the literature review will mainly be confined to this area. Reviews have been done including post GCE O-level choices. They include the review of Entwistle and Duckworth (1977), who examined recent changes in the pattern of science choices among sixth-formers, and summarised factors associated with subject choice in secondary school. Pitt (1973) reviewed the reasons for subject choice at the secondary school level under four groupings: personality factors, influence of school, influence of parents and career possibilities. Ormerod and Duckworth (1975) concentrated their review on pupils' psychological variables with respect to science; Roberts' reviews and work (1981) primarily concern the psychological influences of subject choice. Another work of note, though not a review, is that of Phillips (1969) who dealt with subject choice in general in the educational system in England and Wales and compared it with certain Western European countries.

2.1 Educational Influences

There is no doubt that the school plays a major part in influencing pupils' subject choices. Kelly's investigation (1961) on 117 thirteen-year-old boys in an East London Grammar School in England, at the time of subject choice and later, concluded that one of the important features of the context in which choice was made was that the pupils' choice was a product of their school environment, with influences outside the school being few and vague in effect, and the home only played a neutral role. However, previous research has also shown that this role, albeit a very important one, is also a controversial one. It has even been claimed that the whole concept of pupils' subject choice at the end of

their second or third year in secondary shcool, is a myth (Woods, 1976); that the decision is made by the school on behalf of the pupils by channelling them into particular areas of the curriculum (Adelman, 1978; Haywood and Leece, 1980); or the pupils are made to endorse the teachers' decisions about themselves with regard to their ability and place in the school (Woods, 1977; Ball, 1981). Yet findings from pupils themselves do not lend support to these misgivings, at least not directly.

In Kelly's work already mentioned, it was apparent that the choice was the boys' own and the boys themselves were subsequently convinced that they had made the right decision and that there was little evidence that other people had had any considerable direct influence. In a study in England by Lovell and White (1958) of 102 male training college students (mean age 23.0 years; SD 2.9 years) drawn from ninety-eight grammar schools, and of whom 47 were science students (studying one or more of the sciences at the training college) and 55 non-science students, the students were asked in an interview conducted individually about their school subject choice, with this question: "If you had to make some choice of subjects during your grammar school course, did the headmaster or members of staff exert any pressure on you to take certain subjects rather than others, or did you decide on your own?" Sixteen of the non-science students claimed that the school authorities had advised them to take arts subjects rather than science subjects and 12 of the science students maintained that they had been advised to take science subject(s) in preference to art subject(s). However, Lovell and White were able to ascertain by further questioning that in every instance the view of the school authorities was in accordance with the course the student already thought to be the right course to take. In a longitudinal study of two separate samples (each of 600, with equal numbers of boys and girls) of pupils in eight comprehensive schools representing the different regions of Scotland, Ryrie et al. (1979) found from the pupils in their third year of secondary school, that most of them

claimed that they had chosen their subjects themselves and felt the responsibility for choosing to be largely their own. Ninety percent of the first sample who were in S3, the third year, in 1976-77, felt there was a real choice available to them.

The review of literature on Educational Influences will be treated under Curricular Variables and School Variables:

Curricular Variables

2.1.1.1 Curricular provision before choice point

2.1.1.2 Curricular choice point

2.1.1.3 Curricular choice pattern (options system)

2.1.1.4 Organisation of teaching

School Variable

School Type

The school facilities in terms of availability of equipment and qualified staff have be left out mainly because previous work has been done in Western countries where these have been assumed to be the same (Roberts, 1981) or not markedly different. But since the investigation about subject choice is primarily about science subjects, and these subjects can only be offered if the facilities are available, then there is justification for these variables to be assumed constant, as a choice can only be exercised by pupils where they have the option to drop a subject which they would have taken if they had elected to do so, and not because it is not available in the school or there is nobody to teach it. These could be looked into as constraints on their choice rather than as influences on their choice.

2.1.1 Curricular Variables

2.1.1.1 Curricular Provision Before Choice Point

The problems that arise in this type of investigation are that labels such as "traditional", "progressive", etc., can be misleading. What a teacher is supposed to do because of the policy of the school or the department, may be different from what is actually done in the classroom. Also the research literature points to the fact that teachers are likely to produce the best results with the instructional procedure they prefer. Even General Science can be taught in one school with recognisable Biology, Chemisty and Physics elements and in another school as an Integrated Science. The writer is aware of a school teaching General Science where Biology was taught the first term, Chemistry the second term and Physics the third term. Integrated Science, too, has its problems. It may be taught by a physics graduate and given a physics bias. Observations made by researchers to find out the actual instructional method may seriously affect the external validity of the research (Burroughs, 1971).

Rodger and Simpson (1980) worked with two comparable comprehensive schools in England and used Bernstein's concepts of 'classification' and 'framing' to analyse syllabuses of both schools. A questionnaire based on Bennett's questionnaire on primary school teaching styles was used to isolate factors that characterise progressive and traditional attitudes towards teaching, for all the science teachers. The Science Heads of both schools were also interviewed. The observation of the science lessons was analysed by means of a modified Flanders Interaction Analysis System. School A was described as very 'traditional', streamed pupils from first year, curriculum-subject based: separate sciences taught as distinct disciplines to all ages and abilities, with separate science heads and an overall Head of Science. School B was described as 'progressive', innovative and concerned about curriculum development; mixed ability teaching in first two years then streaming in third year; taught Nuffield

Combined Science in years one and two and SCISP (Schools Council Integrated Science Project) in year three; democratic organisation with no teacher having a single subject loyalty. A questionnaire was given to all the third formers on one school day (170 from School A, 233 from School B, constituting a response rate of over 80% in both schools) to indicate their option for the fourth form, the reasons for their choices, and their attitudes towards science lessons. The investigation revealed that although pupils in both schools were heavily critical of their teachers, and the lessons in School A tended generally to get more adverse criticism from pupils, yet significantly ($p=0.01$) more pupils in School A chose science options than in School B. 7.6% of School A and 24.0% of School B pupils in the third form had no intention of continuing with science. That 96% of the science rejectors in School B were girls could not indicate a sex role factor alone since 54% of the rejectors in School A were also girls.

Bottomley (1979) conducted a longitudinal study on pupils from age 12 to 14, initially 620 pupils (328 boys and 292 girls) at a boys', a girls' and a coeducational grammar school, and a coeducational secondary modern school in England. The pupils in the three grammar schools studied separate Sciences while the secondary modern school pupils studied General Science. She found that there was no significant difference between grammar school girls (separate Sciences) and secondary modern school girls (General Science) in their actual choice of science subjects; but there was a significant difference ($p=0.05$) only for the intended choice of Physics by the separate Science girls over the General Science girls. In the case of the boys, it was the other way round: the significant difference ($p=0.05$) was in the actual choice of Physics only, made by the separate Science boys from the grammar schools over the General Science boys from the secondary modern school. There was no significant difference between the two groups in their intended science choices. The pupils at the secondary modern school were, however, more reluctant to drop subjects than the grammar

school pupils. The two questionnaires for intended choice and actual choice of subject were administered at age 13+ and 14+ respectively.

The questionnaire given to the pupils (313 boys and 279 girls) within a week or two after they had transferred from fifty-two age 8-12 middle schools to the above four secondary schools, was studied (Bottomley and Ormerod, 1977; 1982; Ormerod et al., 1979) to ascertain the experiences of middle school science activities the pupils recalled. The relationships between having done or not done each activity in their middle schools which they recalled in the first year, and the actual science choices made two years later at age 14+, were found. The correlation coefficients were generally low but pupils' experiences of some of the middle science activities that reached a level of significance of 0.05 or better for Chemistry (C) and Physics (P) choices are shown in Table 2.1. The correlations in brackets are not significant but shown only for comparison. However, it is not the obvious Chemistry and Physics activity that correlates with Chemistry or Physics choices and there are also gender differences. These activities, though biological, involve taking measurements and/or the successive recording of a series of observations.

Table 2.1 Significant correlates of Chemistry (C) and Physics (P) choices among some middle school activities

	BOYS		GIRLS	
Activity	C	P	C	P
Use a forcemeter	0.40	(0.01)	0.59	(0.16)
Study worms	(0.03)	(0.24)	0.45	0.31
Sow seeds	0.31	0.39	(0.03)	0.38
Measure seed growth	(0.27)	0.39	(0.09)	0.21
Study growth requirements of plants	0.33	0.38	(0.03)	(-0.09)
Study snails	(0.10)	(-0.08)	0.38	0.30
Topic on sound	(-0.09)	(0.18)	0.29	(0.12)
Use of microscope	(-0.05)	(0.17)	0.29	0.33

There is, therefore, some evidence of specific early science experiences affecting science choices at 14+.

2.1.1.2 Curricular Choice Point

Questions have been raised as to whether subject choices are forced on pupils too early in the educational system in England compared with several European countries (Phillips, 1969). Pitt (1973) claims that a pupil of 13 or 14 has no strong pull either to arts or science and yet he or she is forced to choose by the educational system. Working with 604 grammar school pupils (292 in the fifth year and 312 in the second year) from urban and rural school areas, in England, Duckworth (1972) found that at age 13 potential scientists were identifiable but that the distinguishing features

were not related exclusively to pupils' interests. From the third questionnaire administered to the pupils at the four secondary schools just after subject choices had been made at age 14+, Bottomley (1979) found that the 565 pupils (296 boys and 269 girls) who had responded to her question as to whether their interests were mainly on the science or mainly on the arts side, only 33.5% of boys and 32.0% of girls (no significant difference) were uncertain as to which area their interests lay. It may be argued that a large proportion of pupils were still uncertain about their main direction of interests, and hence seen as evidence - as indeed Bottomley did at that time share this view - to suggest that science choices are made too early. In their work (Bottomley and Ormerod 1977) on her first qestionnaire on the middle school science activities, they said: "The importance of these findings arises from the widespread evidence that interest in science is kindled at an early age, quite possibly in the middle school for these pupils." What is not known is whether there would have been any significant differences between the proportions of pupils in the fourth or fifth forms who would have been uncertain about the main direction of their interests. When Butcher (1969) inquired from students in three faculties (Art, Science and Social Science) of Edinburgh University about the age they had first been attracted to a particular type of subject, the average answers were 12.4 for science, 13.2 for arts and 14.8 for social sciences. In a similar study, but about the job a student wanted to do at age 12, 15, 17 and at the time of entry to the University of Bradford in England in 1967, Musgrove and Batcock (1969) found out from 338 students (288 Science and Engineering, 50 Social Science) that at each stage a higher proportion of students of science and engineering had made earlier and more stable decisions than students of social sciences. There were 18.0% of social science students still undecided compared with 6.6% science and engineering students.

Working with a sample of 604 pupils (312 from the second year and 292

from the fifth year) from six grammar schools in Lancashire (England), Duckworth and Entwistle (1974) were able to test the hypothesis that pupils would show no general attitude to science at least in the second year, by using the repertory grid. Their findings were, that although few significant correlations between interest in different subjects in the second year were found, the correlations between interest in physics and interest in both chemistry and mathematics among girls were noteworthy for them to imply that a group of female scientists was indentifiable even at age 12.

It follows, therefore, that as far as science choice is concerned, a delay to a later stage may help some late developpers and perhaps a substantial proportion of girls to make up their mind, but the vast majority of pupils will have already made a commitment to science even before subject choice, and hence are aware of and capable of making such a choice (Lovell and White, 1958; Roberts, 1981).

2.1.1.3 Curricular Choice Pattern (options system)

People who have done extensive work in observing the options system in many scools (Ryrie et al., 1979; Reid et al., 1974; Bardell et al., 1982) do agree that all the schools do operate an options system whereby their pupils are given an opportunity to choose subjects for the two years preceding the GCE O-level or Certicficate of Secondary Education (CSE) or until they leave school at age 16, the age at which compulsory formal school education ends in Britain. (The CSE, although taken at the same time as the GEC O-level, yet it is different in content and in depth, and generally considered to be of lower academic standing than the GCE O-level). Basically, the procedures adopted by the schools are similar: subjects in five or more vertical columns ordered hierarchically - the traditionally academic subjects at the top down to the non-externally examined courses at the bottom - from which to choose one. Individual

schools ensure balance of subjects either by instructing pupils about subjects that are to be included in their choice, or by the nature of the options system itself. Options forms are sent to parents with an invitation to a parents' meeting. Some schools offer a formal guidance to their pupils but there is ample opportunity for pupils to receive advice or guidance from teachers, although in some schools pupils are discouraged from seeking advice from their subject teachers because of the danger of subject "touting" or competing for the more able pupils (Ryrie et al., 1979).

As to who decides the nature of the options system varies from school to school but as Price (1973) outlined, the option groups are compiled so that subjects are grouped in such a manner that the average pupil in selecting a subject (whether for GCE or CSE) from each group ends up with a "liberal" or "rounded" timetable. One would therefore want to find out how this "liberal" or "rounded" timetable allows for a balanced Science choice. In other words, do the constraints of the options system allow a pupil to choose all the Sciences if he or she wanted?

McIntosh and Ewan (1970), analysing the subject compatibility of schools in Scotland, found that the options system in one school made it impossible for a pupil to choose the three sciences, Biology, Chemistry and Physics, as well as Mathematics, as the choice pattern required one choice from the following:

(i) Mathematics or Biology

(ii) Physics and Chemistry or Biology and Chemistry

The options system of schools have also been criticised for severely limiting the full science choices, particularly for girls. Kelly (1978a) noted from examining the reasons pupils in Scotland gave for dropping or continuing with science in S3, that a substantial proportion of pupils - more common for girls than for boys - dropped science because it was not

possible to take it with another subject. Pheasant (1961) noted that the options system prevented the ablest girls from choosing a physical science as they frequently had to make a choice between a second modern language and a physical science, explaining that "the novelty of the new language and the appeal which language study seemed to have for girls caused them sometimes regretfully to reject the science." Notwithstanding this, Kelly (1978a) did aso observe in her analysis of the reasons of Scottish pupils for dropping or continuing with science in the third year of secondary school, S3, that "as many girls as boys (slightly over half in each case) said that their school allowed them to take three O or H grade science subjects if they so desired." (The O and H grades are the Scottish equivalent of GCE O-level and A-level).

This immediately raises the question whether the options system itself severely constrains the free choice of all science subjects, or the options system has resulted from the experience of the choice pattern of pupils. Have schools given their pupils free choice in the past and allowing for the constraints of examination requirements and accommodation, teachers' requirements and the timetable, pupils' preferences and society's expectations, have come up with the groupings of the subjects?

Edwards (1980) studied the pattern of options in each of nine comprehensive schools in England. Before the pupils chose their examination options they were told how their subject choices could affect their careers. Some of these schools allowed a free choice of options and then drew up the timetable to give the maximum degree of satisfaction to the pupils; the others prepared the timetable before asking their pupils to choose from predetermined lists of subjects. All the schools did stress to the pupils and their parents the importance of a general education and the dangers of premature specialisation. Yet, in only three of these nine schools was a science among the compulsory subjcts to be chosen (Mathematics and English were compulsory in all these schools). In the

study by Reid et al., (1974) some schools advised their pupils to include one science in ensuring that the pupils chose a balance of subjects, whilst others did not.

In the Department of Education and Science (DES) Survey (1979) of 384 schools of different types and sizes which provided for pupils of various ranges of age and ability coming from a variety of catchment areas in England, only 7% of the schools included science in a basic core of compulsory subjects taken by all pupils. However, 12% of the schools required pupils to take at least one science from a group of 'optional' subjects, thus in fact bringing the total percentage to 19 of schools where at least one science was chosen. In 63% of the schools it was offered as part of a scheme of non-compulsory subjects whilst the rest, 18%, adopted some combination of these arrangements. An earlier survey (DES, 1975) of 486 schools in England (447) and Wales (39), gives, in those schools in which the subject is optional, the number of pupils to whom a subject is offered as a percentage of the total population of the sample (only Science subjects, French and German are shown in Table 2.2).

Table 2.2 Percentages of Pupils Being Offered Particular Subjects.

	% of TOTAL		% Difference
	BOYS	GIRLS	
Biology	88	95	7
Chemistry	79	76	3
Physics	90	71	19
French	84	89	5
German	36	40	4

According to the report, these percentages indicate, "in some measure, the importance which schools attach to a particular subject." Nevertheless, a cautionary note was sounded in looking at the results, "because some schools, particularly comprehensive schools, attempt to offer all these subjects to all pupils."

Perhaps some explanation may be gained as to why "optional subjects are timetabled against each other in a bewildering variety of ways" (Ormerod, 1975) from Butcher's study (1969a) of the Scottish situation:

> This requirement of the Scottish universities also has a 'backwash' effect on the schools. While passes in Maths/Physics/Chemistry are a requirement for entry to science departments, Biology and technology subjects count merely as additional qualifications, with consequent lower status as subjects.

It appears, however, that the constraining effect of the options system, bewildering though it is still today, has been in practice for a long time. Brown (1953) studied the science choices of 705 girls from 12 grammar schools in England who took the School Certificate examination in 1947. She found that in five of the schools the curriculum was so arranged that no girl could take more than one Science subject, thus this restriction affected 376 girls. Of the remaining 329 girls who were offered two Science subjects, only 114 (34.7%) did in fact choose two science subjects whilst the rest chose alternative subjects or else took neither the Science subject nor the alternative. She further noted that the highest percentages of girls choosing two Science subjects came from three schools: in two of them the girls were not free to make the choice themselves but in the third school the options system offered the best opportunity for selecting two Science subjects. It is interesting how she discribes the arrangement in the third school:

> The alternative subject arrangement in this school was such that, even if a girl chose to take German or Domestic subjects instead of Chemistry, she would still be able to take both Physics and Biology for which there were no alternatives.

She further pointed out that the two schools with the lowest percentages of two Science choices, offered more than one non-Science subject, such as German or Art, as alternatives to a Science subject like Chemistry.

Criticisms have also come from quarters other than those who have been concerned with the inhibiting way the organisation of the options system has had on the freedom of choice of Science subjects. But of particular interest to Science choice is that made by Powell and Littlewood (1982) for

foreign languages. The reason is that only the interest is different: they, concerned about why boys taking Chemistry and Physics don't also take French; we, why girls taking French and German don't also take Chemistry and Physics. Their criticism of the options system is put in this way:

> It may seem paradoxical to say so, but the options, far from providing all children who show interest, ability or determination in a particular subject with the choice to pursue that subject until the statutory school leaving age, actually pressurize parents, teachers and pupils into making unwise decisions based on false assumptions about the nature of schooling and society.

If the percentage of pupils being offered a subject for choice is an indication of the importance which schools attach to that subject, and if the percentage of pupils actually choosing that subject may reflect the extent of the freedom of the choice from restrictions, then in Table 2.3 from the DES report (1975), it shows that all girls, irrespective of the type of school in which they attend, are restricted in their choice of Chemistry and Physics; and similarly all boys are restricted in their choice of Biology.

Table 2.3 Percentages of Pupils Choosing Subjects that They have been Offered

	BOYS	GIRLS
	%	%
Biology	31	52
Chemistry	35	22
Physics	52	17
French	29	45
German	14	20

Table 2.3 shows that boys are more likely to take Physics and Chemisty and girls are more likely to take Biology. There is therefore a severe and damaging restriction on pupils taking a full complement of the Sciences but more so for the girls.

No study is known to have been done to find out how schools arrived at the arrangement of subjects in their options system to assertain whether schools which allow free choice of all the Sciences to all pupils and those which restrict free choice have done so as a result of past experience, that is, that free choice occurs where pupils actually make full use of the free choice and restriction of choice occurs where pupils did not make use of the free choice of the Sciences when it was made without putting another popular subject or subjects for both or either sex to compete with the Science choice. Hence it will be difficult for schools to be convinced to make the change in the desired way. Schools will always argue that the pattern of the options system is based on experience coupled with the availability of resources and the use made of them. Ryrie et al. (1979)

noted that approximately 93% of all individual subjects given by the pupils as their choices during their interviews with them, subsequently appeared in their timetables. Making either Physics or Chemistry and French as compulsory subjects is unlikely to solve the problem, and if it did, it might lead to pupils taking subjects for which they had no intrinsic preference, thus restricting their free choice.

A recent paper by the Secondary Science Curriculum Review (1983) also has put major blame on the subject option system that operates in most schools at the end of year 3, in explaining why one in ten pupils in England, Wales and Northern Ireland in 1980 were not studying any science after the age of 13+, and why the number of boys and girls taking one or more science subjects differs considerably.

While in no way encouraging an abrogation of professional responsibility, perhaps a change in the present options system may result from pressures from the pupils themselves arising from their desire to study and to choose these subjects. From the writer's experience as a teacher of Physics in both a boys' and a coeducational secondary school, and as a Principal of a coeducational secondary school, Heads of schools are much more readily inclined to change a timetable even when it is made before subject choice, to allow two subjects that have been timetabled simultaneously, to be studied by pupils if a substantial number of pupils wanted to study both subjects, rather than for the educational merit - especially if this is not a requirement for an external examining board - for pupils to study both subjects. Perhaps it is appropriate to point out as Butcher (1969) highlighted from the criticism of the Dainton Report by McPherson (1968):

> If science were compulsory it must be attractive; if it is not attractive it will only suffer if made compulsory; and if it

were attractive, it would not need to be compulsory.

But the school would still have to play a major role both to ensure that there is the arrangement of subjects to allow free choice and to guide and encourage pupils in their counselling on options, and not just to leave it to the pupils themselves.

It emerged from Brown's work (1953) that the two schools with the highest percentages of girls taking Science subjects were those where either the school made the choice or provided the best opportunity to choose two Science subjects. Pont and Butcher (1968), in a study of factors affecting subject choice, studied the choices made by 1011 pupils (536 boys and 475 girls), mostly potential university candidates, at the end of the second year in secondary school in seventeen Scottish schools. They found that the subject choice procedure adopted in three of these schools was the one where the school chose the subjects. However, this was done in three different ways. First, each subject teacher gave an estimated five-scale rating for each pupil's subsequent performance in the O Grade. On the strength of these ratings the Headmaster and all the Principal Teachers chose a course of study, that is, a complete group of subjects, for each pupil, and this was sent to the pupil's parents, who, if they wished, could discuss details of the course with the school. It was pointed out that there was the possibility that either the pupil or the parents might not play any direct part in the choice in this procedure. The second way was initially the same as the first but the course chosen and sent to the parents by the school was in the form of 'main recommendations' and 'possible alternatives', and the parents were asked to show the subjects they would wish their child to study, bearing in mind the recommendations. There was provision for discussing any disagreements with the school. The third method involved first an invitation to the parents to two talks on

careers and subject choice, followed by the pupils filling a form indicating the subjects they liked best, those at which they considered themselves proficient and their career choice. Based on this information and the pupils' latest evidence of performance in all subjects, a school panel recommended subjects to be taken. But before a final decision was made on each pupil's course, a parents' meeting was called for consultations between parents and form and principal teachers, where the parents wishes were noted. So it does not necessarily mean that when the school does the subject choice that the choice is imposed on the pupils any more than when the parent and/or pupils choose a course or a course is arrived at during a discussion involving the pupil, the parents and the school (the other two categories observed by them in the other 14 schools were essentially the ones discussed so far).

Pont and Butcher also found the options system, the arrangement of the subjects, in the seventeen schools similar to the ones discussed so far. They found that some schools offered more choices than others and hence some pupils seemed to have more choices; but in essence there was little diversity of basic courses provided, only minor varieties in extra subjects. There was still the problem of the choice between Science and a second language. They felt "the restrictive nature of the choice, therefore, seems to rest on the taking or dropping of Science." In 7 of the 17 schools it was not possible to take two modern languages and Chemistry or Physics. Nonetheless, in the 10 remaining schools where this was possible, only an average of 6% of the pupils availed themselves of this option.

This is where the school should exercise its professional responsibility. Removing the restriction - though desirable and necessary - is not enough; neither the argument that the choice by pupils for such provision does not warrant it. If the schools realised as Pont and Butcher clearly illustrated, that the arrangement of subjects, consciously or

unconsciously, on the options system might in effect result in pupils making a choice between 'Arts' subjects and 'Science' subjects, and that dropping Chemistry and Physics at this stage would mean these pupils would have one less university faculty to choose from, and that at this stage 20% of boys and more than 60% of girls were dropping science (that is, by the third year of secondary education almost 50% of the pupils have opted out of Science), perhaps this might result in a more realistic arrangement of subjects to allow the choice of a physical science along with, rather than instead of, subjects traditionally preferred by girls (a recommendation made by the Royal Society and the Institute of Physics, 1982). And, as Pont and Butcher highlighted, schools may even actively recommend it to the pupils.

It is appropriate to end this review with a view expressed by a Principal of a Community School as an outsider not involved in the Schools Council study (Bardell et al. 1982) that "options do not mean dropping subjects, the exercise of juvenile whims, premature specialisation and the closing of doors on fundamental educational experiences."

2.1.1.4 Organisation of Teaching

The DES survey (1975) of 113 Middle Schools (on the average, age 8-12) found that there was no striking evidence to show that a pupil was denied any opportunity that would be prejudicial to his/her later study of traditional academic subjects. There seemed to be also a trend towards encouraging both boys and girls to participate in activities traditionally restricted to one sex. One would therefore tend to assume that since this survey also found that some of the patterns of curriculum developed in the first three years of secondary schools, either consciously or unconsciously, produced restrictions on a free choice of options for subsequent years, that whatever part is played by the organisation of teaching in secondary schools stems from the schools themselves.

All schools do have some sort of grouping in an attempt to meet the needs of their pupils. This grouping can be in the form of mixed ability grouping, streaming, setting for specific subjects or banding. Whatever the educational merits of each grouping, the organisation of pupils in groups for teaching has a part to play in the fostering of group co-operation when it comes to subject choice. Woods (1976) referred to it as group perspectives, which he defined according to Becker et al. (1961) as "modes of thought and action developed by a group which faces the same problematic situation. They are the customary ways members of the group think about such situations and act in them... which appear to group members as the natural and legitimate ones to use in such situations."

Since schools in Britain have to cater for courses at three levels, namely the GEC O-level, CSE level and the non-externally examined level, whether the groupings before subject choice are along these levels or not, the pupils themselves are conscious of them. In the longitudinal study by Haywood and Leece (1980) of a cohort of 320 pupils though a large comprehensive school in England, picked up in their third year, they gave the pupils a questionnaire one month before the processes for subject choice started, with this question:

> If you could take any eight subjects at school from tomorrow, which would you prefer them to be in order of preference? (Answer for all eight).

Further, the school was described by them as having mixed ability teaching groups in the first three years but they had setting (ability groups) for English, Mathematics and French. General Science was taught for the first two years followed by separate sciences in the third year, the year when some pupils also did not take French. Subject choices were done by the

pupils during the third year for the fourth year. In the fourth and fifth years the pupils were divided into two bands: one band (47%) to study GCE O-level and/or CSE courses, the other band (53%) to study CSE or non-examination oriented courses. The pupils had not then been told the band they would be assigned when the questionnaire was administered. Their findings revealed that the subjects preferred by band one-destined pupils differed markedly from the band two-destined pupils, with the band one preferences being mainly academic subjects and the band two preferences being mainly non-academic and craft subjects. When in fact the pupils were assigned to bands in the fourth year, the optional subjects that showed the highest positive percentage differences between the percentage of pupils studying that subject in band one and those studying it in band two, were, in rank order for the first six subjects: French (58%), Biology (34%), Chemistry (32%), Geography (25%), Physics (19%) and German (17%). Maths and English were compulsory subjects. Confining to the Sciences: Biology, Chemistry and Physics, the percentages of pupils studying them in band one were respectively 60, 46 and 40; for band two they were respectively 26, 14 and 25. Thus there is no equal access to all subjects by grouping level. (For a comparison, the percentages of band one pupils who studied French and German were respectively 66 and 17, and of band two, 8 and 0).

Reid et al. (1974) also found that the earlier course differences between pupils, that is, by organising the curricula of pupils according to their abilities, substantially limited their subject choices. In four of their schools studied, two schools had a banding system from the first year, with pupils divided into upper and lower ability bands. Pupils in one of these two schools assigned to the lower ability band, followed a general science course in the third year, having already dropped French in the second year. Their counterparts in the upper band did Biology, Chemistry and Physics as separate subjects in the third year as well as German, also introduced in the third year for the abler pupils. The third school also

differentiated between its more and less able pupils from the first year. Only the fourth school had mixed ability groupings in the first three years, with setting in certain subjects. This limitation in subject choice, imposed by the pupils' third year courses, which were determined according to which particular stream or band they were allocated to, had also been supported by Monks (1970).

Ryrie et al. (1979) divided the pupils in their two samples into three "bands" according to the school grades obtained by each child in each sample in all subjects during the first two years of secondary schooling. Pupils with average grades of A or B, C, D or E, were respectively assigned to Band 1, Band 2 and Band 3, approximating to 30, 40, 30 percent respectively in each band. They justified their classification in this way rather than basing it on objective test scores on the grounds that the grades and the construction of the bands appeared in the pupils' school reports and it was their assumption that the bands represented what the school had conveyed to pupils and their parents about the pupils' ability. When the hierarchical order in which subjects were arranged in options sheets were also classified into "orders", with Order 1, Order 2, Order 3 and Order 4 respectively representing the traditionally academic subjects at the top, followed by the other O Grade subjects, then the distinctly practical O Grade subjects and at the bottom the non-certificate subjects, they found a clear relationship between the bands of the pupils and the orders of the subjects they were studying. But the pattern of subjects studied by Band 3 (the less academic) pupils varied with the school. Also for all bands some subjects were studied mostly by one sex. But what was intriguing was that the subjects the pupils were studying were those they had chosen and that the school had made only few changes. The Band 3 pupils were very much restricted in their choices. From the number of pupils in the three bands who reported varying numbers of 'no-real choice' subjects, that is, a choice made because they were "no good" at others or because the

teacher had said they should take it or they just had no choice, only 40% of Band 1 pupils had made at least one such choice compared wit 80% from Band 3. For those making three or more such choices, it was respectively 5%, 9% and 26% for Band 1, Band 2 and Band 3. A teacher was quoted from a school where almost all the pupils were given in their timetables the choices they had made, as having said:

> Some subjects have a dustbin quality... The lower ability groups are channelled into subjects like this - but it's done discreetly.

Woods' (1976) findings also do support this influence of a school's teaching organisation on subject choice. He did his long-term observation project in a Secondary Modern School in England where all the pupils had been unsuccessful at the 11+ examination and where it was decided that six examination subjects were the optimum number for them to choose. The groupings were according to ability: 3a (36), 3b (37), 3c (30); 3a being the ablest pupils and 3c the less academic pupils. He found that 44% of the whole, proportionately twice as many boys as girls, had at least one subject changed from their original choice. Defining 'positive' changes as changes from non-examination to examination subjects, and 'negative' vice versa, 60% of the changes were 'negative' ones with nearly half of these coming from 3c, and most of the rest from 3b.

2.1.2 School Variable

As already stated earlier, the only school variable to be considered is the type of schooling in terms of whether it is a single sex school (all boys or all girls) or a mixed sex (coeducational) school. In this way all schools can easily be classified be they grammar, secondary modern,

technical or comprehensive, and discussed without the attendant problem of compatibility. The names are just used as a description of the school rather than as an emphasis on the school. The emphasis here is whether boys and girls attend secondary school together or separately. School resources (staff, laboratory equipment and accommodation) are considered as constraints on science choice.

Dale's study (1974) on mixed and single sex schools has generated a lot of interest and controversy about these two types of schooling and that they seem to exert different influences on pupils. For example, in the case of a pupil's liking for Physics at age 13, he had shown that there was a significant difference depending on the sex of the pupil and the type of school.

There is some evidence (Hutchings et al., 1975) that the popularity of subjects depends on an interaction between sex of pupil and type of school. Wood and Fergusson (1974) give the impression that the allegiance to a subject depends on the sex of the pupil and the type of school he or she attends. If the popularity of and allegiance to a subject are dependent on sex and type of school, can subject choice be dependent on sex and type of school?

Table 2.4 and Table 2.5 from the DES Survey (1975) which they corrected to enable comparisons to be made between Single Sex Schools (SSS) and Mixed Sex Schools (MSS), indicate that boys are more likely to choose a language and girls a science in SSS, than they are in a MSS. Again if the percentage of pupils being offered a subject is a measure of the importance which schools attach to that subject, and the percentage of pupils taking the offer as an indication of the extent to which choice is free from restrictions, then overall Science subjects are held to a higher esteem in mixed sex schools but at the same time their choice is very highly restricted. This may sound like a contradiction in terms.

Table 2.4 Corrected Percentages of Boys being Offered and Choosing Particular Subjects

	Being Offered: % of Total Pupils		Choosing: % of those to whom offered	
	SSS	MSS	SSS	MSS
Biology	79	91	39	30
Chemistry	81	79	36	35
Physics	85	91	60	52
French	75	87	37	28
German	33	36	21	11

Table 2.5 Corrected Percentages of Girls being Offered and Choosing Particular Subjects

	Being Offered: % of Total Pupils		Choosing: % of those to whom offered	
	SSS	MSS	SSS	MSS
Biology	96	96	49	53
Chemistry	75	78	27	22
Physics	62	75	23	15
French	92	90	49	43
German	44	38	18	21

Kelly (1976), in analysing previous studies noted that despite the disadvantage of girls' schools in that they suffered more than mixed schools from staff shortages and poor laboratory facilities compared with mixed or boys' schools, yet these poor conditions were no deterrent to their studying more science than girls in mixed schools. It appears that with even curriculum revision the effect of school type is still noticeable. Harding (1973) observed from an analysis of the entries for the special Nuffield O-level examinations in science that not only were the three Sciences used more extensively with boys than girls, but "there are signs that the sex bias is more pronounced in mixed schools in all three subjects."

In the work already mentioned by Dale (1974), he had noticed significant differences in preference for certain subjects between mixed school pupils and single sex school pupils even when other factors like

social class differences were held constant. From his analysis of other studies and examination results, he noticed that girls in single sex schools were significantly more likely to choose Physics or a physical science and Mathematics, than girls from mixed schools. He was the first to describe this phenomenon whereby pupils in a mixed school seemed to have a divergence of preference for and choice of certain subjects, as polarisation. But it was Ormerod (1975) who put this polarisation hypothesis, especially with regard to subject choice, to a test. Ormerod (1975) used as his sample 1,204 pupils (518 boys and 686 girls) aged 14+, coming from 19 schools (10 single sex grammar schools, 5 mixed sex grammar schools and 4 comprehensive schools) all over England. There were 664 pupils (293 boys and 371 girls) from single sex schools and 540 pupils (225 boys and 315 girls) from mixed sex schools, drawn from classes in which 75% of the pupils were expected to enter for five or more GCE O-level subjects. By means of the Brunel Subject Preference Grid Ormerod was able to find the subject preference of the pupils for 17 subjects (14 was the median number of subjects taken in the whole sample) as well as their subject choice. After dropping subjects with obvious sex association, such as handicraft, housecraft and boys' technical subjects, the correlations between the relative popularities of the subjects between boys and girls were highly significant ($p < 0.001$). Subjects that were more popular with or predominatly chosen by boys, he called 'male' subjects; and in the case of girls, 'female' subjects. A 'gender spectrum' was then constructed based on the magnitude of the difference in preference between the 'male' and 'female' subjects, ranging from extreme masculinity to high femininity. The 'male' subjects were Chemistry, Physics, Mathematics and Geography and the rest were 'female' subjects. These subject genders he found to be in agreement with those derived by taking the majority sex for each subject from the tables of countrywide 1972 GEC O-level entries (DES, 1974).

Ormerod was then able to test pupils' choice polarisation in

coeducational schools. He found that although in coeducational schools a stronger preference for 'female' subjects by girls and 'male' subjects by boys was found to be significant, in the case of subject choice, it was found to be significant only for boys' subject choice and not significant, but at the same time as predicted, for girls' subject choice. By further examining his results, especially with regard to specific subjects, Ormerod was able to explain why the differences in girls' subject choices failed to support the polarisation hypothesis. He observed that both mixed sex and single sex school girls were unable to make their subject choices satisfactorily in accordance with their subject preferences as did the boys, and that the mixed sex school girls were more culpable for the failure of the hypothesis for subject choices. An explanation for this anomaly will come up during the review of studies on pupils' subject preference and subject choice (Keys and Ormerod, 1976b) to be done later.

Bottomley (1979) was able to show polarisation effects for subject choice at age 14+ between the subgroups in her sample comprising two single sex schools and two mixed sex schools.

Ferguson (1982) has suggested that the environmental characteristics of the two types of schools may explain why girls in single sex schools are more likely to pursue science courses. She argues that girls in single sex schools have more opportunities to assume and to develop confidence in their own abilities without coming into direct competition with boys, at a stage when they are becoming very conscious of the other sex and so find such situations disconcerting. In single sex schools girls are required to exercise leadership roles in sports, school politics, act as president, organise their own affairs and hence are self-confident and more independent. In mixed schools girls need encouragement to assume responsible roles in classroom and extra curricular activities, and that unless for the top few girls who may achieve in any environment, the average girl at this stage tends to play a passive role. She cites a

videotape prepared by researchers in Holland (Raat, 1981) showing groups of boys and girls working together on a simple pendulum experiment. In groups where a boy and a girl worked together the boy carried out most of the active tasks of measurement, timing with a stopwatch and assembling the equipment, while the girl read the results. But where two boys or two girls worked together the work was more equally shared and much greater discussion went on about the experimental procedure. On the other hand, Harding (1983) argues that it is the expectations found in the two types of schools that create the difference in the involvement of girls in physical science. That whereas girls' grammar schools were founded with the avowed aim of giving girls an education equal to boys, the comprehensive schools, containing a high proportion of girls, were set up with the educational objectives of producing good wives and mothers.

Whatever may be responsible for the influences which these two types of schooling have on pupils, "in coeducation boys and girls are expressing preferences and, when possible, choices in such a way as to reaffirm their perceived sex role." (Ormerod, 1975).

2.2 Socio-economic Influences

It was stated earlier in the introduction that emphasis in this study would be mainly on educational influences rather than on socio-economic influences which are much harder to change. At the same time the values of a society are also manifest in its schools. So if certain subjects are predominantly chosen in schools in one society it is obvious that there must be the necessary conditions to encourage this to happen in those schools. It may therefore be worth examining the school system in that society to see how it responds to its societal values.

From a comparative study of women in scientific occupations, Kelly (1976, 1981) notes that only in Africa and Western countries are women under-represented in science compared to their representation in other

subjects. She further draws attention to the fact that although this under-representation is widespread it is by no means universal. There is a big difference between Eastern and Western European countries just as there are differences between Third World countries. Hutchings (1967) feels that sociological factors influence attitudes to studies in that whereas in British society it is expected of girls to choose arts subjects, in the USSR their society expects them to opt for science and mathematics. Ormerod and Duckworth (1975) feel that the reason for this high proportion of women in science in the USSR cannot only be due to their different value system but a closer look has to be made of the important early years of life in Russia. They infer that the Russian success may be due to the fact that a larger proportion of children than in most Western countries, are put into creches from six months onwards where they are given graded mental stimulation by trained helpers. Here boys and girls are given the stimulus of toys and games which develop the spatial skills, a necessity especially for girls, in the study of science and mathematics.

As Bradley and Hutchings (1973) pointed out in their study into the factors influencing secondary school pupils in their choice of subjects and possible careers, and also brought into focus in the studies of Butcher (1969a,b), Butcher and Pont (1969), it is still an open question how far subject choice is related to career choice. Yet one can hypothesise that since pupils who choose science subjects in school are more likely to take up a scientific occupation later in life than those who drop science subjects, that if there is a greater proportion of people engaged in scientific occupations, then a greater proportion of them did choose science subjects when they were in school. Adelman (1978) has shown that the subjects taken in higher education, at least in the British system, stem from choices made at 13+. Also that students who are given the opportunity to change their areas of study after they have entered higher education, of the changes made, over 80% are changes from science to

non-science subjects.

Walford (1983) was convinced from a study made on 800 boys and girls in a large, urban, multiracial comprehensive school in the West Midlands (England) that parents too could play a part in encouraging pupils, especially girls, to enter physical science courses. His findings showed that not only were the occupations the pupils were aspiring to congruent with the work opportunity in the immediate school locality, and commonly held views on gender role stereotypes in the community, but that the major influence on the pupils' job choice was the job they perceived their parents wanted them to do. The extent of this influence was more for the girls than the boys and also depended on ethnic background.

Bottomley's (1979) study seems to lend support to parental role in subject choice, at least for girls. She found that girls who had chosen to take Physics and Chemistry had been more strongly influenced in their decision by their parents than those who had decided to drop these subjects at 14+. She further explained this as due to parents' ambition for a 'medical' type career for their daughters. As regards parental influence on the total number of science subjects chosen in the grammar schools' sample, Bottomley found it was not significant for the boys. But for the girls it was significant especially if the advice came from the mother ($p = 0.005$). Perhaps it can be understood why Kelly's study (1959) on grammar school boys showed that the home was neutral in influencing subject choice.

In the retrospective study by Lovell and White (1958) of 102 male training college students about their subject choice at school, some of the influences operating in the home and the environment were investigated. They found that the influence of local employment opportunities and the awareness of the increasing importance of science and technology upon life played a negligible role on their choice of subjects. As for parental influence through directions or advice, this too was found to be of no consequence in affecting their choice of subjects. The eleven students who

recalled complying with their parents' advice to take science courses (3 students) or Arts courses (8 students), all said it was their intention to take those courses anyway. Nevertheless they found the interests of the parents, clearly displayed in the home, but distinct from their occupation, were significantly linked with later choice of subjects.

In Roberts' study (1981) of 637 fourth form pupils (370 boys and 267 girls) from five comprehensive schools in the Midlands (England), about their choice of subjects at the third/fourth form level, the home environment was investigated in relation to their parents' job. She considered that asking the pupils about their parents' jobs was a very sensitive issue so she got this information indirectly by asking the pupils about the jobs of the friends of their parents. She hoped that the jobs of the friends their parents associated with could be a reflection of their parents' jobs. The responses were then classified on a six-point scale ranging from the top, High Level Management, Professional, down to Semi-skilled and Unskilled. Cautious of the fact that the pupils' socio-economic background might not have been reliably measured in this way, she found that there was a significant ($p = 0.01$) relationship between socio-economic rating and the number of science subjects chosen, that is, the higher the socio-economic rating the greater the number of sciences chosen. The socio-economic status of the boys was significantly ($p = 0.01$) greater than the girls at each level of the number of sciences chosen.

But, as Butcher (1969a) observed, parental influence on choice of specialisation is by no means easy to assess. When pupils themselves have been asked for their reasons for choosing subjects, parental influence has been shown to be of no significance. In the study by Reid et al. (1974), "parents wanted me to" as a reason for subject choice, was ranked very low and given by only 14% of their total sample and with no significant difference according to ability. Parents were said to have had an influence in only 12% of the choice when Ryrie et al. (1979) asked the pupils in

their second sample with regard to each subject they were expecting to take. In the Schools Council study (Bardell et al., 1982), when the fourth formers (112 boys and 116 girls) were presented with a list of twenty possible reasons for their choosing one, randomly selected, subject, "my parents wanted me to do it" was ranked fourteenth. Yet when these fourth formers were presented with a list of eleven factors that might have helped them choose their subjects and to indicate the magnitude of the help for each factor on a five-point Likert type scale, "parents" was ranked first, with an average rating score of 3.48 out of a maximum score of 5.00, and all the 228 pupils responded. (For comparison the average rating scores for "teachers", "friends" (pupil's) were respectively 2.69 and 1.40). Also the 916 pupils in the four schools in the study by Reid et al. frequently cited parents as the most important source of help when the pupils were asked whom they considered to have played the "most important part of all" in helping them decide on their subjects. This response was the same irrespective of the ability of the pupil. The percentages of the pupils citing parents as playing the most important part in helping them in their choice from the four schools were, respectively, 43%, 45%, 38% and 36%. In comparison, the percentages for teachers were respectively 15%, 12%, 15% and 11%; and for pupil's friends, 1%, 4%, 4% and 7%. Reid et al. further noted that in the first two schools where social class data were available, it was the pupils from homes where the parents were non-manual workers who cited the importance of parents more than pupils whose parents were manual workers. It even reached the 5% significance level in one of these schools. It still has to be pointed out that a substantial number of pupils (27%, 14%, 28% and 26% respectively in the four schools) said that no one helped them. However, Ryrie et al. (1979) interviewed almost all the parents of pupils in their first and second samples, visiting nearly 1200 homes, and in 95% of the cases contacting at least one parent. They found out from the parents themselves that those who showed considerable involvement in

helping their children with subject choice amounted to only 15% of the total, and these were mostly middle-class parents. Working class parents were only considerably involved if their children were doing well. But the biggest single group of parents - and this seemed to run right across the occupational level of the father - were those who discussed the subject choice with their children but left the decision to them in the end. The latter came to 45% of the total parents in the second sample, compared for example, with 30% of parents who left it entirely to their children to decide, and these were also mostly working class parents. Woods' (1976) findings also support this type of parental involvement.

Although Rowlands' (1961) work was not directly concerned with subject choice, yet 45% (the biggest group) of the sample of 654 grammar school boys aged 15, constituting the entire fourth form population of six schools around London, UK, ranging from independent to maintained schools, and above average in general educational level and the quality of their science teaching, thought their families were the most influential in their educational and occupational plans.

Ormerod's (1971) attitude to science scale had eight items concerned with the social implications of science. These items relate either to the benefit or harm of science. Here are two examples: "In making our lives easier science is laying up troubles for future generations" and "More scientists are urgently needed" (Ormerod, 1973). Ormerod was able to examine the relationship between the number of science options and the social implications of science scale scores for whole year groups of potential GCE O-level and CSE pupils (age 13-14) in a cross section of over 17 schools spread over England. He found a significant ($p = 0.001$) relationship between the attitude of girls to the social implications of science, as measured by the items on the social implication scale, and the number of sciences they had chosen; but no significant relationship was found for boys.

Perhaps these studies do lend some credence to the model linking adolescent development and subject choice as explained by Head (1980). That most girls in this stage in the model he calls 'foreclosure stage' will not opt for science unless they receive considerable encouragement and a model to do so from their parents and their school. At the same time most boys at this stage find science appealing especially the physical sciences which offer career choices that win the approval of parents, teachers and peers. Also that both boys and girls in another stage called 'moratorium stage', can only be attracted to science if seen to be presented in schools as relevant to the most important issues in life. Further, since girls show concern for personal relationships, they are more likely to be attracted to science if presented in schools in the context of the needs of society and individuals. The latter is shared by Ormerod (1971, 1973, 1979) in the discussion of his results and by Pheasant's (1961) findings from the study of 1511 pre-sixth form pupils (877 boys andv 634 girls) who gave reasons why they had dropped science at or before the end of the third year.

2.3 Psychological Influences

In the first (third form) stage of their longitudinal study into factors affecting pupils' choice of courses which reflect a scientific or technological bias, Meredith and Bradley (1976) asked 1925 boys and girls from 15 secondary schools throughout England and Wales to indicate their favourite subjects at that time. They also administered the High School Personality Questionnaire (HSPQ) Form A to the pupils. Classifying the pupils into subject groups according to their favourite subjects, they found some significant personality trait differences between the physical scientists and the non-scientists among the boys as well as among the girls, although not in an identical way and not as clear-cut as those for the boys. In a similar longitudinal study carried out by Butcher (1969a, 1969b), Butcher and Pont (1969) in Scotland starting with pupils in their

second year, a total of 1160 (604 boys and 556 girls) potential future university candidates from 20 schools were given psychological tests. A range of other information was gathered about these pupils including school marks, career interest and the pupils' rating of seven school subjects for popularity and enjoyment. From the analysis of their measures, they found that even as early as age 13, there were some traits of personality and some cognitive variables to differentiate between Science and Arts pupils of both sexes.

It is one thing to know which characteristics of pupils that are most predictive of a choice of a scientific career and another thing whether pupils with such characteristics do in fact choose science subjects at school in the face of, particularly educational influences and constraints, and socio-economic influences. Anyway, it does show that psychological influences have to be taken into consideration in the study of subject choice. The review will be treated under:

2.3.1 Cognitive factors

2.3.2 Personality factors

2.3.3 Pupil-related factors resulting from participation in or exposure to educational influences.

2.3.1 Cognitive factors

In reviewing the studies on scientists and non-scientists, Entwistle and Duckworth (1973) feel that all the studies do imply that there is a fundamental difference between scientists and non-scientists in the way they think. It appears, therefore, that there must be some differences in the intellectual make-up between science choosers and arts-choosers apart from personality. Since most studies on cognitive factors and subject choice have been done on samples in the post GCE O-level stage, these have been reviewed by Entwistle and Duckworth (1973), Roberts (1981), Child and Smithers (1971).

Roberts (1981) administered the four sub-tests of the Differential Aptitude Test battery, Mechanical Reasoning (MR), Spatial Reasoning (SR), Verbal Reasoning (VR), and Abstract Reasoning (AR), to her sample of 637 pupils (370 boys and 267 girls) from four comprehensive and one boys' grammar schools, at the beginning of their fourth year after they had made their subject choice. As expected, the boys' superiority over girls in tasks involving mechanical reasoning was confirmed at the one percent significance level. But as far as science choice is concerned only AR ($p = 0.01$) and SR ($p = 0.05$) related significantly with the number of sciences chosen. The boys' SR was significantly ($p = 0.01$) better than the girls. But the significant ($p = 0.05$) gender difference for VR was vitiated in that there was also a significant interaction between Verbal Reasoning and sex. Overall, however, the boys choosing 0 to 2 Sciences had higher mean scores on all the Differential Aptitude Tests than the girls choosing 0 to 2 sciences. But girls choosing 3 sciences, though comparatively very few, had much higher mean scores for SR, VR and AR, than boys choosing 3 sciences.

Roberts also investigated the contrasting styles of thinking by administering two Cognitive Style Tests, the Conceptual Preference Test and the Hidden Figures Test. The Conceptual Preference Test (CPT) was to examine three conceptualisation styles involving the groupings of objects or events on the basis of respectively, descriptive, categorical or relational attributes, in order to measure the pupil's leaning towards concept formation. The Hidden Figures Test (HFT) was to inquire into the pupil's field dependent/independent thinking styles by testing the pupil's ability to recognise a simple form hidden within a given complex figure.

Each item in the Conceptual Preference Test consisted of three pictures followed by three statements each representing the three classes, namely, Descriptive, Categorical and Relational. Pupils were to award on a four-point scale a score indicating how much each statement about the

pictures appealed to them. Roberts' analysis was based on 23 items and with a score range of 1 to 4, each class had a total score range of 23 to 92 for each pupil. Scores calculated in this way for each pupil she called 'Normative scores'. Also for the 23 items one point was awarded to the class getting the highest score on that item, so the aggregate score for the three classes for each pupil was 23. Scores calculated in this way she called 'Ipsative scores'. There was no significant difference between boys and girls on the normative scores for the three classes, nor was there any significant relationship between number of sciences chosen and performance on the CPT on the normatively derived scores. On the ipsatively derived scores, there was a significant ($p = 0.01$) relationship between the number of sciences chosen and the descriptive classification, indicating that science oriented pupils do not tend to show a preference for dealing with situations in a descriptive way. However, the girls significantly ($p = 0.05$) preferred a relational association than the boys while the boys also significantly ($p = 0.05$) preferred a descriptional association than the girls.

For the Hidden Figures Test, a mark was awarded for the correct answer and no mark for an incorrect answer. With the HFT there was neither a significant gender difference nor a significant relationship with subject choice.

For Duckworth's (1972) sample which consisted of 312 second year pupils (143 boys and 169 girls) who had not then made their subject choice, and 272 fifth year pupils (134 boys and 158 girls) who had made their subject choice, there were no significant differences between the verbal reasoning scores of the science choosing groups of both sexes in the second year and those of other groups; but for boys in the fifth year, there was a significant ($p = 0.01$) correlation between the test scores on fluency and science choice. (A test of fluency, 'uses of objects', was used for the fifth form sample).

2.3.2 Personality Factors

From the studies of the characteristics of adult scientists, Head (1979) concludes that the choice of subject specialisation and of later career involves the whole personality just as any other major choice like the choice of a marriage partner. Further examination of the studies of pupils' progress through secondary schools (Butcher 1969a, 1969b; Hutchings, Bradley and Meredith, 1975) convinces him of a model to link adolescent development and subject choice. The model (Head, 1980) already referred to, originated from Erikson (1965) and then Marcia (1966, 1976) developed it. It involves decisions which need to be made especially by adolescents in trying to acquire an ego-identity. That is achieving ego-identity from an initial ego-diffusion condition, two processes are involved. First, there must be a crisis, which requires an intensive self-examination by questioning ones beliefs and values, followed by a commitment, that is when one becomes convinced about one's beliefs and values. Some adolescents may achieve ego-identity by undergoing simultaneously a crisis and a commitment. Others take a long period of self-examination, which is called moratorium, without making a commitment, before finally making the crucial commitment. Other adolescents hang on, at least for some time, to beliefs and values taken from, for example, parents, teachers or peers, without questioning them, a condition known as foreclosure, but eventually face up to a period of crisis before acquiring ego-identity. But others hold on tenaciously to these beliefs and values taken from others without ever questioning them.

In explaining subject choice on this model, Head feels that pupils who make a choice for science after achieving ego-identity will remain committed to science, although they will be fewer. However, for pupils at the foreclosure stage who make a choice for science - and these are mostly boys who are attracted to it at this stage by its male image - they may later change their mind. There is support for this from Hutchings et al.

(1975) where two-thirds of boys who placed a science subject or mathematics as their first choice at age 13, changed their mind before they reached the school leaving age. Girls at the foreclosure stage, Head argues, need considerable encouragement and a model to do so from parents and their school, because of the male image of science. Hence most girls entering science are most likely at the ego-identity stage. For both boys and girls at the moratorium stage, they need to be attracted to science and this can only be done if science is seen by them to be relevant to the important issues of life.

With regard to delaying subject choice until pupils reach the ego-identity stage, though this will improve the quality of pupils who will then opt for science, it will be at a considerable loss to the quantity of pupils, especially boys, who though uncertain about their commitment, might have opted for it earlier, according to Head.

Taylor and Hawkins (1978) asked 165 third formers (84 boys and 81 girls) and 180 fourth formers (95 boys and 85 girls) within the top 20% ability range, from three comprehensive schools in the English Midlands, to complete the Junior Eysenck Personality Inventory and give details of their subject choice and whether they considered themselves as 'scientists', 'artists' or a combination of the two. The third formers had already made their subject choice and the fourth formers had had one year studying their chosen subjects. The four personality types of the pupils: stable introvert, neurotic introvert, stable extrovert and neurotic extrovert, were derived by computing the median scores on the E and N scales for each of the sample subgroups divided according to sex and year group. The pupils were designated into 'scientists', 'artists' and 'mixed' according to their subjects rather than according to how the pupils had perceived themselves to be, as there were some discrepancies. They found that personality characteristics did influence pupils considerably in their choice of subjects. They even found significant ($p < 0.01$) differences in the

importance pupils of different personality traits attached to peer group and teacher influence in choosing subjects. Duckworth (1972) had also used the Eysenck Personality Inventory for the fifth form sample and the Junior Eysenck Personality Inventory for the second form sample, among the instruments he used. He found that personality was one of the variables required to identify potential scientists.

Roberts (1981) used the Cattell High School Personality Questionnaire (HSPQ) to investigate the relationships between personality variables and science choice, for her fourth form sample. Only the three personality variables shown below, reached a significant (for all $p = 0.05$) relationship:

HSPQ C: affected by feelings to emotionally stable

HSPQ E: obedient to assertive

HSPQ H: shy to adventurous.

In addition, only HSPQ E showed a significant ($p = 0.05$) gender differentiation: boys being more assertive than girls irrespective of the number of Sciences chosen. Worthy of note too was that the HSPQ H scores for girls went in the opposite direction to those of boys, thus implying that it is the shy boy who displays a leaning towards science and in the case of the girl, she has to be adventurous - a person going very much against what is socially accepted.

2.3.3 Pupil-related factors resulting from participation in or exposure to educational influences

The manner by which the pupil characteristics interact with the school influences is very important in subject choice. These variables are treated under the following headings:

2.3.3.1 Subject preferences/subject liking

2.3.3.2 Perceived subject difficulty/ease (Perceived ability)

2.3.3.3 Interests in/attitudes to activities and subjects

(Motivation)

2.3.3.4 Perception of usefulness of subjects, possibly for further education or careers

2.3.3.5 Perception of school opportunities eg. facilities, teacher quality, reputation of success, school friends

2.3.3.6 Teacher liking

2.3.3.1 Subject Preferences/Subject Liking

As already mentioned, the failure of the subject choice polarisation hypothesis in coeducational schools for girls (Ormerod, 1975), especially as the subject preference polarisation hypothesis was confirmed, acted as a stimulus for Ormerod to pursue this anomaly further. Keys and Omerod (1976b) therefore decided to look at the actual choices of Science subjects made by boys and girls in relation to their expressed preferences for these subjects in an effort to get at the root of this anomaly. They chose two samples in GCE O-level streams at the end of their third year of secondary education. Sample 1 consisted of 457 boys and 677 girls which was part of Ormerod's (1975) earlier sample. Sample 2 consisted of 92 boys and 147 girls from 9 schools and at the same age as Sample 1, but some schools in Sample 2 did not have subject choices at this stage. Data on Sample 1 were gathered in 1972 and 1973, and on Sample 2 in 1974. The same instrument Ormerod (1975) used, the Brunel Subject Preference Grid, was used to get a measure of each pupil's subject preference on a 14-point scale. The grid also enabled the pupils to state if they were taking a subject (scored 2) or had dropped a subject (scored 1) or if the subject was compulsory in the school (scored 3 and omitted from the study). They did an analysis for each sample and for each subject. The median for the expressed preference for each sample was found and each sample was divided into two groups: those above their sample median level and those below it. For each sample, the two groups were further divided by sex. Within each group the number of

boys opting for each Science was expressed as a percentage of the total number of boys in that group. This was similarly done for girls. Each sample had two groups of boys and girls - the low preference groups, those below the median level of their group, and those above their median level, the high preference groups. Their findings for each subject is given below:

Biology: The proportion of girls choosing Biology from the low preference groups was significantly more than that of the boys from the same group ($p = 0.01$ for both samples). But there was no significant gender difference in the proportions choosing Biology from the high preference groups for Sample 1 except for Sample 2 where a significantly ($p = 0.05$) higher proportion of girls than boys were choosing Biology. It shows that a significantly high proportion of girls who do not particularly like Biology are choosing it.

Chemistry: There was no significant gender difference for the choice of Chemistry from low and high preference groups except for the high preference group of boys in Sample 1 whose percentage of Chemistry choice was significantly ($p = 0.01$) higher than that of girls in the same group and sample. Thus in Sample 1 boys having a high preference for Chemistry are significantly more likely to choose Chemistry than girls with a high Chemistry preference.

Physics: Significantly ($p = 0.01$) the percentage of boys choosing Physics in each preference group and for both samples (except for the high preference group in Sample 2 where $p = 0.05$) was higher than that for girls. Thus a significantly high proportion of girls with a high Physics preference comparable to that of boys, are dropping Physics.

Keys and Ormerod therefore came to the conclusion that factors other than pupils' preferences are influencing girls to tend to choose Biology and boys to choose Physics.

In another study, Keys and Ormerod (1976a) used the Brunel Subject Preference Grid among the instruments used for their sample of 348 GCE O-level stream pupils (154 boys and 194 girls) aged 14+ from 9 grammar (3

mixed, 2 boys', 4 girls') and 2 comprehensive schools in England, at the end of their third year. Using the Goodman and Kruskal's gamma coefficient, they were able to find the correlation between subject choice and subject preference (the magnitude of gamma is supposed to be usually 0.05 to 0.1 less than the Pearson product moment correlation coefficient in circumstances where both are appropriate). They found values of gamma to be significant for all 13 subjects (English and Mathematics were omitted being compulsory subjects) and to range from 0.62 for girls Housecraft to 0.87 for Music and Biology, with a median value of 0.78. In particular the correlates between Science choice and Science Preference were respectively 0.87, 0.86 and 0.79 for Biology, Chemistry and Physics. Keys and Ormerod pointed out that the relationship is not perfect since one has to take into consideration that these coefficients measure the resultant interaction on pupils' choice resulting from the pupils' real inclinations, the school influences and socio-economic influences.

Bottomley (1979) did also find the association between subject preference and subject choice. The pupils were to indicate on a 5-point scale their liking for each of the Science subjects and Mathematics. Since the secondary modern school pupils were studying General Science up to the choice point, this was based on General Science. For both boys and girls in the grammar schools there was a significant association ($p = 0.002$ in each case) between their preference and choice for each of the Sciences. For the secondary modern school there was only one significant association for each sex: General Science preference and choice of Chemistry ($p = 0.01$) for boys and choice of Biology ($p = 0.002$) for girls. However, when she did a discriminant analysis between choosers and droppers, boys' choice of Physics and Chemistry and to a lesser extent Biology, was more dependent than girls' upon their preference for these subjects.

But what do pupils themselves feel about the relationship between their liking/preference for a subject and their choice of that subject? In

the longitudinal studies reviewed so far, liking/preference for subject has consistently topped the list for both boys and girls as their reason for choice of subjects. (Reid, Barnett and Rosenberg, 1974; Ryrie, Furst and Lauder, 1979; Bottomley, 1979; Bardell et al. 1982). This has been the case too in retrospective studies (Bremner, 1980. Kelly, 1978). What is also interesting is that there has been no significant gender difference on this reason (Bottomley, 1979; Kelly, 1978).

2.3.3.2 Perceived subject difficulty/ease (Perceived ability)

Keys and Ormerod (1976a) had found that subject choice and perceived easiness of subject exhibited moderately strong relationships with gamma ranging from 0.33 (for Art and Latin) to 0.78 (for second foreign language) with a median value of 0.54. Thus subject choice, in spite of its restrictions, is also significantly influenced by perceived easiness although to a lesser extent than subject preference. They further noted that whilst boys' and girls' rankings of perceived easiness were closely similar (Spearman's rank order correlation coefficient, $r = 0.89$, $p < 0.01$) their rankings of subject preference were not ($r = 0.47$, n.s); also whilst the relationship between boys' preference and boys' easiness rank orders was not significant ($r = 0.32$) that for the girls was significant ($r = 0.77$, $p < 0.01$). These observations led them (Keys and Ormerod, 1977) to test the hypothesis that "amongst able 14-year old pupils subject preferences are closely related to a hierarchy of subject easiness common to both sexes, whilst boys' subject preferences are not so related." From the results of their earlier study (Keys and Ormerod 1976a) they were able to obtain support for this hypothesis by examining the relationships between subject preference and perceived easiness for boys and girls separately in 13 common subjects. The gamma values between subject preference and perceived subject easiness were higher for girls in 10 subjects (among them were Chemistry 0.57, 0.70; Physics 0.50, 0.51; Art

0.45, 0.54; French 0.63, 0.69), equal for girls and boys in three subjects (Biology = 0.53, second foreign language = 0.70 and History = 0.63), and lower for girls in none. The Wilcoxon matched-pairs signed ranks test showed this result to be significantly ($p = 0.01$) valid.

Keys and Ormerod, using the magnitude and direction of the difference between the expressed preference means for the 13 common subjects for boys and girls in this sample, constructed a 'gender hierarchy' of the 13 school subjects similar to the 'gender spectrum' Ormerod (1975) constructed, which has already been reviewed under School Type influences. Spearman rank correlations between this 'gender hierarchy' ranging from Physics, second foreign language, Chemistry, Mathematics, at the top down to English, Art, Music and R.I. at the bottom, and the boys' and girls' rankings of easiness, were respectively -0.62 ($p < 0.05$) and -0.88 ($p < 0.01$). They further compared this 'gender hierarchy' and the 'gender spectrum' obtained by ranking subjects according to the magnitude of the percentage of the total (boys and girls) GCE O-level entries for each subject made by boys in 1973 (DES, 1975). The correlation between rank orders was 0.77 ($p = 0.01$), showing that school subjects can be classified as predominantly 'male' or 'female' and ranked accordingly, and that 'male' subjects are perceived difficult, and 'female' subjects, easy. Their findings therefore suggest that, at least amongst able 14-year-old pupils, perceived difficulty affects girls more than boys in their subject preferences and choices. Keys and Ormerod therefore went on to suggest that this may explain while girls are more likely than boys not to choose the physical sciences even though both sexes equally perceive these subjects as difficult.

Pupils, however, hardly give 'subject ease' as a reason for choosing a subject. They more often give 'good at', that is, in terms of their perceived ability. The difficulty of a subject is more often associated with reasons for dropping a subject. Unlike liking for or interest in a subject, perceived ability is not a top priority reason given for choosing

a subject. In the Scottish samples (Ryrie et al. 1979), only 8% of their second sample gave 'good at' the subject compared with 31% for interest in or liking for a subject, for choosing a subject. In the English sample (Reid et al., 1974) 46% of the total sample gave 'good at' the subject compared with 81% for interest in or liking for subject, as reason for choosing a subject. However, significantly ($p < 0.02$) more boys than girls said they had chosen a Science subject because they were good at it in Bottomley's (1979) longitudinal study. In Kelly's (1978) retrospective study on the Scottish O Grade and H Grade leavers for their reasons why they had chosen a Science subject for their third year of secondary education, a significant ($p = 0.01$) gender differentiation was found only with the H Grade leavers - the boys gave 'good at' more than the girls why they had chosen to continue with Science subjects in S3. The 103 third form pupils (47 boys, 56 girls) in Wood's (1976) study in a secondary modern school asked to give reasons for choosing a subject, of the 65 reasons given for good ability, 75% were given by the boys. Reid et al. (1979) noted that 'good at' a subject was given as a reason for choosing a subject more frequently by the above average group (51%) and least often by below average ability pupils. There was a significant ($p = 0.05$) difference overall among the ability range (above average, average, below average) for this reason but no significant difference was found in each of their individual four schools. By contrast, only 10% of the total sample chose subjects because they were easy and they were mostly below average ability pupils with an overall significant ($p = 0.001$) difference on ability, and in three of the schools, and not significant in only one school where pupils were assessed by teachers of their chosen subjects prior to their choices being ratified, and the pupils were aware of this assessment. Wood's sample was streamed according to ability with 3a (15 boys, 21 girls) being above average, 3b (17 boys, 20 girls) average and 3c (15 boys, 15 girls) below average. Of the 65 reasons given for choosing a subject

because of good ability, 31 (19 boys, 12 girls) came from 3a, 31 (23 boys, 8 girls) from 3b and 3 (3 boys, 0 girls) from 3c.

In order to find out what pupils anticipated in their choice of subjects, Taylor and Hawkins (1978) constructed the Expectation Preference Inventory with five categories, one of them being 'Perceived Cognitive Style of the Subject.' One of the four items (each of the five categories had four items) under this category was, "I expected to be able to study some of the subjects how I wanted to, without having the teachers to show me how it could be done." Their sample of third formers who had just made their subject choice, and fourth formers who had made their choice a year earlier, ranked this perceived cognitive style category fourth and there were no significant differences between the forms for this category - one of the two categories (the other being 'Subject Utility' which was ranked first) which showed no significant differences between the year groups.

2.3.3.3 Interest in/attitude to activities and subjects (Motivation)

The object of Kelly's (1961) study on the 117 Grammar School boys aged 13, was to investigate the attitudes of school pupils when they decide to take a scientifically biassed curriculum and at the same time to compare them with pupils who choose to specialise in arts subjects. His study started at the time of subject choice and went on nine months after the choice was made. On the basis of their choices the pupils were assigned to three groups those who chose to specialise in Science (45), those who chose to specialise in non-scientific subjects (43) and those who were not given a choice (29). The latter group was the control group. some of the ways in which the science group differed significantly from the non-science group were that they had long-standing, stable attitudes favourable to Science, expressed for example, in their high rating of the social prestige of Scientists, and in relating scientific subjects to their eventual career

even when they were not sure what it would be. They also had attitudes biassed towards choice two years earlier than the non science group who seemed not to make up their mind about choice until very near the time it was given. Further, there was a distinct difference between the science group and the non-science group in their attitudes towards the perception of choice. The science group were influenced by their liking or disliking school subjects and the effect of the choice on their future occupation; the non-science group were influenced by their ability and attainment in their subjects of choice and cared less about future occupation.

Ormerod's (1971, 1973) attitude test also had 12 items related mainly to science as a school subject. For example, two of the items are: "I am glad that I am able to take science subjects at school" and "Science is the most boring subject in the timetable." These 12 items made up his Subject Attitude Scale (SUBATT). He found a significant ($p = 0.001$) relationship between SUBATT scores and science options but no significant gender difference for his third form sample.

In Robers (1981) study she also examined pupils' attitude to, and motivation in school in general, and school science. Her Likert type questionnaire included positive and negative attitudinal and motivational statements covering such areas as homework and outside class activities, school based work and activities, and general commitment to education. An example of one scale item concerning the enjoyment of Science experiments is, "I always enjoy doing Science experiments." As a result of factor analysis, six scales emerged: three for science and three for school in general. The science scales were:

1. Effort and involvement in science work and homework compared with other subjects.
2. Involvement and enjoyment, particularly in Science practical work.
3. Extent to which Science is not unimportant or a waste of time.

The school in general or general scales were:

1. Effort and involvement in school work.
2. Enjoyment of school and school work.
3. Extent to which school is not unimportant or a waste of time.

There was a significant ($p = 0.01$) relationship between the number of sciences these fourth form pupils had chosen at the end of the third form, and each of the three science scale variables. There was also no significant gender differences for those scales. As for the general scales, there was a significant ($p = 0.05$) interaction for Scale 3 so no valid conclusion can be made. There was a significant ($p = 0.05$) gender difference for Scale 1 but no significant relationship with science choice. On further examining the Scale 1 mean scores for both boys and girls choosing 1, 2, 3 sciences, the scores for each sex for each subgroup were almost the same, rising slightly with the number of sciences and with the girls' subgroups having higher scores. However, for pupils who did not choose any science, this subgroup for the boys had the highest mean score; but this subgroup for the girls had the lowest mean score. It shows that the comparatively small number of boys who had dropped science (7.6% compared with respectively 26.9%, 36.6% and 29.0% who had chosen 1,2 and 3 sciences) were more highly motivated towards their chosen course of study; whereas for the girls who had dropped Science (16.6% compared with 58.6%, 17.7% and 7.2% who had chosen respectively 1, 2 and 3, Sciences) they were the least motivated. There was a significant relationship ($p = 0.05$) on Scale 2, enjoyment of school and school work, with Science choice, with the girls scoring significantly higher ($p = 0.01$) than the boys. This seems to imply that girls choosing more sciences get more enjoyment from all aspects of school and school work.

The study by Meyer and Penfold (1961), though not directly connected with subject choice, had revealed factors associated with interest in Science on a sample of 150 pupils (equally divided between first and third

year pupils) from a large coeducational school around London, England. They measured three aspects of interest in science from leisure interest, interest in Science topics and interest in Scientific Method, and used the unweighted total from the three measures as a criterion measure of interest in Science. 28 of their 47 variables showed a significant correlation with interest in Science, with correlation coefficients ranging from 0.212 to 0.729. The top four were Interest in School Physics (0.729), Interest in School Geology (0.728), Interest in School Chemistry (0.714) and Interest in Science as a School Subject (0.676). Attitude towards science as a school subject, Attitude towards science as a general concept, Interest in School Biology and Attitude to school were respectively 0.584, 0.481, 0.311, 0.284, and were comparatively low even though significant.

In giving reasons for choice of subjects pupils usually express their attitude towards a subject in terms of their interest, liking, how enjoyable they find the subject and preference for the subject; in other words, from the point of view of the affective dimension and this has already been reviewed under subject preference/subject liking. Here attitude is viewed from the motivational aspect or as defined by Ormerod (1973) in an educational context "as a state of preparedness or predisposition to learn or not to learn."

2.3.3.5 Perception of usefulness of subjects, possibly for further education or careers

Closely following liking for or interest in subject as a reason for subject choice is the usefulness of the subject for job or career. In most cases, too, this utilitarian reason has been rationally consistent with the job the pupil had in mind. Overall Reid et al. (1974) found this reason tied for top place with 'like/interest' as the most popular reason (81%) with no overall significant difference according to ability. It is interesting that in their only school where there was a significant

difference according to ability ($p < 0.01$), it was the below average and above ability pupils that gave this reason more than the average ability pupils: above average (81%), average (61%) and below average (88%). But although this reason was the second most popular reason in other studies (Ryrie et al., 1979; Kelly, 1978; Bottomley, 1978 and Woods, 1976), in Woods' study this reason came mostly from the top pupils, the 3a stream (57.8%) and least from the least able pupils, the 3c stream (17.7%), with 63.7% of the total for this reason coming from the girls in the third form of this secondary modern school, and mostly from the 3a girls (43.1%) - more than that coming from all the boys in the three streams (36.3%). Nonetheless, in Bottomley's sample consisting of 3 grammar schools (1 all boys, 1 all girls, 1 mixed) and a secondary modern school, there was no significant gender difference for this reason nor for Kelly's H Grade leavers, as a reason why they had continued with science in their third year; but there was a significant ($p < 0.05$) gender diference (the boys giving it more than the girls) for the O-grade leavers. In the Schools Council study (Bardell et al., 1982), this reason, "thought it would help in future job", was pushed to third place by the reason "wanted a subject I could do well in at CSE or GCE O-level." The Subject Utility category on the Expectation Preference Inventory (Taylor and Hawkins, 1978) topped the other categories as being the most important reason the third and fourth formers gave for choosing a subject, and there was no significant difference between the forms for this category. Nevertheless, an analysis of the items under this category may suggest that this category combined the usefulness of a subject for a job and the usefulness of a subject because the pupil expected to find it intrinsically enjoyable, in other words, interest in or liking for the subject. Two of the four items under this category were: "I anticipated being interested in the subject for a few years after leaving school" and "I counted upon them helping me to get a job later on."

Ryrie et al. (1979) did note that although the most popular reason for choosing a subject is interest in or liking for a subject, yet if two subjects, one the pupil liked and another the pupil felt was useful for a job, clashed for choice, precedence was given to the subject considered useful for a job. It would appear that the pupils put more weight on the usefulness of a subject more than their liking or the general interest of a subject, when faced with a choice.

2.3.3.5 Perception of School Opportunities

The review here will focus on the opportunities in the schools that maximise science choice in the pupil's view or are irrelevant or play no significant role, and not in what is not available in the school like staff shortages or no laboratory facilities, which as has been said, are considered as constraints on subject choice.

Facilities: All the studies so far generally agree that as far as the pupils themselves are concerned, most pupils feel that the options offered them in their schools are real choices and that there is some scope for making genuine free choices. In addition, that there is an apparent relationship between the general ability of the pupil and the degree of satisfaction with the choice: the less able pupils tend generally to be less satisfied with their options. Some of these reasons are nevertheless given for choice of subjects: "not able to take subjects I really wanted" (Reid et al., 1974), given by only 7% of their total sample, and mostly by the below average pupils, with an overall significant ($p < 0.001$) difference by ability. This reason also came up in the Schools Council study (Bardell et al., 1982) but ranked very low - sixteenth out of twenty. "I had to take the subjects," (Kelly, 1978) was ranked very low by both the H Grade and O Grade leavers as a reason for choice of science subjects for S3, but with a significant ($p < 0.01$) gender difference (given more by the boys) for the H Grade leavers.

Ryrie et al. (1979) noted that some 24% of all choices were made without the pupil exercising any positive choice - forced choices. These forced choices were choices the pupil made because "the teacher said it was a good one to do", "the teacher said I should take it and it would help me with a job", "the teacher picked it", "I didn't choose them", "there was nothing else I could do", "it was the only one left in the column", "I couldn't take any other", etc. It does show that forced choices make up a major reason for choosing subjects. Reid et al. (1974) showed that nearly 60% of pupils in their sample would still keep the subjects they had chosen even if given the chance to change, and that only over 25% would change and 15% remained uncommitted.

Bardell et al. (1982) pointed out the striking similarity between boys and girls on their satisfaction with their options, but that the fifth formers who had had their options for over a year seemed less satisfied with their options than the fourth formers who had had only a term's experience with their options. The association between satisfaction and ability was found (Reid et al. 1974) to be significantly more marked for girls ($p < 0.001$) than for boys ($p < 0.05$).

With regard to the actual mechanics of choosing, Bardell et al. (1982) found that just over 50% of the fourth formers interviewed had experienced difficulty in choosing their subjects, 33% found it fairly easy and generally welcomed the opportunity, and the rest did not indicate any clear or specific feelings.

Teacher quality: The teacher quality *per se* is hardly mentioned as a reason for choosing a subject. Whether a pupil sees the quality of a teacher in the light of his or her performance in school or external exams, is hard to tell. This reason has not featured so far in the major longitudinal studies as making a direct influence on pupils' choices. Because the disliking of subjects in Pheasant's (1961) study seemed to result from the unsatisfactory teacher-pupil relationship in the classroom

(this will be touched on fully under Teacher liking), Pheasant felt the quality and method of preparation of subjects in the lower school were extremely important factors in conditioning the choice of subjects taken at GCE O-level. Despite the importance of the quality and method of presentation of subjects in the lower school, studies so far do not support their perceived importance by pupils in significantly influencing their subject choice.

Kelly (1978) found that "the subjects were well taught" as a reason for choosing a science for S3 was ranked very low by both the H Grade and O Grade leavers with no significant gender difference and ranked even lower than "I had to take the subjects" by all the pupils except the girls among the H Grade leavers. When asked whether the teaching of subjects had acted as a stimulant in influencing their choice of subjects at the grammar school, the majority of the training college students questioned by Lovell and White (1958) could not recall the exact methods and techniques of their teachers to say precisely how they were influenced, for any valid conclusions to be drawn.

The Teacher Characteristics category, one of the five categories on the Expectation Preference Inventory developed and used by Taylor and Hawkins (1978), included both personality characteristics (warm and friendly) and teaching skills (organisation of subject matter and clarity of exposition). This category was ranked third as an influence on pupils in choosing a subject by all the third year and fourth year pupils from three comprehensive schools. But what is noteworthy was that on every classification: sex, subject orientation (artists, scientists or mixed), personality (stable or neurotic extroverts, stable or neurotic introverts), it was the fourth year pupils, who had had a year's experience with their options, who significantly ($p < 0.01$) attached more importance to this factor. Thus indicating that the older pupils who were following chosen courses viewed highly the importance of the teacher in their study.

In investigating the role of the school in subject choice, Bardell et al. (1982) asked their 228 fourth formers to identify teachers who had played an important part in helping them choose their subjects. 32% of them said that no teachers played an important part; the rest convincingly identified the subject teacher as playing the most important role. There was also no significant differences in response between the sexes or ability groupings. It appears, therefore, that pupils more readily identify teachers with subjects than with positions of responsibility. Reid et al. (1974) also had similar findings in their study.

Reputation of success: It has already been pointed out that the perceived usefulness of a subject for a job takes precedence over interest in or liking for a subject when a pupil is faced with such a choice. If the perceived usefulness of a subject for a job is a major reason for choosing a subject, then the reputation of success especially at external examinations, should play a significant influence on pupils' choice of subjects. It is interesting to note that in the Schools Council survey of young school leavers (1968) not only did these pupils aged 13 to 16 overwhelmingly rate statements stressing preparation for future employment 'very important', but felt it was a prime function of schools to help them do as well as possible in public examinations.

In the Schools Council project (Bardell et al. 1982), the reason, "wanted a subject I could do well in at CSE or GCE O-level" ranked second after "liked the subject and found it interesting" as a reason for choosing a subject, when the fourth formers in their sample were presented with a list of twenty possible reasons for their choosing one, randomly selected, subject. Reid et al. (1974) found this reason "I wanted subjects I could pass in at CSE or GCE O-level", an important reason for pupils' choices at the third-year option stage. It was given by 53% of the total sample, with a significant ($p < 0.01$) difference by ability (given more often by the abler pupils) and coming after "like/interest" and "help in future job"

reasons which tied for first place with 81% each, in rank order of importance.

The fourth of the five categories in the Expectation Preference Inventory by Taylor and Hawkins (1978) was "previous success." It had items like "I counted upon doing as well in them as I always have done" and "I expected to be able to get satisfactory exam results." This category was rated by all the third and fourth form pupils as the second most important factor in choosing a subject. But, the third year pupils significantly ($p < 0.01$) put more emphasis on its importance than the fourth year pupils, presumably because the third year pupils had just made their choices and had just undertaken recent examinations. Also introverted girls put more emphasis on the importance of previous success, and significantly more ($p = < 0.01$) by the younger girls.

It does appear, however, that far more weight is placed on anticipated examination success (CSE or GCE) than on previous examination success (school exams) when both have been given as reasons for choosing a subject (Reid et al., 1974; Bardell et al., 1982).

School Friends: Since schools provide the atmosphere where pupils not only learn together but also foster friendships, and pupils of the same age group are usually in the same classes, it is expected in an atmosphere where pupils may freely discuss their problems and ambitions, that peer group influence at this stage in pupils' lives may be considerable. Hence to find that pupils themselves feel that they are hardly influenced by their friends in choosing subjects is usually accepted with some scepticism. But from all the research on subject choice it has consistently emerged that 'influence of friends' on subject choice has either been ranked at the bottom of the reasons or mentioned the least number of times.

It is interesting that even teachers ascribe considerable influence to peers on subject choice (Reid et al., 1974). All the same, when Reid et al. confronted pupils in interviews that they must be influenced by their

friends, the pupils strenuously denied it and came up with well-reasoned arguments to substantiate their denial. Ryrie et al. (1979) found that although only in one percent of the cases was the influence of friends or classmates acknowledged by pupils in their second sample, yet on further discussion with them two things came to light. The first was that the pupils had been led to believe apparently from advice or instructions from teachers that choosing a subject because a friend had chosen it, was wrong and hence admitting to have done something that was considered wrong had to be avoided at all cost. Secondly, while some pupils denied the influence of friends on their choices, they regarded that most other pupils were influenced by their friends. The former view was shared also by Bardell et al. (1982) in their study because of the low ranking given to friends' influence on choosing subjects. So whatever influence friends may have on subject choice, it is either not recognised or the pupils are unwilling to admit it.

Small though the peer group influence on subject choice is, all pupils are not influenced to the same extent. Bottomley (1979) found that girls were influenced to a significantly ($p < 0.002$) greater extent by "friends in the same class" and "friends of the same age" than were boys. Peer group influence, the last of the five categories on the Expectation Preference Inventory used by Taylor and Hawkins (1978) to find out the expectations on which third form pupils based their choice of subjects, contained among its four items "I anticipated that some of my best friends would be in the classroom with me" and "I expected to enjoy the courses because others, who had already done them, had spoken well of them." This peer group influence category was rated a poor fifth with mean preference score of 3.45 (compared with 9.84 and 8.54 for the first and fourth rankings, respectively) by all the fourth and fifth formers. But there were some significant differences ($p < 0.01$): the third formers, especially the boys, seemed to be more influenced than the fourth formers. Moreover, boys who

had chosen a mixture of arts and science subjects were more influenced by peer group pressure than boys committed to arts or science specialisations. The mean scores for the introverted boys of the third year were significantly ($p < 0.01$) higher than those of the introverted boys of the fourth year.

Interviews with pupils' parents indicate that parents seem to be in complete agreement with pupils that the direct influence of friends and classmates on subject choice is not substantial (Ryrie et al., 1979; Woods, 1976).

2.3.3.6 Teacher Liking

Roberts (1981) chose 'teacher liking' as a pragmatic variable in examining the influence of the teacher since she felt that pupils had difficulty in separating the teacher's influence as a person from that relating to the educational setting in general. But in this review the writer has chosen to separate the two, treating teacher quality separately from teacher liking. The reason for this is twofold: first, because pupils themselves seem to perceive teacher quality as distinct from teacher liking both when they give reasons for choosing a subject or in ranking their importance. Secondly, and perhaps this is more important, from the writer's experience as a principal of a coeducational school in Sierra Leone for seven years, a teacher who is perceived by pupils to be able to teach very well, and capable of explaining his/her subject matter clearly, or capable of maintaining good class discipline, or has a reputation among pupils for his/her commitment to teaching, or makes pupils achieve a high success rate in his/her subject in external examinations, is not necessarily the most popular teacher. It is true that pupils have profound respect for teachers having these qualities, but respect and liking are not synonymous.

In the review of the research and evaluation programme for the Harvard Project Physics course (USA), there was concern, inter alia, to determine

the impact of teacher characteristics and pupils recruited into the course. Welch (1973) noted that during the first study and also replicated in the second study, that teacher personality characteristics exerted more powerful influence than did content preparation in Physics, knowledge of Physics, and years of Physics teaching experience, on what pupils learnt, how their interest changed and their overall attitude towards Physics. Gardner (1975) too pointed out that the same teacher behaviour could exert opposing and varying effects in different kinds of pupils.

As regards subject choice, because of the central and dominant role the teacher plays in the school it has usually been assumed that pupils put considerable weight on teacher liking when choosing a subject. Perhaps this is why, as Ormerod (1975) suggested, much attention had not been paid to measuring its effect or possibly the reason for schools' reluctance to allow it to be measured. But no study has to date come up with a strong relationship between liking teachers and choice of subject. In Bottomley's (1979) study, 586 pupils gave reasons for choosing or dropping a subject, and more than one reason could have been given for taking or for dropping a subject. Yet liking the teacher was given only three times as a reason for choosing a subject and disliking a teacher six times as a reason for dropping a subject!

Using the Brunel Subject Preference Grid, Ormerod (1975) found only weak relationships between subject choice and teacher liking and gave as a possible explanation that pupils often did not know whether the teacher teaching them at the time of subject choice and on whom teacher liking measures were made would continue to teach them in subsequent years. There were also a wide range of positive and negative values, indicating that there were external constraints on choice whereby many pupils were choosing subjects in spite of not liking the teacher, thus explaining the negative values. He noted that positive values arose in 'practical' subjects where there was the possibility of having the same teacher because the groups

were usually smaller.

Roberts (1981) also used the same Brunel Subject Preference grid but based her measures on the teachers of the science subjects the fourth formers had chosen. She found a significant ($p = 0.01$) relationship between science teacher liking and the number of sciences chosen. However, this should not be taken at face value; and, as she herself pointed out, there was no evidence of a simple trend. The science teacher liking value (2 points for like, 1 for neutrality and 0 for dislike; and expressed as a percentage of the total possible points obtainable based on a pupil's total number of sciences chosen) was obtained for each pupil and averaged by groupings according to the number of sciences chosen (1, 2 or 3) and by sex. Thus the average science teacher liking score for 1, 2 and 3 sciences chosen, were respectively 85, 69 and 70 for boys and 89, 76 and 84 for girls. For both boys and girls the teacher liking score was highest for pupils studying one science, then dropped sharply for pupils studying two sciences and rose only slightly for the boys but steeply for the girls studying three sciences. It shows that for pupils choosing one science (choice of a science subject was not compulsory in all her five comprehensive schools, although for her study the subjects accepted as science subjects were Biology, Chemistry, Physics, Integrated Science and Geology; a breakdown analysis of pupils by school and number of sciences showed 25 boys and 56 girls were not studying any science), they were on average influenced by the liking for the teacher. For boys choosing 2 or 3 sciences they might be influenced by teacher liking for one science but not much for the second and might not even like the third science teacher. But for girls studying 1 science (103) and 3 sciences (18), though the latter is comparatively smaller (for boys 50 for 1 science and 79 for 3 sciences), teacher liking does play a considerable influence. The fact that overall there was a significant ($p = 0.01$) gender difference on teacher liking means that teacher liking is a more important variable for girls than for

boys.

Bottomley's (1978) third questionnaire, given after the pupils had made their subject choices at age 14+, also inquired about the pupils' preference for the teachers teaching Biology, Chemistry and Physics, on a three-point scale: like, neutral, dislike. She then calculated the gamma values for the association between preference for subject teacher and subject choice separately for Biology, Chemistry and Physics. For the boys, the gamma values for Biology, Chemistry and Physics were all significant ($p < 0.02$) and were respectively 0.49, 0.75 and 0.28. For the girls they were respectively 0.24, 0.46 and 0.62; but the gamma value for Biology was not significant whilst those for Chemistry and Physics were significant ($p < 0.002$). Of particular interest are the high gamma value for boys for Chemistry, 0.75 (compared with 0.46 for girls) and their low gamma value for Physics, 0.28 (compared with 0.62 for girls), and both showing a significant ($p < 0.02$) gender difference. It appears boys will choose Physics and girls Biology, in spite of not liking the teacher. Bottomley and Ormerod (1982) later showed from a discriminant function analysis for choice of Chemistry, that girls were less put off than boys by the dislike of the teacher.

In the study by Reid et al. (1974) 'liked teachers who taught subjects' was given by only 13% of the total sample for choosing subjects, and given mostly by the below average pupils and least by the above average pupils ($p < 0.001$).

Woods (1976) states that 'liking for subject' includes a strong teacher element, so it is arguable that if liking for a subject is a major influence in pupils' subject choices, then the teacher element too cannot be discounted. But the extent of this 'teacher element' is difficult to assess, and its effect on pupils' subject choice as other studies have shown, is indirect (Kelly, 1961; Ryrie et al., 1979; Reid et al., 1974). It can also be argued that 'liking for subject' or 'interest in subject' has

some element of being 'good at the subject', and it may be that pupils tend to like the subjects they are good at, and if so, 'liking' and being 'good at' may be the case for most pupils (Ryrie et al.). However, it is also possible for pupils to be interested in a subject and yet to find it very difficult (Duckworth and Entwistle, 1974b). Meyer and Penfold (1961) have shown that neither 'pupils' attitude to science teacher' nor 'science teacher's attitude to pupil' is significantly related to interest in science. That the role of the teacher is crucial in the development of the pupil's affective behaviour in all spheres of school life, cannot be denied, and this critical role of the teacher, in particular the science teacher, has been reviewed extensively by Ormerod and Duckworth (1975). But in the context of subject choice, teacher liking is not perceived by pupils to be a major influence on their choices. Even in Woods' (1976) study, out of the 472 actual reasons given by his sample of 103 third formers (47 boys and 56 girls) for subject choices only 10 were reasons for 'liking for teachers' and 19 'dislike for teachers.' So that the like/dislike teacher categories contained only 6% of the reasons given. The number of reasons given for teacher liking is very small to make any valid interpretation with regard to sex and ability especially for the latter, since all the pupils in this secondary modern school had been unsuccessful at the eleven-plus examination. But 8 of the 10 reasons were given by girls and only the top stream, 3a (5 girls and 1 boy) and the average stream 3b (3 girls and 1 boy) gave this reason for subject choice. This was the same pattern for dislike of teachers: 13 for 3a (11 girls, 2 boys) 4 from 3b (1 girl, 3 boys) and 2 from 3c (1 boy, 1 girl).

On recalling their reasons for choosing to study certain subjects in the grammar school, it was not clear from the 102 male training college students (Lovell and White, 1958) whether their choice was influenced by teacher liking. While some students said they liked the teacher irrespective of the way the subject was taught, for others liking the

teacher was associated with liking the subject he taught. But from the 1,511 (634 girls and 877 boys) pupils in the pre-sixth form year at 18 schools, Pheasant (1961) found that the largest single reason for dropping subjects at or before the end of the third year, "seemed to be unsatisfactory teacher-pupil relationships in the classroom." Apparently Pheasant's study seems to be the only investigation where teacher liking has been a major determinant of subject choice at this level. However, apart from the fact that this was a retrospective study and projection was bound to take place in recalling events which had taken place some two years ago, an observation made by Lovell and White in their own retrospective study when some of their students' dislike of the teacher reflected the dislike of the subject taught, the background of the pupils in Pheasant's study may explain the uniqueness of this finding. The boys' schools in Pheasant's sample had Chemistry and Physics freely assessible for choice and most boys studied these subjects up to the GCE O-level. But this was not the case in the girls' schools, and Biology was the only Science offered to most of the girls after the third year. Since Pheasant's study was concerned with careers in Science one would assume that at least twice as many girls as boys would have dropped science subjects in the sample. If a comparison is made with Bottomley's (1979) sample, the grammar school boys and girls were taking the same total number of science subjects with a median value of 1.94 and 1.91 for boys and girls respectively, and no significant difference between them. Yet even though only 5.71% of all pupils in her sample gave 'dislike of subject teacher' as a reason for dropping subjects, it was given far more by the girls (7.02%) than the boys (4.17%). It is therefore not surprising to find 'dislike for teacher' to be the largest single reason for disliking subjects in Pheasant's study.

In discussing the pupil-teacher relations and their effect on pupils in choosing subjects, Pitt (1973) recalled only 3 cases over 5 years as a Housemaster where pupils wished to change subject options because they

could not get along with the member of staff concerned. In the writer's experience as a Principal for seven years in a coeducational school he cannot recall any case of dislike or liking for teacher being given initially for dropping or taking a subject at the time of subject choice. But there have been quite a few cases where dislike for a teacher had been given as a reason for dropping a subject which a pupil had chosen and had already embarked on its study. Usually two types of pupil did this: the very weak and the very able pupils. In the case of the weak pupil, he/she suddenly found that his/her weakness was then conspicuous since other weak pupils had dropped the subject, and looked for the slightest confrontation with the teacher to use it as a 'reason' to drop the subject. This was done by boys and girls alike. In the case of the able pupil, he/she had originally chosen an unpopular subject (for girls usually a subject unpopular with girls) only because he or she had been doing exceptionally well in it. So when a clash did occur with the teacher, the pupil thought it was a way of hitting back at the teacher by dropping the subject and giving dislike for the teacher as the 'reason' for dropping the subject.

It does seem that teacher liking may gain some importance after subject choice, but as far as pupils are concerned it is not important in its influence on their choice of subjects.

2.4 Summary

It has not yet been firmly established which curricular provision before subject choice that enhances Science choice, but it appears that pupils following a separate Sciences course seem to have an edge over those following a General Science or Integrated Science course. Some primary school science activities, though biological, but which involve measurements, have been shown to have significant correlations with Chemistry and Physics choices and also to show gender differences.

Although there has been some reservation about the choice point being

early, there is firm support that pupils have already made a commitment to Science before the choice point. But the arrangement of subjects on the options system does severely limit the choice of certain subjects, in particular, a full complement of Science subjects for boys and the choice of a physical Science for girls. The curricular course differences for pupils before the choice point do restrict pupils, especially the least able ones, in their choice. The type of schooling, too, that is whether a pupil attends a single sex school or a mixed sex school, does affect subject choice. Boys are more likely to choose a language and girls a Science in a single sex school, than they are in a mixed sex school. In addition, polarisation of subjects occurs in mixed sex schools, and this polarisation hypothesis has been shown to hold for boys in their choice of subjects, but not for girls although not contradicting it.

The social implications of science seems to affect only girls in their choice of Science subjects. Parental influence, although difficult to assess, seems also to have more effect on girls' choice of Science subjects than on boys. Generally parental involvement in subject choice appears to be closely linked with the family background - the higher the occupational level of the father, the more the family is involved.

Psychological tests have been shown to discriminate between scientists and non-scientists, but only tests on Abstract Reasoning ($p = 0.01$) and Space Relations ($p = 0.05$) have been shown to correlate with number of Sciences chosen. Science oriented girls, that is girls choosing three Sciences, though comparatively smaller in number have been shown to score much higher mean scores for SR, VR and AR than science oriented boys. Only three personality traits on the HSPQ have reached a significant relationship (for all $p = 0.05$) with number of Sciences chosen: emotional stability, assertiveness and shyness for boys and adventurousness for girls. Boys are also more assertive than girls irrespective of the number of Sciences chosen.

As far as pupils are concerned, the major reasons for choosing subjects are interest in or preference for a subject and the usefulness of the subjects for job or further education (anticipation of success in external exams). But boys' choice of physics, Chemistry and to a lesser extent Biology, are more related to their preference for these subjects than that for girls. Even though boys and girls seem to have the same perception of difficulty for subjects, perceived difficulty affects girls more than boys in their subject preferences and choices.

Pupils feel that the choices they make are largely their own and that teacher influence (liking for or quality of teaching) and peer group influence have no significant effect on their choices. Most pupils are also satisfied with their choices although satisfaction seems to be highly associated with ability especially for girls.

CHAPTER THREE

The Research Design

The method of investigation adopted for this study and the reason for its adoption will be given in this chapter. The instruments utilised in this investigation will be described, as well as the particular variables each instrument was selected to measure. The population is defined and the sample selection discussed. A description is given of the preparation of the tests, inventories, and questionnaries, and how they were actually administered. At the end of the chapter the size of the two samples for the study is detailed.

3.1 Experimental Strategy

Previous studies on subject choice have mainly focussed either on the intended choice or on the actual choice of subjects. The intended choice is an indication by pupils of the subjects (from the range available) which they wish or propose to study after the choice point (the point in their school after which they take optional subjects). The actual choice is the subjects they eventually end up taking after the choice point. The actual choice and the intended choice may or may not correspond.

Studies on pupils' intended choice may reveal a clearer picture of why certain pupils are predisposed to choose certain subjects and why they have an aversion to other subjects, since it is the subjects the pupils really wanted to choose or drop that are being investigated. However, from the review of previous work on subject choice, the subjects that pupils end up taking after the choice point are not always the same subjects they had intended to take. So how these changes come about, which subjects are usually affected, what types of pupil are mostly affected, may not be easily discernible. It is, nevertheless, possible while working on the

actual choice the pupils have made to get some information about their intended choice. But such information about the pupils' intended choice got after their actual choice has been made, has to be treated with some caution. With the passage of time important information about their intended choice may not be accurately recalled. The pupils also have grown and matured, and what at that time they thought was important may at their present state apppear trivial. There is also the benefit of hindsight and they may tend to rationalise what they had done. Hence, such information may not adequately project what was happening at the time they were deliberating which subjects they intended to choose. This is why some previous studies on subject choice have been on both the information about the intended choice and the actual advice, obtained at the right stages.

Gathering information about the intended choice and the actual choice can be done in two ways. Ideally, the sample is picked up at some stage before the choice point and then followed through till after making the actual choice. This is a longitudinal study. During this study information about the educational variables, socio-economic variables and the pupils' psychological variables are also got. The other way is to carry out a one-shot study on two samples at the respective stages, while also getting information about the educational, socio-economic and the pupils' psychological variables. In the second way it is assumed that the educational and socio-economic conditions for the two samples are the same or do not differ appreciably.

In the present case, it was not possible to undertake a longitudinal study because of the time factor. Nobody can do it in the course of a three-year research period.

Two samples were therefore required for this study. The first sample was to be selected before the choice point and when choice was imminent, so that pupils would actually have been contemplating on their choice. The second sample was to be selected after the choice point when the pupils

would actually have embarked upon studying their chosen subjects and in a position to make some evaluation of their actual choice.

3.2 Description of Research Instruments

The purpose of this study, as already given in the introductory chapter, is to investigate the factors and variables that influence subject choice, with special emphasis on the choice of science subjects. Some of the variables to be investigated have already been identified from previous studies elsewhere, mainly in Western countries, and have been classified into educational, socio-economic and psychological areas. As this research is primarily concerned with school-related issues, the variables selected for measure had mostly to be variables describing or relating to school factors and influences.

In order, therefore, to be able to investigate the relationship between pupils' subject choice (or subject choice patterns) and variables describing or relating to school factors, the following variables were selected.

Educational Variables: School type, curriculum choice point, curriculum structure and provision before choice point, curricular choice pattern (options system), organisation of teaching.

Socio-economic Variables: Perceived social benefits of subjects, parental background and influences, pupils' out-of-shcool activities, local job opportunities.

Psychological Variables: Specific abilities, personality, subject preferences or subject liking, subject ease/difficulty, interest in/attitude to activities (motivation) and subjects, perception of usefulness of subjects for further education or careers, perception of school opportunities: facilities, teacher liking, teacher quality, peer group influence, reputation of success, subject choice (intended and actual).

The instruments used in this study are shown in Table 3.1. Some instruments were chosen to measure specific variables while others measured several variables. The variables measured by each instrument are indicated in its description. Some of the instruments have, immediately following their description, an explanation of how their measures were quantified. This was thought necessary as it gave more meaning to their description and in their data analyses references will be made to them.

Table 3.1 Research Instruments and Their Areas of Measure

Instrument	AREAS OF MEASURE		
	Educational Variables	Socio-economic Variables	Psychological Variables
School Subject Preference Grid			X
Repertory Grid		X	X
Learning Environment Inventory	X		X
Differential Aptitude Test (DAT)			X
HSPQ			X
Principals' Questionnaire	X	X	X
Pupils' Questionnaire	X	X	X

3.2.1 School Subject Preference Grid

This grid is based on the Brunel Subject Grid devised and used by Ormerod (1975). It has since been used by Keys and Ormerod (1976) and

Roberts (1981). The grid it-self and how the pupils were to use it to indicate their Subject Preference and Teacher Liking, appear in Appendix 1. This grid enables the pupil, by a paired comparison method, that is, comparing subjects two at a time, to rank the subjects being studied in order of preference. First, all the subjects that are not being studied are eliminated from the comparison by shading the entire rows and the entire columns corresponding to those subjects. The total number of unshaded squares left in the grid corresponds to the total number of comparisons to be made. This will total $\frac{1}{2}n(n-1)$, where 'n' is the total number of subjects being studied. Each unshaded square represents two subjects. In other words, each square is where the row corresponding to one subject and the column corresponding to another subject meet. The preferred subject between these two subjects is entered in the square. All the unshaded squares are each filled in this way.

Our concern here is how to measure the Science Preference. If a pupil is studying 10 subjects among which is one Science subject, say Biology, there will be 9 comparisons between Biology and each of the 9 other subjects to register a preference for or against Biology. So there are 9 possible preferences for Science. If there are two Science subjects, say Biology and Chemistry, 9 comparisons will have to be made for Biology and another 8 comparisons between Chemistry and the other subjects, making a total of 17 possible preferences for Science. If there are three Sciences, Biology, Chemistry and Physics, a total of 17 comparisons will be made for Biology and Chemistry, plus 7 comparisons between Physics and the other subjects, making a total of 24 possible preferences to be registered for Science. If a pupil is studying General Science or Integrated Science, it is considered as one subject. Table 3.2 gives the possible preferences for Science for the number of Sciences studied among the total number of subjects.

Table 3.2 Possible Preferences for Science in Relation to Subjects Studied

Number of Sciences Studied	Total Number of Subjects Studied										
	14	13	12	11	10	9	8	7	6	5	4
1	13	12	11	10	9	8	7	6	5	4	3
2	25	23	21	19	17	15	13	11	9	7	5
3	36	33	30	27	24	21	18	15	12	9	6

The Science Preference Score (SCPRE) is calculated as the total preferences for Science registered by the pupil (t), expressed as a percentage of the total possible preferences for Science (T).

$$SCPRE = \frac{t}{T} \times 100$$

A pupil studying Biology, Chemistry, Physics, among a total of 10 subjects and who indicates 18 preferences for the three Sciences, will have a Science Preference score calculated as shown:

$$SCPRE = \frac{18}{24} \times 100 = 75$$

At the bottom of the grid pupils are asked to show their liking for the teacher currently teaching them that subject, by entering under the appropriate subject "+" (for like), "-" (for dislike) and "?" (for undecided).

In calculating the Science Teacher Liking score (TLIK), scores of 2,

1, 0 were respectively awarded for "like", "undecided" and "dislike". TLIK is also calculated as a percentage of the total possible score. So in the previous example if the pupil had entered "+" for the Biology teacher, "+" for the Chemistry teacher and "-" for the Physics teacher, the Science Teacher Liking score would have been

$$TLIK = \frac{4}{6} \times 100 = 67$$

3.2.2 The Repertory Grid

This grid (see Appendix 2) is based on the one originally developed by Duckworth (1972), Duckworth and Entwistle (1974). It seeks to measure four distinct attitudes to school subjects.

(a) interest, or lack of interest, in the subject;

(b) difficulty or easiness, in relation to other subjects;

(c) 'freedom' of the subject in terms of freedom to expreess one's own ideas; and

(d) 'worth-whileness' of the subject in terms of its perceived social benefit.

The grid has 20 pairs of opposing descriptive comments (A and B) and pupils are to indicate under the appropriate subject the comment they agree with for that subject. For example, one pair of comments for the Interest scale is given below:

Comment A: Usually interests me

Comment B: Often bores me

For each of the 10 subjects on the gird the pupils indicate which comment they agree with for that subject.

A score of '2' is given if the comment chosen agrees with the attitude scale, and '0' if it opposes it. If the pupil does not agree with either

comment for a subject, this neutrality is indicated by an 'N' under that subject, and it is given a score of '1'. This indication of neutrality or uncertainty is meant to prevent the unwillingness to respond inherent in making forced choices. Pupils were, however, asked to make use of the neutral response only when they were absolutely sure it was the only response they could give. In the above example, comment A is scored '2'.

Table 3.2 shows the comment numbers of the 20 pairs of comments used, against their scales. The letter in parenthesis beside the number of the comment shows the comment that was scored '2'.

Table 3.3 The Repertory Grid Scales

Scale	Comment Numbers	Number of Items	Score Range
Interest	1(B),2(A),7(B),13(A),14(A),18(A)	6	0-12
Ease	4(A),6(A),10(B),17(B),20(B)	5	0-10
Freedom	3(A),8(B),9(A),12(A),16(A)	5	0-10
Social Benefit	5(A),11(A),15(A),19(A)	4	0- 8

3.2.3 Learning Environment Inventory, (LEI)

According to Fraser and Walberg (1981), there are three distinct methods for assessing and studying classroom environments. They are:

(a) Naturalistic inquiry and case study

(b) Interaction analysis

(c) Pupil or teacher perceptions of psychological characteristics of the classroom.

The first method has rarely been used in science classrooms according to Fraser and Walberg, and it is an expensive and time consuming method. Hence it was ruled out for this study. The second method involves observation and systematic coding of classroom communication according to some category system. But as earlier pointed out in the review of literature, the appearance of a strange observer in a classroom immediately disturbs the usual atmosphere of the class and hence will seriously affect the reliability of the result. Besides, measures by this method usually concentrate on teacher behaviour and may not adequately reflect the complexity of the classroom. The most important reason, however, for not using this method is that few studies have reported significant predictions of learning from their use.

Apart from the fact that only the third method is left, there are many advantages for its use. It is cheaper and less time consuming to get pupil perceptual measures, and previous studies have shown that perceptual measures of classroom environments have been found to account for considerably more variance in pupil learning outcomes than interaction analysis measures (Welch, 1973). It was decided to use pupils instead of teachers because the pupils are less likely to know the "correct" or expected response for describing teaching methods, and hence less likely to be inhibitive in their reponses or want to give responses in order to "help" the researcher with the "correct" response. Pupil perceptual measures are based on their experiences over many lessons and represent the pooled judgements of all the pupils in a class and thus one is able to get a balanced view of the many small events of instruction and activities that take place in the classroom. On the other hand, measures from interaction analysis are usually based on a very small number of lessons. It is even

more important to obtain information from pupils of their perceived behaviour than having their real behaviours observed by someone else. Fraser and Walberg further state that studies have shown that pupils are quite capable to perceive and weigh classroom stimuli and then make valid judgements about the psychological characteristics of their classroom.

Original interest in measuring classroom environments arose when it became necessary to evaluate the effectiveness of a new Physics course, the Harvard Project Physics, being tried out by a national sample of teacers in the USA (Walberg 1969).

The most widely used perceptual measure in science education has been the Learning Environment Inventory, LEI (Anderson and Walberg, 1976). Research on Learning Environments and the development of the LEI have been documented by Fraser and Walberg (1981) and Welch (1973).

The LEI used in this study is the one developed by Anderson (1973). It has two distinct uses: The assessment of

(i) the perceptions of an individual pupil of the class,

(ii) the learning environment of the class as a group.

There are 15 scales each consisting of 7 items which describe a typical classroom situation and pupils express their agreement or disagreement with the items on a five-point scale.

Nonetheless, Fraser and Walberg (1981) pointed out that the LEI excluded important aspects of the environment of science classrooms particularly relevant to individualised, open and inquiry-based settings. Therefore three scales which Kelly (1980, 1978b) had re-analysed by 'a judicious mixture of factor analysis and common sense' from data originally used in the Internatioal Association for the Evaluation of Educational Achievement (IEA) survey (Comber and Keeves, 1973), were incorporated into Anderson's LEI. The three scales are: Behave, Explore and Authity. 'Behave' is concerned ith the strictness of school discipline and behaviour standards, while 'Explore' and 'Authity' are used to measure science

learning environments. Items on the Explore scale investigate the way science is taught: whether pupils are encouraged to make their own exploration of the subject through laboratory work, field work or reading. While items on the Authity scale find out if science is taught mainly by appeal to external authority, either the authority of the teacher or of the written word. These three scales were derived from the responses of pupils to questions about their science lessons. The Behave scale items had been on a two-point scale (agree/disagree) while the Explore and Authity scale items had been on a three-point scale (always/sometimes/never). But the Behave scale items were put on a five-point scale to harmonise with the Anderson version of the LEI scale, and the Explore and Authity scale items were put on a four-point scale.

The LEI used for this study is shown in Appendix 3. It consists of 100 items: 81 from the Anderson LEI and 19 from the three scales revised by Kelly. Table 3.4 gives a description of the 15 scales according to Anderson, and the 3 scales revised by Kelly, with a sample item from each scale. The item number in the Inventory for each scale is also shown. An 'R' in parenthesis beside an item number shows that scoring for that item is reversed before inclusion in the scale. The item numbers that are underlined were excluded from the scoring so that items for which pupils were to indicate the degree of their agreement or disagreement, were the same, five, for each scale.

In scoring, 5 was given for "complete or strong agreement", 4 for "mild or partial agreement", 3 for "undecided or netural", 2 for "mild or partial disagreement" and 1 for "strong or total disagreement". Also 4 was given for "always", 3 for "sometimes", 2 for "rarely" and 1 for "never". Items for which scoring was reversed meant that the scoring was in the opposite direction for those items, that is, the highest score became the lowest and vice versa. The score range for all the scales was from 5 to 25, except for Explore and Authity which had a score range of 7 to 28.

Although the LEI was originally developed primarily for Physics classes it has also been widely used for Chemistry and Biology classes and the Anderson (1973) version has been translated into Hebrew and used under Israeli conditions (Gluzman, 1978; Hofstein and Lazarowitz, 1985).

Table 3.4 Learning Environment Inventory Scales

Scale	Description	Item Nos.	Meaning	Sample Item
1	Cohesiveness	1,17,43 55(R),70, 45	The amount of intimacy between the individuals within the class	All pupils know each other very well.
2	Diversity	4,28,67, 72,82	The extent to which the class atmosphere provides for a diversity of pupil interests and activities	The class has pupils with many different interests.
3	Formality	7,15,37 46(R),47	The extent to which the behaviour within the class is guided by formal rules	The class is rather informal and few rules are imposed (R)
4	Speed	23,56(R), 58(R),78, 83	The rate of progress of the class in the subject	Pupils do not have to hurry to finish their work during Science lessons (R)

5	Environment	2,11,22, 41,69 44(R)	The physical environment of the class (laboratories, books, etc.)	The equipment pupils need or want are easily available to them in the classroom
6	Friction	8,25,35, 53,79	The scale measures three categories: disagreement, tension and antagonism within the class	Certain pupils in the class are responsible for petty quarrels
7	Goal Direction	10,52,54(R), 65,84	The recognition of goals and their acceptance by the class	The class knows exactly what it has to get done
8	Favouritism	9,13(R), 20,38,57 74	Teacher favouritism of some pupils over others	The better pupils are granted special privileges
9	Cliqueness	5,24,60, 73(R),76	Demonstrates the existence of sub-groups or cliques within the class	Certain pupils work only with their close friends

10	Satisfaction	6,16,18(R), 30(R),63 49	Measures whether or not pupils like the subject, the teacher and their classmates	The pupils enjoy their class work in Science
11	Dis-organisation	3,26(R), 31,71,86	The extent to which pupils consider the class disorganised	The class is well organised (R)
12	Difficulty	12,15,62(R) 77(R),80 36	Demonstrates whether pupils consider subject matter difficult	Pupils in the class tend to find the work hard to do
13	Apathy	40,66(R) 68(R),75(R), 85	Indicates whether individuals within the class have any affinity for class activities	Members of the class don't care what the class does
14	Democracy	21,29(R), 39,48,64(R)	"Democratic" procedure of the class activities	Each member of the class has as much influence as any other member

15	Com-petitiveness	14,32,50(R), 61,81(R) 34	The extent to which class members compete one with another	Pupils seldom compete with one another. (R)
16	Behave	19,27(R), 33,42,59	The strictness of school discipline and behaviour standards	Most of our teachers are very strict about Science homework
17	Explore	87,89,91(R) 93,95,97, 99	The way in which Science is taught so that pupils are encouraged to make their own exploration of the subject through laboratory work, field work or reading	Pupils are encouraged to read Science magazines and reference books to become familiar with all aspects of Science

18	Authity	88,90,92, 94,96,98, 100	The appeal to an external authority in Science lessons, either the authority of the teacher or that of the written word	We do our practical work from written instructions which tell us how to carry out the experiment

3.2.4 Differential Aptitude Tests

The Differential Aptitude Tests (DAT) are well known psychological tests which were developed for educational and vocational guidance purposes. It is necessary to know as much as possible about pupils, their skills and abilities, the level at which they can perform, in order to get a broad view about their capabilities and hence guide them towards careers for which they are most suitable. These tests were therefore intended to provide such information in a meaningful way so that the guidance counsellor could help the pupil make the right choice of career.

The battery of DAT comprises eight tests and each is independent. The abilities or aptitudes that they measure are those which have been judged from experience as being important or relevant in many educational and vocational situations. The history of these tests, their development over the years, and how they are administered are found in the manual (Bennett, Seashore and Wesman, 1968).

As already mentioned in the review of literature, intelligence tests have been widely used both before and after subject choice to discriminate between science choosers and non-science choosers among boys and girls (Butcher and Pont, 1969; Bradley, 1981). But Roberts (1981) used four of the DAT, Mechanical Reasoning, Space Relations, Verbal Reasoning and Abstract Reasoning, to investigate the relationship between performance on

each of them and the number of science subjects pupils chose. The DAT were considered to be "minor" in the context of this study and used chiefly for "comparison purposes", hence only the same four DAT Roberts used have been used in this study. It was necessary to make alterations only on the Verbal Reasoning test as some items were not appropriate for use in Sierra Leone. The following item numbers were deleted: 17, 20, 22, 43, 44, 45, 46, and 47. To keep the sequence of the numbering, 50, 49 and 48 became 17, 20 and 22, respectively. The handbook states that one of the aims of this test is to measure the pupil's reasoning in a way "that is relatively complex without being tricky or esoteric". Table 3.5 shows the time that was allowed for each of the DAT and the score range. The four tests are respectively in Appendix 4, 5, 6 and 7.

Table 3.5 Differential Aptitude Tests (DAT)

Symbol	Measure	Number of Items	Time Allowed	Score Range
MR	Mechanical Reasoning	68	30 mins	0 - 68
SR	Space Relations	60	25 mins	0 - 60
VR	Verbal Reasoning	42	30 mins	0 - 42
AR	Abstract Reasoning	50	25 mins	0 - 50

3.2.5 Cattell's High School Personality Questionnaire (HSPQ)

The HSPQ used for this study is the anglicised version of the Jr. - Sr. High School Personality Questionnaire Form A, the 1968/69 edition, developed by Cattell (Cattell and Cattell, 1968). It measures 14 distinct dimensions or traits of personality found by psychologists to cover nearly

all the individual personality associated with pupils in the age range of 12 to 18.

As also shown in the review of literature, the HSPQ has been used on several occasions for investigations of differences between pupils with science or arts orientations and between sexes. It is a standardised test which makes it particularly useful for comparative studies. There is no time limit on the completion of the test but it is expected to be completed by most pupils in about forty minutes. This makes it possible to administer it within a normal class period.

Table 3.6 gives a brief description of the fourteen personality factors and the items corresponding to each factor. There are 142 items (the first and the last being buffer items), and each factor consists of ten items. The pupils respond to each question on an answer sheet with three response categories, one of them allows for a neutral answer. Although this neutral response is meant to discourage pupils from skipping items when they cannot agree with either of the two possible responses, they are told to use it sparingly. The HSPQ itself is administered according to the manual prepared by the Institute for Personality and Ability Testing, IPAT, (1973).

In the anglicised HSPQ version some modifications were made on the American version in respect of spelling, lexical terms and phraseology, to meet the needs of British children. Hence some inappropriate phraseologies in the anglicised version were changed to make the test applicable to the Sierra Leone situation. There were slight modifications for clarity and appropriateness on these twelve items: 2, 19, 26, 47, 62, 73, 74, 78, 94, 110, 128 and 139.

The HSPQ used for this research is shown in Appendix 8. The raw score for all the scales ranges from 0 to 20, except Scale B, which has a score range of 0 to 10.

Table 3.6 High School Personality Questionnaire (Form A) Factors

Low Score Description	Factor	High Score Description	Question Numbers
1. Reserved	A	Warmhearted	(a)
2. Dull	B	Bright	(b)
3. Affected by feelings	C	Emotionally stable	(c)
4. Undemonstrative	D	Excitable	(d)
5. Obedient	E	Assertive	(e)
6. Sober	F	Enthusiastic	(f)
7. Disregards rules	G	Conscientious	(g)
8. Shy	H	Adventurous	(h)
9. Tough-minded	I	Tender-minded	(i)
10. Zestful	J	Circumspect individualism	(j)
11. Self-assured	O	Apprehensive	(k)
12. Sociably group-dependent	Q2	Self-sufficient	(l)
13. Uncontrolled	Q3	Controlled	(m)
14. Relaxed	Q4	Tense	(n)

Key to Question Numbers

(a)	2	3	22	42	62	82	102	103	122	123
(b)	23	24	43	44	63	64	83	84	104	124
(c)	4	5	6	25	26	45	65	85	105	125
(d)	7	27	46	47	66	67	86	87	106	126
(e)	8	9	28	48	68	88	107	108	127	128
(f)	10	29	30	49	50	69	70	89	109	129
(g)	11	31	51	71	90	91	110	111	130	131
(h)	12	32	52	72	92	93	112	113	132	133
(i)	13	33	34	53	54	73	74	94	114	134
(j)	14	15	35	55	75	95	115	116	135	136
(k)	16	26	56	57	76	77	96	97	117	137
(l)	17	18	37	38	58	78	98	118	138	139
(m)	19	39	59	79	80	99	119	100	120	140
(n)	20	21	40	41	60	61	81	101	121	141

3.2.6 Principals' Questionnaire

This questionnaire (Appendix 9) was specifically designed for this study for all Secondary School Principals in Sierra Leone, whose schools were known to be at least up to the fifth form.

In designing this questionnaire it had to be borne in mind that Principals are in general very busy people, that it was to be the only questionnaire in this research that was not going to be self-administered as it had to be mailed, and hence a reasonable response rate was needed for any generalisation to be made. First, as information about schools in Sierra Leone was going to be sent out of the country, Principals had to be assured of confidentiality and that the information was needed for research purposes only. Secondly, the purpose of the research had to be explained and its relevance to the educational scene in Sierra Leone in order to make them interested and hence more likely to respond. This was done in the

covering letter.

The questionnaire itself was designed so that it could easily be completed without much writing although some provision was made for additional information. There were six sections to the questionnaire. The first section was for a general information about the school to help eventually with the sample selection of the schools. The second, third and fourth sections were respectively concerned about the curriculum before subject choice, the options system and the choice process itself. The groupings of the subjects in Section II(5) were the WAEC (1983) subject groups. But under languages the following were omitted: Italian, African Languages and Arabic, because most secondary schools in Sierra Leone do not offer these subjects, and any school offering any of them could have easily indicated it. (It was later learnt from some schools that responded to the questionnaire that Italian was being offered). Also under Technical Subjects, Applied Electricity, Basic Electronics and Elementary Surveying, were omitted as these subjects are usually offered only in Technical Schools or Institutes. It was thought convenient to have all the subjects listed on one page. The subjects had to be grouped according to WAEC because WAEC is the only Examination Board for schools in Sierra Leone, and the requirement for entering pupils for SC is that every pupil must enter and sit for a minimum of six and a maximum of nine subjects from any four groups, English Language being compulsory. Since there is no statutory school leaving age, all courses after the choice point are geared towards the GCE O-level/SC of WAEC. In the fifth section Principals were asked about the importance they considered pupils attached to certain factors in choosing subjects. Comparison could then later be made with what pupils themselves felt. The final section was for any additional comments or observations, so that Principals could feel free either to dilate further on any answers or give some other information they felt was relevant to the research.

In the analysis of the data from the questionnaire it will be shown under the appropriate section how certain responses were quantified.

3.2.7 Pupils' Questionnaire

This questionnaire too was designed specifically for this research. It is shown in Appendix 10. Whereas all the other instruments were not to be administered to all the test population because of the time factor, at the time of its construction this questionnaire was intended to be administered in its entirety to all pupils in the sample schools (It will be shown later under administration of the tests that because of transportation costs it was not possible to achieve this aim). Hence it had to be designed so that it could be completed easily and quickly by pupils of all ability range. Some sections, of course, relate only to pupils who had already embarked on their chosen courses as in the case of question 10. Questions T9 and F10A are the same in content but differ only in the introductory remarks depending on which side of the choice point the pupils were. These 21 variables, (a) to (u), were arrived at from the research literature of reasons given by pupils for subject choice and from the suggestions made by Principals in their questionnaire. It can easily be noted that some of the variables may never have cropped up in studies in Western countries. For example, the variable "if I can get suitable textbooks easily for that subject" is not or may not come up as a reason for subject choice in the West. But in Sierra Leone pupils (or their parents) buy all their books as well as pay school fees. It may well not be of any importance in subject choice but it was worth finding out. It is not uncommon to hear a parent say to his child, "make sure you choose the subjects that I can afford the books." Indeed the cost of books has become astronomical in the past few years in relation to the salary the average father earns, that one should investigate if it plays any part at all in subject choice. Some variables like subject choice (intended and actual) and reasons for choice, were

measured only by this questionnaire and this section (questions 6 and 7) had to be responded to by all pupils in the sample. Asking pupils to write the subjects they had chosen or intended to choose in order of preference was a way of ensuring that they did not forget any subjects as well as preparing them to answer the School Subject Preference Grid from which the preference score was measured. The subjects were limited to nine because it was the highest number allowed by the schools as well as WAEC (1983). The intention here was that pupils were not just to list any subjects up to 9 that they wished they could have studied regardless of the school in which they were, but that those would be the subjects they would list had their school asked them to do so. In other words, subjects listed were to comply with the respective school regulations for subject choice in the case of pupils who had not made their subject choices. Question 7 was provided for any such wish or fantasy.

Like the Principals' questionnaire, most of the questions were in the form of checklists or rated scales. The rating for each answer will be shown during the analysis. The ratings were, however, Likert type ones. As a rule of thumb, the highest score was consistent with the variable being investigated. If liking for subject was investigated, then the highest score was for most liked and the lowest score for least liked. In the case of boredom the highest score was for most bored and the lowest score for least bored. For the ease/difficult situation, the highest score was for very easy and the lowest score for very difficult. Except, of course, where the rating was already given for the question, as in the Science Home Work question (8d) where the rating was kept. The variables each question was intended to measure are shown in Table 3.7. Just in case some pupils might have had some difficulty with filling a grid, which is almost a two-way inventory, the interest and ease questions on the Repertory Grid, were asked is a straightforward way in questions 1 and 2 of this questionnaire. An example was given in the instruction prepared for completing the School

Subject Grid, as already explained. To discourage pupils giving prestigious job identifications of their parents' occupation, pupils were asked to name their parents' job and also to describe the work they did (Oppenheim, 1966).

In investigating about Science Home Work, since we were interested in motivation, it was felt that the question (8d) should embrace all types of homework in a school. Always liking to do the homework that will definitely be marked, and perhaps in some schools failing to do so is an infringement of the school regulation, is difficult to assess the motive. But for example, reading ahead of a topic, which is sometimes difficult for a teacher to find out, is a different matter altogether.

Table 3.7 A Breakdown of the Pupils' Questionnaire by question number and variables to measure

Questionnaire question number	Variables to measure
1	Subject preference
2	Subject ease
3,4,5	Severity of subject marking
6,7,T9/10A,10B	Subject choice
8	Science teaching and homework
11	Science/arts area of interest
12	Further studies
13	Career ambition
14	Enjoyment of school
15	Preference for Primary School subjects
16,17	Home and parental background
18	Leisure interest

3.3 Sample Selection and Administration

In December 1982, the Principals' Questionnaire was sent to 124 Secondary Schools known to have presented candidates for the GCE O-level/SC in June 1982. This was to make sure that these schools were at least up to the fifth form and hence could have had some experience of the subject choice process. All the questionnaires were posted to the Mathematics Department of Fourah Bay College, Freetown, from where they were posted to the respective schools, and where the completed questionnaires were returned, before eventually being mailed to the writer. A breakdown of the

number of schools by regions that were sent the questionnaires and that returned them, is given in Appendix 11 with a statistical analysis of the response rate.

Since this study is concerned with factors affecting subject choice with special emphasis on Science choice, only schools offering Biology, Chemistry and Physics, as separate subjects up to GCE O-level/SC were eligible for selection. All the sample schools could have been selected from Freetown (Western Area). This could have been convenient and far less expensive since the schools would have been in the same area. Also Freetown being the city means that there is a fair cross section of people from all over Sierra Leone working there, and this is bound to be reflected in the schools. But schools in Freetown are on average much bigger schools than provincial schools. Smaller schools may not have the same problems or influences as bigger schools. Hence schools from the provinces were included in the sample schools. One striking observation from the returned questionnaires was that while one could easily select two single sex schools with comparable number of boys and girls, the ratio of boys to girls ranged from 2:1 to 5:1 in the mixed sex schools. Thus there were by far more boys than girls in mixed sex schools.

Initially 15 schools were selected as sample schools: 8 from Freetown and 7 from the Provinces, comprising 4 girls', 4 boys' and 7 mixed sex schools. The Principals of these 15 schools were informed by letter in August 1983, and it was explained in that letter what was to be done. A reminder was sent in October, before the writer returned to Sierra Leone at the end of October 1983.

The timing for the schools' work, the first term, was chosen because it was the best time of the school year for a one-shot study to be done involving several schools. During the second term most schools are involved in sporting and other school activities. So it would have been difficult to fix dates for several schools within a short period. The GCE O-level/SC

examinations take place during the third term thus the fifth formers would have been ruled out of the sample. Besides, schools too would have been involved with these examinations and would not have welcomed any disruptions of classes. Hence the choice of the first term, and after the schools have settled down after reopening, and before the terminal examinations start at the end of the term.

The tests, questionnaires, inventories, etc., were prepared and printed at Keele University. It was found much cheaper printing them here and transporting them to and from Sierra Leone, than printing them in Sierra Leone. But to pre-empt any eventuality, stencils were prepared and taken along. Since transportation was involved wherever the printing was done, this had to be taken into account in the total number of pupils to comprise our two samples - the pre-choice point and after choice point samples.

From the Principals' questionnaires it was found that almost all the schools did their subject choice at the end of the third form. It was therefore decided initially to have our first sample drawn from the second and third froms, and the second sample from the fourth and fifth forms. But for a total of 3,000 pupils for both samples, it was found that even using the lightest sheet of paper available for printing, the total weight of the paper alone would have been required to print all the questionnaires, tests, etc., was 181.1kg. This meant the cost of transportation by any means was just colossal. Also, the pupils' questionnaire alone came to 77.5kg. It was therefore imperative to make drastic modifications to cut down on the weight.

We therefore decided to select our first sample from only form three and our second sample from preferable form five, if possible, or form four, or from both forms. The final arrangements as to which forms could be available for this study from each school were to be made on arrival in Sierra Leone. There was the possibility that Principals might be more

readily inclined to release their form four classes for this study than the form five classes because of the impending GCE/O-level examinations. Then most of the form three to form five classes in the sample schools did not exceed 120 pupils. So 120 re-usable questions could be printed and answer sheets printed separately. Hence 120 each of the following were printed: the four Differential Aptitude Tests (MR, SR, VR and AR), the Learning Environment Inventory, the High School Personality Questionnaire, and the Subject Preference Grid Instructions. Answer sheets were printed for the test population. The Subject Preference Grid and Repertory Grid are in effect answer sheets. The pupils' questionnaire was not printed as a separate test instrument, but broken down by question and printed at the back of the different answer sheets. Table 3.8 shows at the back of which answer sheet the questions were printed. Questions T9 (for Form 3 only) and F10 (for Forms 4 and 5) were printed as separate sheets. In this way all the original test instruments and answer sheets were printed and the total weight came to about 72kg.

Table 3.8 Rearrangement of Pupils' Questionnaire

Answer Sheet	Questionnaire Number Printed At The Back
MR and SR	1, 2
LE1	3, 4, 5
Subject Preference Grid	6, 7
Repertory Grid	8
VR and AR	11, 12, 13, 14
HSPQ	15, 16, 17, 18

It was necessary in this study, since it was not undertaken by a team, to have the entire population of the form that was needed to work with in a school, to come together in one place. As this meant bringing together many classes, it was felt that spending a whole school day at one school would be better for the school than making say three visits to last for two class periods, on different days. Even using a class period was bound to cause some disruptions in the school, so it was thought schools would much rather endure the disruptions for a whole day than for shorter periods on different days.

On arrival in Sierra Leone the Principals of the sample schools were contacted and arrangements were made as to which forms to work with and on which days to spend at each school. The whole six-week period was booked and once the study commenced it went on continuously. There was no difficulty in being given a whole school day. Only in one of the 13 schools that were finally used was it not possible to have a full school day. But two full school days were spent at schools where both the form 3 and form 5 classes were used.

How the schools passed on the information to their pupils and staff was left entirely to each school. While others informed their pupils about the study a day or so prior to the day they were to spend on this study, others preferred not to, but informed the pupils on the morning they were to work with the researcher. Also in some schools a Senior Teacher helped for the whole day or teachers supposed to teach the classes checked to see if they were needed. On the whole the Principals and Teachers were very cooperative and made it clear that pupils were in no way to be inhibitive by their presence and even encouraged them to be honest and frank as the school was in no way going to find out what they wrote.

Although it was left with the researcher how the school day was to be spent, from experience, it was felt that some cooperation and confidence could be established if the pupils had their breaks just as they had been

accustomed to and to keep to their school regulations. The day usually started by the researcher being introduced to the pupils and the purpose of the study explained by the Principal or a Senior Teacher. The first task after that was to create a good rapport with the pupils, assure them of confidentiality and that there was enough to keep them busy for the whole day and they were not to think it was a 'free' day for them. It was also emphasised that the study was concerned with individuals and each pupils was to write what he or she felt or appealed to him or her. That trying to write what someone else had written would defeat the whole purpose of the study as it would only give the other person's opinion twice and not theirs. Also that since they had been assured of confidentiality it was just fair that no one should attempt to find out what the other person had written. They were told that the whole exercise was not an examination where some would fail and others would pass, hence they were not to be afraid of being honest.

The tests, questionnaires, etc., that were to be administered in each school were planned ahead, but in order to keep to the school schedule with respect to break times, changes had to be made as the day wore on, depending on how much time was left to start another test. It was only the Differential Aptitude Tests that were administered strictly according to examination conditions. For the Learning Environment Inventory and the High School Personality Questionnaire, although each was allowed 40 minutes - and in most cases they were completed before the time allowed - yet if a pupil had not finished he or she was allowed a few minutes to complete. But the rearrangement of the questionnaire at the back of the answer sheets proved very useful as in cases when less than 10 minutes remained for a break or end of school, there was something for the pupils to do and hence prevent them being restless and noisy. It also meant pupils had something to do while test papers were handed out or collected. But there was also the disadvantage especially for the Differential Aptitude Tests, that

because one had to ensure that there was time for it to be completed, sometimes a test had to be abandoned just as the pupils were about to start. This usually happened - something unavoidable in a school situation - when there was a school announcement to be made or some other necessary interruption. This therefore led to bad sampling for some of the tests.

There were only two schools where it was not possible to have the entire year group together in a hall. But in these two schools they had mixed ability groupings for the Form 3 classes, so classes were selected at random. In one case two days were spent in the school, and in another, it was possible to have the classes in adjacent rooms. In the one case for Form 5, the classes were divided into Arts and Science. It was only possible to use the Science group.

The pupils on the whole were very cooperative. Although in a few schools there was a roll call at the end of the school day, yet even in those schools where this was not the practice, the pupils stayed throughout the whole day.

Contrary to our reservation about Form 5, the Principals were quite willing for them to take part in the study. So although Form 4 classes were used in some schools, it was not necessary to include them in the analysis. Table 3.9 and 3.10 give the Form 3 and Form 5 samples respectively.

because one had to ensure that there was time for it to be completed, sometimes a test had to be abandoned just as the pupils were about to start. This usually happened - something unavoidable in a school situation - when there was a school announcement to be made or some other necessary interruption. This therefore led to bad sampling for some of the tests.

There were only two schools where it was not possible to have the entire year group together in a hall. But in these two schools they had mixed ability groupings for the Form 3 classes, so classes were selected at random. In one case two days were spent in the school, and in another, it was possible to have the classes in adjacent rooms. In the one case for Form 5, the classes were divided into Arts and Science. It was only possible to use the Science group.

The pupils on the whole were very cooperative. Although in a few schools there was a roll call at the end of the school day, yet even in those schools where this was not the practice, the pupils stayed throughout the whole day.

Contrary to our reservation about Form 5, the Principals were quite willing for them to take part in the study. So although Form 4 classes were used in some schools, it was not necessary to include them in the analysis. Table 3.9 and 3.10 give the Form 3 and Form 5 samples respectively.

Table 3.9 The Third Form Sample

School Number	School Type	Boys	Girls	Total
01	SSS		120	
02	SSS		115	
			235	
05	SSS	86		
06	SSS	105		
08	SSS	100		
		291		
				526
09	MSS	115	78	
11	MSS	55	27	
12	MSS	73	17	
		243	122	365
Total		534	357	891

Table 3.10 The Fifth Form Sample

School Number	School Type	Boys	Girls	Total
01	SSS		117	
03	SSS		96	
			213	
05	SSS	94		
06	SSS	116		
		210		
				423
09	MSS	101	35	
11	MSS	35	9	
		136	44	180
Total		346	257	603

SSS = Single Sex School

MSS = Mixed Sex School

CHAPTER FOUR

Factor Analyses and the Reliabilities of the Derived Scales

In this chapter the series of factor analyses performed on the scores of some of the variables measured will be presented. The factors identified for each factor analysis will be discussed for the whole sample, and where it was necessary to perform additional factor analyses for each gender subgroup, the gender differences too will be discussed. Having established, through factor analyses, the nature of the derived scales, the 'technical' aspects of the performance of each scale will be examined. In particular, scale reliabilities will be determined.

There are three reasons why factor analyses were performed. First, in the case of instruments designed specifically for this study, an independence of the variables chosen was originally assumed. This assumption itself cannot be accepted without some check, and the factor-analytic procedure allows this check to be made. The check enables any 'structure' underlying the variables to be detected. Secondly, in the case of established instruments, the validity of the scales incorporated in them is usually assumed and accepted. However, some check on this is also warranted since the present population of pupils is rather different (because of cultural/geographical difference) from those for whom the validity of the scales had been established. Thirdly, as a means of investigating the overlap (or otherwise) between variables on different instruments - where this is necessary.

Method of Factor Analysis

The method used in all the analyses to be discussed is the principal factoring with iteration procedure, followed by a Varimax rotation using the Kaiser criterion. By this technique only the factors with eigenvalues

equal to or greater than one are considered as common factors (Nie et al., 1975). Child (1973) has pointed out that there is a tendency, though not a serious one, for this method to extract a conservative number of factors when the number of variables is less than 20, and too many factors for more than 50 variables.

Interpreting the Results

In deciding which factor loadings are to be considered in interpreting the factors, only loadings equal to or greater than 0.3 are considered, as in all the cases the sample size far exceeds 50. Loadings of 0.5 and above will be regarded as 'high', while those less than 0.5 as 'low'.

Sample for the Factor Analyses

The sample on which most of the factor analyses were performed was the sample from the single sex schools of the third form. This was done for pragmatic reasons. First, all the factor analyses that were to be done involved these schools, and the single sex school results were available for processing well before those for the mixed schools. Hence this "time gap" was filled by conducting preliminary statistical investigations on the "structure" of the data obtained from the various instruments and measures. Secondly, there is no *a priori* reason to assume that school type should in any way affect the psychological connections between any of the variables examined and, therefore, the clusters of variables appearing in the various "factors" (or scales) identified by the factor analyses. It can be argued that school type is an "external" variable, whilst in the examination of data structures we are looking at the "psychological response" of subjects to the items incorporated in the various tests and inventories. Thirdly, and this applies in particular to this study, in the single sex schools there is not a preponderance of boys over girls as in the mixed sex schools. Nonetheless, when all the results finally became available, it did

not make any difference in the factors extracted. There were only slight differences in the magnitude of the loadings.

4.1 Subject Choice Variables

The variables involved in this analysis are those of question T9 (or F10A) of the pupils' questionnaire (Appendix 10) described in Chapter 3. The variables are shown in a shortened form in Table 4.1.

The pupils were asked to make any additions to the 21 variables if they felt any had been left out. The very few pupils who responded in this way either repeated a variable already on the list or elaborated on the importance of one of the variables.

It was felt that all the 21 variables or factors were not unique hence their subjection to factor analysis. The sample size for the factor analysis was 473 (285 boys and 188 girls). A score of 4 was given if the variable was considered 'very important' 3 for 'important' 2 for 'slightly important' and 1 for 'not at all important'.

Table 4.1 Symbols for Abridged Form of Variables of the Factors Influencing Subject Choice

Symbol	Variable Influencing Subject Choice
073	last examination marks
074	good at the subject
075	interest in or liking for subject
076	class and terminal reports
077	usefulness of subject for further studies
078	requirements of subject for job
079	status of subject
080	blend of subject with others
081	usefulness of subject in life
082	easy availability of scholarship for subject
083	demand for qualification in subject
084	liking for subject teacher
085	quality of teaching
086	easy availablity of text books
087	external exam success rate
088	if study pal chooses it
089	if chosen by many friends
090	subject teacher's advice
091	any friendly teacher's advice
092	advice from upper form friend or relative
093	parental advice

Table 4.2 Subject Choice Factor Loadings

Symbol	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
073					0.641		
074							0.380
075							0.397
076					0.361		
077						0.319	
078						0.455	
079		0.419		(0.308)			
080						0.303	
081							
082				0.473			
083				0.530			
084			0.506				
085			0.573				
086			0.518				
087					<u>0.285</u>		
088		0.714					
089		0.677					
090	0.513						
091	0.696						
092	0.466					(0.305)	
093	0.572						

Only loadings above 0.3 are listed. Loadings in parenthesis are not considered under the factors they appear. Loadings underlined just failed to meet the criterion but do give more information to the factor.

Factor analysis resulted in the identification of seven factors for the 21 variables, accounting for 55.2% of total variance. Only one variable failed to reach the minimum acceptable loading on any factor, 081, "usefulness of subject in life". The factor loadings on the seven factors are shown in Table 4.2

4.1.1 Discussion of Factors Identified

Factor 1: Advice (090, 091, 092, 093).

All the four advice variables loaded together on this factor. Two stand out clearly with respect to their high loadings: 'advice from any teacher I know is interested in me' and 'advice from my parents or guardians or close relations'. Since a pupil is more likely to look up to a teacher who manifests interest in him, as a parent, it is not surprising that the two stand out together. The other two variables, 'advice from the subject teacher' and 'advice from a friend or relative who is studying that subject in the upper form', which are also high, indicate that the advice is from someone with better knowledge of the subject, and possibly the pupil's capability as well.

Factor 2: Subject Popularity Among Peers (079, 088, 089).

Two variables have very high loadings on this factors: 'whether the friend with whom I study will choose the same subject' and 'if it is a subject many of my friends will also choose'. The third variable, 'a subject everybody speaks highly of in the school or in the community' is relatively low, but is in fact directly related to or a consequence of the first two variables.

Factor 3: Teacher Liking and Teaching (084, 085, 086).

It is surely of some surprise (and interest) that pupils do not seem to be able to distinguish between 'liking for subject teacher' and 'quality of teaching', as the two variables are grouped together, with high loadings, along with 'easy availability of text books'. This may suggest that pupils perceive subject teacher liking and quality of teaching to be inextricably linked together. However, it will come out in the discussion of the differences between boys and girls on this factor that this is not necessarily the perception of all pupils - at least not for the girls.

Factor 4: Importance of Subject (082, 083).

The fact that the 'demand for qualification in subject' variable and the 'easy availability of scholarship in subject' variable are loaded together and separated from variables concerning career and further studies, may imply an element of prestige and status ascribed to this factor. This is borne out by the low loading of the status variable, 'a subject everybody speaks highly of in the school or in the community', on this factor, and already accounted for in Factor 2.

Factor 5: Performance Feedback (073, 076, 087).

The only high loading on this factor is the variable, 'the marks I shall get in the last examination before making the choice'. The low loading of 'my previous class and terminal reports' variable, and lower still 'the success rate achieved in that subject in external exams' variable loading, shed some light on this factor: performance in the last exam prior to the choice stage is seen as the culmination of previous performances; it is also seen as a precursor to the external exams success rate.

Factor 6: Career Requirement (077, 078, 080).

There is no high loading on this factor compared with the other factors discussed so far. This, however, may be due to a sex differentiation which will be dealt with later. The moderatley high loading on this factor is the variable, 'whether the subject will be required for my future job'. The low loadings of the other two variables, 'a subject I feel will be useful for further studies' and 'if the subject fits in well with other subjects', highlight the career aspect of this factor. It is therefore not surprising that the variables, 'advice from a friend or a relative who is studying that subject in the upper form' which has been accounted for in Factor 1, also has a low loading on this factor. Since the pupil wants the subject for his future job, it follows he will pay some heed to advice from someone - especially a friend or a relative - who had already chosen it, to find out how it fits in with other subjects.

Factor 7: Interest and Ability (074, 075).

These two variables loaded on this factor, 'my basic interest in and liking for that subject' and 'if I think I am good at that subject', are low. Again there may be a sex differentiation to explain these low loadings. However, it is interesting that these two variables are loaded together and with nearly equal loadings. It does suggest, as already mentioned in the review of literature (Ryrie et al., 1979), that interest and ability may not be unrelated - at least for some pupils.

4.1.2 Factors Affecting Subject Choice: Differences for Boys and Girls

In order to make a comparison between boys and girls on these factors, the original 21 variables were again subjected to factor analysis separately for boys (N=285) and girls (N=188) so that seven factors could be extracted for each sample. The seven factors accounted for 56.1% and

57.5% respectively of the total variance for the boys' and the girls' samples. The factor loadings are shown in Table 4.3. A discussion of the differences follows.

Table 4.3 Subject Choice Factor Loadings for Boys and Girls Separately

Factors	BOYS Symbol	BOYS Loadings	GIRLS Symbol	GIRLS Loadings
1: Advice 090,091,092,093	090	0.472	090	0.576
	091	0.749	091	0.684
	092	0.505	092	0.453
	093	0.557	093	0.581
			077	0.290
2: Subject Popularity Among Peers 079,088,089	079	(0.367)	079	(0.394)
	088	0.686	088	0.676
	089	0.727	089	0.648
			078	-0.288
3: Teacher Liking and Teaching 084,085,086	084	0.499		
	085	0.573	085	0.731
	086	0.521	086	0.532
	087	(0.327)	080	(0.317)
4: Importance of Subject (079),082,083	079	0.389		
	082	0.434	082	0.387
	083	0.368	083	0.797
	087	0.429	086	(0.409)
5: Performance Feedback 073,076,087	073	0.303	073	0.570
	076	0.614	076	(0.347)
			079	0.554
			080	0.437
			087	0.389
6: Career Requirement 077,078,080,(092)	077	0.333		
	078	0.583		
	079	(-0.327)		
			076	0.448
			084	0.640
7: Interest and Ability 074,075	074	0.497		
	075	0.306	075	0.478
			081	0.354

The footnotes for Table 4.2 apply here as well.

(i) Teacher Liking

The girls have a separate Teacher Liking factor which also has a low loading on it of the variable, 'class and terminal reports'. This may suggest that for the girls there is an association between teacher liking

and performance in class. While for the boys there is no deviation from the Teacher Liking and Teaching factor, there is also a low loading of 'the external exam success rate' on this factor. This may suggest that for boys their liking for a teacher does not depend on the teacher's assessment of their performance but of their assessment of the teacher's teaching which in some extent is reflected in the examination success rate.

(ii) Performance Feedback

On this factor the high loading for the boys is 'the class and terminal reports' which has a low loading for the girls, and accounted for on their teacher liking factor. The girls have a high loading for their last examination performance before subject choice, which has a low loading for the boys. There is no loading on this factor for boys of an external exam success rate, but the girls have a low loading - albeit an appreciable one (0.389). In addition, the girls have a high loading of the status variable, 'a subject everybody speaks highly of in the school or in the community' and also a fairly good loading (0.437) of 'the blend of subject with others' variable loaded on this factor.

The previous discussion on teacher liking may shed some light here. For these pupils in the third form, they may have been taught in their secondary schooling up to this stage by more than one teacher in a subject. Their previous class and terminal reports would therefore have involved more than one teacher for a subject and they probably would not have liked all these teachers. So for the boys these marks may indicate their capabilities rather than their liking for the teachers. The girls may think differently. But the last examination marks for a subject may involve only one teacher. Since the girls depend more on the teacher's assesment of their capability more than the boys, and it may appear the school rates the last performance highly for subject choice, hence the girls, more than the boys, also rate it higher than their previous performances. The girls also,

because they are more dependent on the teacher's assessment than the boys, may feel that their performance in this last examination prior to subject choice in a subject, augurs well for their subsequent performance in the external examination, especially if this subject fits in well with other subjects. This is why the girls also attach a status to this performance feedback factor.

(iii) Interest and Ability

Both the boys and the girls have the 'interest in or liking for subject' variable loaded on this factor. But whereas the boys have also the 'good at the subject' variable loaded on this factor, the girls don't have it loaded on any factor. Instead the girls also have 'if the subject is reckoned to be of general usefulness in life' variable loaded, which the boys don't have loaded appreciably on any factor. It appears, therefore, that for boys perceived ability is associated with interest in subject, but with girls they are interested in a subject not because of their perceived ability, but because they feel it will be useful in life. Also, because girls rely more on performance feedback, that is on the assessment of the teacher of their ability, it is not surprising that perceived ability does not reach acceptable loading on any factor.

(iv) Career Requirement

The girls don't have any career requirement factor. The variables loaded on this factor, usefulness of subject for further studies, requirement of subject for a job and blend of subject with others, are all loaded on different factors. The 'usefulness of subject for further studies' variable has a minor loading on the Advice factor. Perhaps at this stage girls depend on advice for this. The 'requirement of subject for a job' has a negative minor loading on subject popularity among peers' factor. It shows that if a girl is to choose a subject for a job it will

not be just because it is a popular subject. The 'blend of subject with others' is loaded on the performance feedback factor already discussed and also has a low loading on the teacher liking and teaching factor. Girls therefore consider this variable as a teaching variable rather than as being directly related to a career requirement.

There is no deviation by the boys from this factor. There is only one additional variable which has a low negative loading on this factor, 'a subject everybody speaks highly of in the school and in the community', indicating that for boys also choice of a subject for a career at this stage is not influenced by the status of the subject.

(v) Importance of Subject

The boys have two additional variables loaded on this factor. The first, 'status of subject', is a low loading on this factor, anyway. The second is the 'external exam success rate'. The girls have only one additional variable, 'easy availability of text books', which is also loaded on the teacher liking and teaching factor, with a high loading, and hence accounted for there. But an explanation for these additional variables may be got from the loadings of the factor variables. The girls have a very high loading of the 'demand for qualification in subject' variable whereas the boys have a low loading. It appears the girls are saying that if a qualification in a subject is in great demand, then suitable text books should be made easily available for that subject. Hence the association between the two and a reason for this loading on this factor. For the boys, all the loadings are low but the one that stands out is the 'easy availability of scholarship' variable. Understandably scholarships are associated with external examination success and it carries some prestige as well. This therefore explains the additional variables for the boys.

(vi) Variables Not Significant

For the total sample only one variable 'usefulness of subject in life' did not load appreciably on any factor. For the boys two variables did not load appreciably on any factor: 'blend of subject with others' and 'usefulness of subject in life'. Perhaps they are accounted for in the career requirement factor. For the girls only the 'good at subject' variable did not reach an acceptable level on any factor. This may be accounted for by the 'interest in or liking for subject' variable on the interest and ability factor, as already explained.

4.2 The Repertory Grid Variables

The Repertory Grid is shown in Appendix 2, and it has been described in Chapter 3. A factor analysis on the 40 variables relating to the curriculum subjects was carried out for the sample of 519 pupils (287 boys and 232 girls) from the single sex schools of the third form who completed this grid, to see how the variables grouped. The symbols for the 40 variables are shown in Table 4.4. Various solutions with the factor number ranging from 15 to 10 were explored. That for N factors = 12 gave the best clustering. This is the solution that is discussed. It accounted for 56.9% of the total variance. (The factor loadings for the solutions for N factors = 15, 14, 13, 11 and 10, accounting respectively for 64.8, 62.3, 59.7, 54.0 and 51.0% of the total variance, are shown in Appendix 12). Table 4.5 shows the factor loadings for N factors = 12.

Factor 1: Science Freedom and Geography Freedom

(055, 057, 059, 062).

The three Sciences, Biology, Chemistry and Physics, are all loaded on this factor with high loadings. The fact that Geography has a low loading on this factor does indicate that certain aspects of Geography, with regard to "freedom to express one's own ideas", are perceived by pupils as a science subject.

Table 4.4 Symbols for Repertory Grid Scale Variables.

Subject	S Y M B O L S			
	Interest	Ease	Freedom	Social Benefit
English Language	033	043	053	063
Literature	034	044	054	064
Physics	035	045	055	065
History	036	046	056	066
Biology	037	047	057	067
French	038	048	058	068
Chemistry	039	049	059	069
Religious Knowledge	040	050	060	070
Mathematics	041	051	061	071
Geography	042	052	062	072

Table 4.5 Repertory Grid Factor Loadings

N = 12 Factors

PART 1 - Symbol 1-6

Symbol	1	2	3	4	5	6
033						0.340
034				0.500		
035			0.575			
036					0.651	
037			0.621			
038						
039			0.605			
040						
041						
042				0.518		
043				0.628		
044						
045					0.518	
046						
047						
048						
049				(0.386)		
050						
051						
052						(0.318)
053						0.396
054						(-0.297)
055	0.684				0.475	
056						
057	0.635					
058						
059	0.585					
060						
061						
062	(0.444)					(0.322)
063						0.520
064						
065		0.744			0.299	
066						
067		0.480				
068						
069		0.726				
070						
071		(0.337)				
072						

PART 2 - Symbol 7-12

Symbol	7	8	9	10	11	12
033						
034						
035						
036						(0.428)
037				0.667		
038						
039			0.525			
040						
041	0.625				0.681	
042						
043						
044						
045		0.471				
046						0.437
047				0.506		
048						
049		0.550				
050		(-0.391)				
051	0.443	(0.473)			0.428	
052						
053						
054						
055						
056						
057				0.463		
058						
059						
060			0.491			
061	0.423				0.266	
062						
063		(-0.308)				
064						
065						
066						(0.408)
067				0.378		
068						
069						
070			0.673			
071	0.457				0.417	
072						

Loadings in parentheses are not accountd for where they occur. Underlined loadings did not reach the criterion but give some added information to the factor where they occur.

Factor 2: Science Social

(065, 067, 069).

The three Sciences are again loaded together on this factor but with much higher loadings for Physics and Chemistry than that for Biology. The low loading for Biology may be explained by the fact that it is also loaded with Biology Ease on factor 12. The low loading for Mathematics on this factor is expected. In perceiving the 'worthwhileness' of the Science subjects in relation to their social benefit, the pupils must think of mathematics as well, even though the social benefit of Mathematics as a subject is recognised by its being loaded on factor 7, the Mathematics factor.

Factor 3: Science Interest

(035, 037, 039).

All the three Sciences have high and comparable loadings on this factor. It is only Biology that is again loaded on another factor, with a low loading, the Biology Ease factor, factor 12.

Factor 4: English/Literature Interest and Ease

(034, 043, 044).

These variables appear on this factor with high loadings. Religious Knowledge Ease is also loaded on this factor with a low loading. It is however understandable: a pupil with an interest in Literature and who finds English and Literature easy, is likely to find Religious Knowledge easy.

Factor 5: History Factor

(036, 046, 056, 066).

All the History variables are loaded together on this factor. Loadings for Interest and Ease are high but the Social Benefit loading is very low.

Factor 6: English/Literature Freedom and Social Benefit

(053, 054, 063, 064).

Only the Freedom variable loading is high - the others are comparatively low. The low loading of the Interest variable is expected. What is puzzling is the negative loading - albeit a very low one (0.297) - of Physics Freedom. It is true that the Freedom items on this grid include the use of imagination and the pupil's own ideas, and these are different in the two subjects. But the fact that Physics alone and not Chemistry or, for that matter Mathematics, has the negative loading may imply that perhaps pupils see Physics as the embodiment of the Physical Sciences.

Factor 7: Mathematics Factor

(041, 051, 061, 071).

The four maths variables are all loaded together on this factor. But the loading that stands out over the others which are nearly all equal, is that for Interest, which is high. The Ease variable is also almost equally loaded on factor 8, the Ease factor for Physics and Chemistry, the Physical Sciences, and this is expected.

Factor 8: Chemistry and Physics Ease

(045 and 049).

It is not surprising for the Physical Sciences Ease to be loaded together and separately from Biology Ease. As already mentioned, Mathematics Ease is also loaded on this factor with an equal loading to that of Physics. The low negative loadings for English and Religious

Knowledge on this factor just add more information to the nature of this factor in terms of its difficulty.

Factor 9: Religious Knowledge (RK) Factor

(040, 060, 070).

Except for the Ease variable which is loaded on factor 4, the English Interest and Ease factor, all the RK variables are loaded on this factor. The highest variable loading, a high one, is for Social Benefit.

Factor 10: French Factor

(038, 048, 058, 068).

There is some uniqueness about these variables in that in all the factor analyses performed in trying to achieve the best cluster of variables, the French variables invariably always clustered together, with not even a minor loading on any other factor. The magnitude of the loadings may change but they still clustered together. The magnitude of the Interest loading stands out over above the others, and it is high.

Factor 11: Geography Factor

(042, 052, 072).

Only the Freedom variable did not load appreciably to reach the criterion for consideration, on this factor. This variable, as has already been discussed, loaded on factor 1, the Science Freedom factor. The only high loading is the Interest variable.

Factor 12: Biology Ease

(047).

As has already been stated, Biology Ease loaded on a separate factor from the other two Sciences, Chemistry and Physics. But Biology Interest and Biology Social Benefit also loaded on this factor with almost equal

loadings as the Ease variable. These two have been accounted for where they loaded with higher loadings with the other Science variables. However, the comparatively low loadings of the Interest and Social Benefit variables on this factor highlight the association between Interest, Social Benefit and Ease of Biology, the only Science displaying this property in this analysis.

4.2.1 Rationalisation of Findings

On the basis of the groupings of the forty variables, 033 to 072, the following rationalisation can be made: that Science subjects, Biology, Chemistry and Physics, are grouped as Social Benefit, Freedom, Interest and Ease factors; the other subjects are grouped as Subject factors.

It can be argued that the loading of the Geography Freedom variable on the Science Freedom factor is because some aspects in the learning of Geography are seen by pupils as a Science subject. Its appearance, therefore, on this factor is only to add more information and detail to the factor. Hence it is reasonable to put this variable together with the other three variables under the Geography factor.

For the Ease variable, the Sciences are split into two factors: Chemistry and Physics (Physical Sciences), and Biology. In the review of research on pupils' attitudes to Science (Ormerod and Duckworth, 1975), the division of Chemistry and Physics from Biology in terms of difficulty, as perceived by pupils, is clearly highlighted. One would then consider the Ease factors as one factor but subdivided into two: Physical Sciences and Biology.

There are two factors, 4 and 6, on which are loaded a cluster of variables which are almost all Language variables - English and Literature. There was no Literature - only English - on the grid used by Duckworth and Entwistle (1974). However, since the grid was to be administered to a population whose mother tongue is not English, even though English is the

medium of instruction in schools, it was decided that Literature should be included among the subjects on the grid. The reasons for this were that for a pupil in England for example, the subject English embraces English Literature as well. But for pupils studying English as a second language, and where English had traditionally been taught as English Grammar and English Literature, it might have been confusing. Secondly, even in the lower forms English is taught separately and timetabled separately from English Literature. As this distinction was made in other areas of this study, it was just wise to keep to this pattern. In any case since it turned out that English and Literature variables were grouped together, it is reasonable to combine the two subjects and to refer to them as English, and to use the higher loadings in each case. The English factors too can then be considered as one factor subdivided into English Interest and Ease, English Freedom and Social Benefit.

The following factors, based on the variable clusters, are now presented:

1: Science Freedom

2: Science Social Benefit

3: Science Ease

(a) Biology

(b) Physical Sciences

4: History Factor

5: English

(a) Interest and Ease

(b) Freedom and Social Benefit

7: Mathematics Factor

8: French Factor

9: Geography Factor

Religious Knowledge (RK) has been left out because some of the sample schools did not teach it. But for any comparative purposes, it has to be pointed out that RK is a school subject taught in schools in Sierra Leone and can be chosen like any other subject for GCE O-level/SC. However, some schools in addition teach Religious Instruction (RI) but this is not a subject for GEC O-level/SC. It was made clear to pupils that their responses were to be based on RK and not RI.

4.3 Science Teaching and Home Work Variables

As shown in Chapter 3, these variables constitute question 8 of the Pupils' Questionnaire (Appendix 10). It was also shown that the scoring for the enjoyment of the Practical and the Theory scales was opposite in polarity to those of the Boredom and Home Work scales. That is, the score ranges from 1 for 'dislike(d) it very much', to 5 for 'very much enjoy(ed) it'; but for the Boredom scale the range is from 1 for 'never boring' to 5 for 'always boring'. Also the Home Work scale ranges from 1 for doing Home Work 'always', to 3 for 'never' doing Home Work. Hence in the factor analysis, the factor loadings (and these are actually correlation coefficients) for Practicals and Theory will be opposite in sign to the Boredom and Home Work loadings.

The sample size for the factor analysis on the 24 Science Teaching (9) and Science Home Work (15) variables was 474 (271 boys and 203 girls) from the single sex schools. The factor analysis resulted in the extraction of 8 factors accounting for 68.9% of the total variance. Table 4.6 and 4.7 give the symbols for the Science Teaching and Science Home Work variables, and the factor loadings for the eight factors extracted, respectively.

Table 4.6A Symbols for the Science Teaching Variables

	Biology	Chemistry	Physics
Practicals	158	159	160
Theory	161	162	163
Boredom	164	165	166

Table 4.6B Symbols for the Science Home Work Variables

A C T I V I T Y	Biology	Chemistry	Physics
Fetching materials for class	167	168	169
Reading ahead of topic	170	171	172
Supplementary reading	173	174	175
Revision exercises NOT for marking	176	177	178
Exercises for teacher marking	179	180	181

4.3.1 Discussion of the Factors

The variables grouped into factors according to School work and Home Work. There is a Subject differentiation with regard to School work. This indicates a great subject specificity in the responses. But for Home Work, there is an activity differentiation with no specific subject

differntiation. It follows, therefore, that the enjoyment of Science teaching for these pupils depends on the subject, that is, whether it is a Biology or Chemistry or Physics class, rather than on what is done. In the case of Home Work, it is the type of Home Work not the Science Subject, that determines their liking to do the Home Work. Three of the eight factors (1, 3, 8) are for the teaching of each of the Sciences, and the rest are for each of the five Home Work activities.

Table 4.7 Science Teaching and Science Home Work

Factor Loading

	F A C T O R S						
Symbol	1	2	3	4	5	6	7	8
158								0.308
159			0.664					
160	-0.705							0.510
161								
162			0.811					
163	-0.756							-0.530
164								
165			-0.572					
166	0.747						0.548	
167							0.669	
168			(-0.319)				0.598	
169	(0.387)					0.633		
170						0.680		
171						0.426		
172	(0.456)			0.553				
173				0.895				
174				0.687				
175								
176		0.773						
177		0.871						
178		0.793						
179					0.542			
180			(-0.325)		0.833			
181	(0.329)				0.681			

Note: Boredom and Home Work variables should load in opposite direction to Practicals and Theory variables according to the scoring.

Only loadings equal to or greater than 0.3 are shown. Loadings in parentheses are not accounted for under the factor they appear.

School Work

As expected, the boredom variables loaded in opposite direction to the Practical and Theory variables. The Physics variable loadings, enjoyment of the practical work, theoretical work and the classes, are all very high with almost the same loadings. The low loadings of three home work activities, fetching materials for use in class, reading ahead of a topic in class, and doing exercises that have to be marked by the teacher, on this Physics Teaching factor, and also opposisitely loaded as explained, add some more detail and meaning to this factor. It is the pupil who finds Physics very interesting that would like doing activities as well. It is noteworthy that the highest of these low loadings, 0.456, is for 'reading ahead of topic', which implies a high degreee of motivation for the subject. The loadings of the Chemistry variables on the Chemistry Teaching factor are also all high. But the outstandingly high loading (0.811) is for liking for Chemistry Theory. The Chemistry Teaching factor also has two low Home Work activity variables loaded on it, fetching materials for class and doing exercises for Teacher marking, with nearly equal loadings. But for the Biology Teaching factor, only the liking for the theoretical work and not being bored in class, have high loadings. The 'liking for practical work' variable has a low loading, but this may be due to a sex differentiation. Enjoyment of Biology teaching has no association with liking for doing home work.

Home Work

The five home work activity factors all have high loadings of the Science subject variables loaded on them, except for the 'reading ahead of topic' in Physics loadings which has a low loading. The loading for

Chemistry on each factor is consistently the highest. Like for the loadings on the Physics teaching factor, the loadings of the 'revision exercises not for marking' activity are all very high. Loadings on the 'fetching materials for class' and 'reading ahead of class' activity factors are, on average, not as high as those for the other activities.

4.3.2 Science Teaching and Home Work Activity Factors: Differences for Boys and Girls

A separate factor analysis was performed for the 271 boys and for the 203 girls from the single sex schools of the third form who constituted the total sample for the factor analysis. 'Normal' factor analysis in each case yielded eight factors accounting respectively for 70.4% and 70.5 of the total variance for the boys' and girls' samples. In each case the factors were divided into school work with Subject differentiation, and Home Work with activity differentiation rather than Subject differentiation. The differences between boys and girls are therefore discussed under School Work and Home Work. Table 4.8 gives the Science Teaching and Home Work Activity Factor loadings for boys and girls.

Table 4.8 Factor Loadings for the Science Teaching and Science Home Work Activity Factors for Boys and Girls

Factors	BOYS Symbol	BOYS Loadings	GIRLS Symbol	GIRLS Loadings
Biology Teaching 158,161,164	158	0.424		
	161	0.584	161	0.709
	164	-0.476		
Chemistry Teaching 159,162,165 (168),(180)	159	-0.676	159	0.639
	162	-0.782	162	0.732
	165	0.654	165	-0.591
	168	(0.306)	168	(-0.353)
	171	(0.318)		
	180	(0.420)		
Physics Teaching 160,163,166 (169),(172)	160	-0.698	160	-0.778
	163	-0.734	163	-0.813
	166	0.705	166	0.779
	169	(0.382)	169	(0.376)
	172	(0.434)	172	0.455
			175	(0.341)
			178	(0.309)
			181	(0.412)
Fetching Materials for Class 167,168,169	167	0.542	167	0.590
	168	0.648	168	0.689
	169	0.597	169	0.560
Reading Ahead of Class 170,171,172	170	0.644	170	0.450
	171	0.695	171	0.514
	172	0.460		
			164	0.482
			165	(0.500)
Supplementary Reading 173,174,175	173	0.567	173	0.587
	174	0.851	174	0.849
	175	0.784	175	0.624
			170	(0.423)
			172	(0.301)
Revision Exercise NOT for Marking 176,177,178	176	0.776	176	0.781
	177	0.894	177	0.837
	178	0.827	178	0.697
Exercises for Teacher Marking 179,180,181	179	0.550	179	0.550
	180	0.794	180	0.832
	181	0.647	181	0.773

Note: The footnotes for Table 4.7 are also applicable here.

School Work

As expected from the discussion of the total sample, there is no appreciable loading on any factor for liking for Biology Practicals for girls. Only liking for Biology Theory is loaded on the Biology Teaching factor. It shows that for girls enjoyment of Biology is not strongly linked to any activity, for example, practical work. Also, boredom in class for girls is not specific to Biology, but relates more to Sciences in general, especially to Chemistry.

The Chemistry Teaching factor has high loadings for the three variables for both boys and girls. But in addition to the low loading for 'fetching material for Chemistry class' which is common for both boys and girls, boys again have two low loadings for Chemistry home work, 'reading ahead in class' and 'doing exercises for Teacher marking'. It appears that a boy who very much enjoys Chemistry shows a little more motivation towards home work than a girl who also very much enjoys Chemistry. On the other hand, for Physics, it is the girl who very much enjoys Physics who is more motivated towards doing Physics home work. The Physics Teaching factor for girls has minor loadings for all the five Home Work activities. In particular, the 'reading ahead of class' variable is accounted for on the Physics Teaching factor where it is has a higher loading. Thus the girl who very much likes Physics is very highly motivated to it. The boys also have low loadings of the 'fetching of materials for class' and 'reading ahead of class' variables on this factor.

Home Work

The only marked differences for boys and girls are on the Reading Ahead of Class Activity factor and the Supplementary Reading Activity factor. There is no appreciable loading for the 'reading ahead of class' variable for Biology for girls on the Reading Ahead of Class Activity factor. Also there is a high loading for boredom in Chemistry and a nearly

high loading (0.482) for boredom in Biology (the only place where it is acceptably loaded) on this factor. It implies that for girls reading ahead of class in Biology and in Chemistry is associated strongly with boredom. The low loadings of the 'reading ahead of class' variables for Biology and Physics on the Supplementary Reading Activity factor further confirm the observation made earlier, that for girls the boredom variable is not specific to Biology but to Sciences in general.

4.4 Some Questionnaire Variables: Subject Preference, Subject Ease Severity of Teacher Marking, Pupils' Forecast of Teacher Marking

These variables relate to questions 1, 2, 3 and 5 of the Pupils' Questionnaire (Appendix 10). As already mentioned in Chapter 3, questions 1 and 2 were intended to be used for internal validation of the scales measuring the same variables on the Repertory Grid (RG). Hence having carried out a factor analysis on the RG variables, it was necessary to do one on the scores for question 1 and also question 2. But since questions 3 and 5 were intended to find out if the difficulty or ease of a subject as perceived by pupils depended on the nature of the subject or on how it was marked by teachers, and hence related to question 2, they too were all submitted to factor analysis.

The factor analysis carried out for each of these questions was on the total sample of the third form pupils from both types of school who responded to these questions. Data for the mixed sex schools were then available on the computer.

The sample for the subject Preference question was 425 (276 boys and 149 girls) and the scoring was: 5 for 'muched liked', 4 for 'liked', 3 for 'liked a little', 2 for 'neither liked nor disliked' and 1 for 'disliked'. For Subject Ease, sample 459 (304 boys, 155 girls), 6 was given for 'very easy', 5 for 'easy', 4 for 'neither easy nor difficult', 2 for 'difficult'

and 1 for 'very difficult'. In scoring for the Severity of Teacher Marking question, sample 537 (309 boys, 288 girls), 5 was awarded for 'very severe', 4 for 'severe', 3 for 'neither severe nor lenient', 2 for 'lenient' and 1 for 'very lenient'. The Teacher Marking Forecast question sample 583 (326 boys and 257 girls), was scored thus: 5 for 'far above what I expected', 4 for 'above what I expected', 3 for 'same as I expected', 2 for 'below what I expected' and 1 for 'far below what I expected'. This question had only the Sciences, Mathematics, English Language and French.

Table 4.9A Pupils' Questionnaire Variables: Subject Preference

Subject	FACTOR LOADINGS Factor 1	Factor 2	Factor 3	Factor 4
Biology	0.303			
Chemistry	0.725			
Physics	0.831			
General Science or a Combined Science			0.707	
Mathematics	0.465			
English Language		0.403		(0.356)
English Literature		0.492		
Geography		0.404		
History	(-0.290)	0.602		
French				
Bible Knowledge				0.609

Table 4.9B Pupils' Questionnaire Variables:

Subject Ease

Subject	FACTOR LOADINGS Factor 1	Factor 2	Factor 3	Factor 4
Biology			0.702	
Chemistry		0.713	(0.350)	
Physics		0.556		
General Science or a Combined Science				0.771
Mathematics		0.503		
English Language	0.572			
English Literature	0.722			
Geography	0.394			
History	0.519			
French				
Bible Knowledge				

Table 4.9C Pupils' Questionnaire Variables: Severity of Teacher Marking

Subject	FACTOR LOADINGS Factor 1	Factor 2	Factor 3
Biology	0.724		
Chemistry	0.483		
Physics	0.429		
General Science or a Combined Science	0.335		
Mathematics			0.429
English Language		0.546	
English Literature		0.811	
Geography			0.657
History			0.332
French	0.384		
Bible Knowledge	0.551		

Table 4.9D Pupils' Questionnaire Variables:
Pupils' Teacher Marking Forecast

	FACTOR LOADINGS		
Subject	Factor 1	Factor 2	Factor 3
English Language			0.590
Biology		0.605	
Chemistry	0.359	(0.314)	
Physics	0.491		
Mathematics	0.490		
French			

Only loadings equal to or greater than 0.3 are shown. Loadings less than but close to 0.3 are underlined. Loadings in parentheses are not accounted for where they occur but do elucidate the factor.

4.4.1 Discussing the Factors

All the factors and factor loadings are shown in Table 4.9A - 4.9D.

As far as the Sciences are concerned, Biology, Chemistry and Physics, the groupings are similar to the Repertory Grid groupings for Interest and Ease: the Science Preference factor has Biology, Chemistry and Physics loaded on it, but for Ease, Biology again loads on a separate factor apart from Physics and Chemistry.

It is puzzling why General Science or a Combined Science should load separately for preference, from Biology, Chemistry and Physics. It is logical for it to load separately for 'ease of subject' noting its

composition, and that the pupils might have been aware of its physical sciences and biological sciences elements, and hence would have rated it differently. It is difficult to draw any valid conclusion about why there is a General Science factor for preference since it was not included among the RG subjects, to make comparisons. It has, however, to be pointed out that only one of the sample schools was actually studying General Science as a subject in Form 3. As will be discussed in the next chapter, General Science or a Combined Science is usually studied in the first two or three years of secondary school. Also, only very few schools offer it as a subject for GCE O-level/SC, and where it is offered in schools in addition to the other Sciences, it is usually for the less able pupils. Thus General Science has a lower status as a GCE/SC subject. It may well be that the introductory phrase 'your preference for the subject', in the light of the foregoing, might have been confusing.

The results for the 'Severity of Teacher Marking' and 'Pupils' forcast of Teacher Marking' reveal that for the Sciences forecasting the marks is associated with the difficulty of the subject rather than with the teacher. The clustering of the variables is similar in both factor analyses. The fact that all the Sciences including General Science are loaded on the same factor for the marking severity may indicate that the difficulty or ease of a subject as perceived by the pupils is independent of the teacher marking, but rather, it has to do with the nature of the subject itself.

As regards the other subjects, it has to be noted that the marking forecast question had only the Sciences, English, Mathematics and French listed. Again like in the RG analysis, English and Literature cluster together for preference and ease. Mathematics also loads with the Physical Sciences for 'ease of subject' and 'marking forecast'. That it also loads in a Science Preference factor is not unexpected in a straigtforward question about liking as in this case. Perhaps this is why Geography has loaded on the English Preference factor together with History. French

does not load appreciably on any of the Preference and Ease factors, and the Forecast factors. Bible Knowledge is the only other subject that has a single subject factor for preference. It does have a low loading for English which is expected. Bible Knowledge like French, does not load appreciably to be considered on any factor for 'ease of subject'.

4.5 Learning Environment Inventory (LEI)

The LEI scale items are shown in Appendix 3. The description of the scales and the scoring are given under 'Description of Research Instruments' in Chapter 3. The symbols for the scales are in Table 4.10.

In the use of the LEI, the usual assumption has been the relative independence of the LEI variables, and authors have treated them as independent variables (Welch, 1973; Fraser, 1981; Kelly, 1978). Nonetheless, on 'logical' grounds some interrelationships can be hypothesised to exist between different variables. For example, cliqueness might be thought of being associated with diversity, and disorganisation with apathy. Hence a factor analysis was carried out.

The sample for the factor analysis was 508 pupils (273 boys and 235 girls) from the single sex schools of the third form sample. The six factors which resulted accounted for 51.6% of the total variance. The results are given in Table 4.11.

4.5.1 Discussion of the Factors

Some major groupings of the variables emerge which are identified and discussed.

Factor 1: Social Fabric and Structure (002, 006, 008, 009)

The cluster of these variables, diversity, friction, favouritism, clequeness, with nearly all high loadings, gives us an idea of the social atmosphere of the class - hence the name of the factor. 'Disorganisation'

does have a very low loading, and this is expected as in a way it gives some description of such an atmosphere; but it is accounted for under Factor 2.

Table 4.10 Symbols for Learning Environment Inventory (LEI) Scales

LEI SCALE	SYMBOL
Cohesiveness	001
Diversity	002
Formality	003
Speed	004
Environment	005
Friction	006
Goal Direction	007
Favouritism	008
Cliqueness	009
Satisfaction	010
Disorganisation	011
Difficulty	012
Apathy	013
Democracy	014
Competitiveness	015
Behave	016
Explore	017
Authity	018

Table 4.11 Learning Environment Inventory Second Order Factor Loadings

	F A C T O R S					
SYMBOL	1	2	3	4	5	6
001		0.323				
002	0.502				(0.322)	
003				0.295		
004						0.467
005				0.628		
006	0.665					
007		0.310				
008	0.468					
009	0.609					
010		0.447				
011	(0.300)	-0.426				
012		-0.283				
013		-0.419				
014						
015					0.403	
016						0.283
017			0.665			
018			0.521			

Loadings in parentheses are not accounted for where they are.

Underlined loadings did not reach the criterion for acceptance but are nonetheless close enough to be considered.

Factor 2: General Attitudes towards Learning and being Taught (001, 007, 010, 011, 012, 013)

This factor has the largest cluster of variables but none of them is high. Notwithstanding, three variables stand out clearly: satisfaction, disorganisation and apathy. The last two have, of course, negative loadings. The variables with low loadings are: cohesiveness, goal direction and difficulty. The later loaded with a much lower loading (-0.283) on this factor, but this could have been due to a sex differentiation, hence its acceptance on this factor, as it is related to satisfaction, goal direction, and in some way, to apathy, for certain pupils. Perhaps this caused the sex differention and hence the very low loading. These variables describe the pupil's attitude to learning (satisfaction, apathy) and to the teaching process (goal direction, disorganisation, difficulty, cohesiveness).

Factor 3: Approach to Science Instruction (017, 018)

These two variables, as explained in Chapter 3, make up the three scales incorporated into the LEI, which Kelly (1980) had given new descriptive scale names from the ones used in the International Association for the Evaluation of Educational Achievement (IEA) survey of science achievement (Coomber and Keeves, 1973). Kelly did say that these two scales were "slightly positively correlated." From their definitions given in Chapter 3, they are concerned with the teaching of Science. These two variables do not make the distinction between laboratory work and use of the text book which is a characteristic feature they have. It is therefore not surprising that they load together on one factor and both with high loadings.

Factor 4: Physical Environment (003, 005)

This factor concerns equipment, books, displays in the classroom,

adequate space, that facilitate learning and which make the pupil take pride in her classroom. Such a classroom where everything is kept in its place so that it is easily available for use, is associated, from a pupil's point of view, with a teacher who likes formality. It is therefore not surprising for the high loading of the environment variable to have a low loading of the formality variable as well.

Factor 5: Competitiveness (015)

The "competitiveness" variable is isolated on this factor although it has some relation to "diversity" which also has a low loading on this factor. To a lesser extent "competitiveness" is also related to "favouritism" and "cliqueness" which are loaded on Factor 1, where "diversity" is loaded with a high loading, and hence not inappropriate to incorporate it there.

Factor 6: Teacher-inspired (004, 016)

One of these variables, 'behave', is the third scale included in this LEI which Kelly (1978b, 1980) derived from the descriptive scales in the IEA survey already mentioned. It concerns strictness and behaviour standards. It, however, has a low loading on this factor but this may be due to sex differentiation which will come to light in the discussion of the deviations by the boys' and the girls' samples from the factors. Both the 'behave' variable and the 'speed' variable, that is, the rate at which learning in the classroom takes place, originate from the teacher, hence the name of the factor.

4.5.2 Differences between Boys and Girls

Another factor analysis performed separately for the 273 boys and for the 235 girls produced, with 'normal' factor analysis, six factors in each case, accounting respectively for 54.4% and 53.3% of the total variance.

The results are shown in Table 4.12. The deviations are discussed below.

Table 4.12 Learning Environment Second Order Factor Loadings for Boys and Girls

FACTORS	BOYS		GIRLS	
1. Social Fabric and Structure 002, 006, 008, 009 (011)	002		002	0.583
	006	0.506	006	0.669
	008	0.654	008	0.400
	009	0.446	009	0.652
			011	(0.293)
			012	0.298
2. General Attitudes towards Learning and being Taught 001, 007, 010, 011 012, 013	001	0.386	001	
	007		007	
	010	0.723	010	-0.520
	011	(-0.382)	011	
	012		012	
	013		013	
			016	0.338
3. Approach to Science Instruction 017, 018	017	0.721	017	0.438
	018	0.433	018	0.813
	013	-0.418		
4. Physical Environment 003, 005	003		003	0.414
	005		005	0.538
	007	0.645	001	0.467
	013	(-0.297)		
5. Competitiveness 015, (002)	002	0.566	002	
	015	0.416	015	-0.365
	009	(0.375)	009	(-0.290)
	003	0.299	007	0.380
			014	0.329
6. Teacher-inspired 004, 016	004	0.420	004	0.381
	016		016	
	011	0.417	011	0.433
	013	(0.387)	013	0.488
	014	-0.318	003	(-0.298)

Same rules apply as for the main factors

Social Fabric and Structure: Only the boys have the "diversity" variable loaded in the Competitiveness factor instead of on this factor. But as has been explained earlier, this is understandable. The main deviation is the loading of the "difficulty" variable - a very low one - for the girls. The boys do not have the "difficulty" variable loaded acceptably on any factor. This may imply that finding difficulty with the class work is of concern a little more for the girls than for the boys. It has to be noted that this low "difficulty" loading for the girls is not on the Teacher-inspired factor nor on the Approach to Science Instruction factor or the General Attitude towards Learning and being Taught factor, but on this factor where it is associated with friction, favouritism, cliqueness and diversity. Perhaps girls perceive difficulty as a social problem, hence it concerns them more.

General Attitudes towards Learning and being Taught: Only the "satisfaction" variable is loaded on this factor for both boys and girls and with a high loading for both sexes. But the low loadings of the other variables on this factor provide an explanation of the difference between the boys and the girls as to why they derive satisfaction from their science classes. The association for girls of the "satisfaction" variable negatively with the "behave" variable, may indicate that girls derive more satisfaction from classes if the teacher is less strict. On the other hand boys derive more satisfaction from their classes if their class is a closely related one, as shown by the low loading of the "cohesiveness" variable and the low negative loading of the "disorganisation" variable. Gluzman (1978) found, using the LEI (Anderson, 1973) which did not include the "behave scale", in predicting the achievement in Chemistry classes, that the "cohesiveness" scale was much more positively related to cognitive learning for boys than for girls.

Approach to Science Instruction: There is no deviation on this factor but the loadings for the boys and girls are worthy of note. It is the "authity" variable which is the authoritarian teaching involving following instructions from the teacher or the text book that has a very high loading for the girls. In the case of the boys, it is the "explore" variable, which concerns teaching science in a way that pupils are encouraged to make their own exploration of the subject either through laboratory work, field work or reading, that has the very high loading. It bears some resemblance to the factors affecting subject choice, already discussed, of the dependence of girls far more than boys on the teacher. For both sexes, the fairly high loading of the other variable is a support for the peculiar feature of these variables in that they do not correspond to the traditional distinction between laboratory work and use of the textbook. In the use of these two scales, "explore" and "authity", to describe the science learning environments of 14-year-old pupils in 14 Western countries, Kelly (1980) noted that they were similarly related to achievement in the Sciences. But while there were no noticeable sex differences with "authity", in two countries "explore" was significantly correlated with achievement more for the boys than for the girls.

Physical Environment: The boys deviated totally from this factor. In fact the "environment" variable is not loaded appreciably on any factor. Instead the boys have a "Goal Direction" factor. The "formality" variable has only a very low loading on the competitiveness factor. The high loading of the "goal direction" variable with a low negative loading for the "apathy" variable points to the fact that knowing exactly what they have to do in class is far more important and stimulating for boys than the physical environment of the class. For the girls, in addition to the Physical Environment variables of which the "environment" variable has a high loading, there is also a fairly high loading of the "cohesiveness"

variable, thus indicating that the physical environment of the class, that is, having displays and orderly arrangement of equipment ready for use, means much to them and even unites them.

Competitiveness: There is no deviation from this factor by both boys and girls. While both boys and girls associate competitiveness with cliqueness and to a larger extent with diversity for boys, the loading of the "competitiveness" variable negatively with the "goal direction" and "democracy" variables for girls may indicate that for girls competition in class detracts from understanding the goal of the class and runs counter to everybody being able to participate fully in class decisions.

Teacher-inspired: The only deviation is the non-loading of the "behave" variable sufficiently to be considered on this factor, for boys and girls; and in particular, for boys on no other factor. The loading of the "behave" variable negatively with the "satisfaction" variable on Factor 2 for girls, has already been discussed. Nonetheless, there is near unanimity between boys and girls that "speed" is associated with "disorganisation" and with "apathy", more so for the girls, for whom the "apathy" variable is loaded nowhere else but here. In addition, whilst boys see "speed" as a hindrance to full participation in class decisions, not surprisingly, girls with a greater concern for the physical environment of the class, have a low negative loading for the "formality" variable.

4.6 High School Personality Questionnaire

The HSPQ items are in Appendix 8. A description of the factors with the items corresponding to each factor, is given in Table 3.5. The description of the HSPQ itself, the relevant modifications that were made and the scoring, are to be found in Chapter 3. For ease of reference, Table 4.13 again gives a description of the personality traits with the score

descriptions.

Although the HSPQ has been used widely in many countries, especially the Form A which is very popular, nevertheless numerous criticisms have been made questioning the number of Cattell's 'personality sphere' factors that were identified (Howarth, 1976). Recent findings (Ormerod and Billing, 1982; Billing, 1984) have shown that at the 14 to 17-year old stage, six clear-cut factors (if the intelligence factor is included) can give a reliable and valid model of personality. It was therefore deemed appropriate to perform a factor analysis on the HSPQ results.

The entire third form sample, that is all of those pupils (576:294 boys and 282 girls) who responded to this questionnaire irrespective of school type, was the sample for this analysis. The responses to the ten items for the intelligence factor, Factor B (dull to bright), were excluded from the factor analysis. "Normal" factor analysis therefore extracted five factors which accounted for 52.7% of the total variance. The loadings for these second order factors are shown in Table 4.14. No separate factor analyses were done for boys and girls. Only the J trait (first oder factor J) did not load sufficiently enough to be accommodated under any factor.

Table 4.15A shows the comparison between traits identified under the five factors compared with common trait components in previous studies and the tentative nomenclature of the five factors, as provided by Ormerod and Billing (1982) and Billing (1984). In their experimental work, Ormerod and Billing (1982) administered the same questionnaire used in this study (Form A of the anglicised version) to 343 pupils in six secondary schools of different types "in one partly rural and partly industrial county" in England. They too omitted the ten intelligence items and the scores for the remaining 130 items were submitted to a principal components analysis followed by a Varimax rotated solution. Since basically the same version of the HSPQ was used and the same method of factor analysis, their results are shown in Table 4.15B for comparative purposes.

Table 4.13 HSPQ First Order Factors

Symbol	Trait	Low Score Description	High Score Description
019	A	Reserved	Warmhearted
020	B	Dull	Bright
021	C	Affected by feelings	Emotionally stable
022	D	Undemonstrative	Excitable
023	E	Obedient	Assertive
024	F	Sober	Enthusiastic
025	G	Disregards rules	Conscientious
026	H	Shy	Adventurous
027	I	Tough-minded	Tender-minded
028	J	Zestful	Circumspect individualism
029	O	Self-assured	Apprehensive
030	Q2	Socially group-dependent	Self-sufficient
031	Q3	Uncontrolled	Controlled
032	Q4	Relaxed	Tense

Table 4.14 HSPQ Second Order Factor Loadings

Trait	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
A				0.363	
C	0.416				
D		0.432			
E			0.302		
F	-0.347				
G	0.435				
H				0.400	
I			-0.504		
J					
O					0.338
Q2					-0.450
Q3	0.546				
Q4		0.673			

Note: First Order Trait B items, the Intelligence Factor, were excluded from this analysis. Only loadings equal to or above 0.3 are shown.

Table 4.15A Second Order HSPQ Factors

Factor	Tentative Nomenclature	Trait components found in this study	Common trait components found in previous studies
1	Super ego strength	Q3, G, C, -F	Q3, G, -F
2	Anxiety - Stability	Q4, D	Q4, D, -C, -H, O, -Q3
3	Toughness - Gentleness	-I, E	-I, E, (-A)
4	"Classical" extraversion	H, A	H, A, F, -Q2, -J
5	"Non-classical" extraversion	-Q2, O	-Q2, E, -J

Table 4.15B Second Order HSPQ Factors

Findings in this study		Findings by Ormerod and Billing (1982)	
Factor Number	First Order Trait Components	Factor Number	First Order Trait Components
1	Q3, G, C, -F	V	(F), -G, (-Q3)
2	Q4, D	II	-C, D, (-Q3), Q4
3	-I, E	III	E, -I
4	H, A	I	(-A), -F, -H, (-J)
5	-Q2, O	IV	A, -J, -Q2

4.7 Reliability of Derived Scales

The instruments for this study had been chosen because they had been used extensively elsewhere and were of proven reliability. Thus it would be easier to make comparisons and not be bothered first to ascertain the reliability of any instruments specifically designed for this study. But having performed these factor analyses it was perforce to find the reliabilities of the derived scales.

McKennell (1970) has given a formula to obtain rapid reliability estimates for scales derived from either factor or cluster analysis. It is in terms of Cronbach's Alpha (α), which is a particular type of coefficient which measures the reliability of a test, or item battery, in relation to its internal consistency.

$$\alpha = \frac{n\bar{r}}{1+(n-1)\bar{r}}$$

where n = the number of separate items in the scale

$\bar{r}$ = the average of all the inter-item correlations

α is the most popularly used reliability coefficient. From the formula it is seen that the reliability depends on the homogeneity, that is the intercorrelations of the items, and the number of items on the scale. It is possible, as McKernell illustrated, to obtain about the same alpha with three items with a higher homogeneity ($\bar{r} = 0.50$) as nine items with a lower homogeneity ($\bar{r} = 0.30$). Hence if the items of a group cluster on a factor with high intercorrelations, a high alpha is assured for a scale comprising these items, no matter how few they are. At the same time reliability can also be assured by increasing the number of items even for very low intercorrelations. So while reliability and homogeneity are essential preconditions for establishing the construct validity of a scale, they are

not a sufficient condition for a useful scale.

The reliabilities of the scales being discussed were all calculated based on the responses of the entire third form sample - both single sex and mixed sex schools.

4.7.1 Factors Affecting Suciect Choice Scales

The α for these scales are shown in Table 4.16. It is not surprising that the factors on which there were marked gender deviations are the ones with very low α. It will be recalled that for the Perceived Interest and Ability scale, the girls' sample did not have the "ability" variable loaded appreciably on any factor. Hence on the main factor the two variables, ability and interest, as was pointed out, both had low loadings, so that the Perceived Interest and Ability factor was one of the two factors - the other being Career Requirement - that had no high loadings. The intercorrelation between "ability" and "interest" for the entire third form responses (N = 694) is 0.049! Similarly for the Career Requirement scale there was complete deviation from this scale by the girls' sample as was pointed out in the discussions. In fact it is only for the two factors that there wasn't much of a gender deviation that have an alpha of above 0.6. But again as McKennell (1970) argued, "The soundest procedure is to give an obtained cluster the benefit of the doubt, use the clustered items (or a selection of them) as a scale, and base the judgement of the utility of the scale, and the interpretation of its meaning, on its pattern correlation with other variables in the study."

Table 4.16 Reliability Coefficients of Factors Affecting Subject Choice Scales

Scale	Items	Symbols of Items	α
Advice	4	090, 091, 092, 093	0.658
Subject popularity among peers	3	079, 088, 089	0.662
Teacher liking and teaching	3	084, 085, 086	0.554
Importance of subject	2	082, 083	0.324
Performance feedback	3	073, 076, 087	0.395
Career requirements	3	077, 078, 080	0.283
Perceived interest and ability	2	074, 075	0.093

Table 4.17 Reliability Coefficient of Repertory Grid Rationalised Factor Scales

Derived Repertory Grid Scale	Items n	Symbols of Items	α
Science Freedom	3	055, 057, 059	0.679
Science social benefit	3	065, 067, 069	0.693
Science interest	3	035, 037, 039	0.613
Biological science ease	1	047	
Physical sciences ease	2	045, 049	0.614
History factor	4	036, 046, 056, 066	0.596
English interest and ease	2	034, 044	0.596
English freedom and social benefit	2	054, 064	0.418
Mathematics factor	4	041, 051, 061, 071	0.568
French factor	4	038, 048, 058, 068	0.559
Geography factor	4	042, 052, 062, 078	0.528

4.7.2 Repertory Grid Rationalised Factor Scales

Since these factors were based on the best cluster of variables after a series of factor analyses, it is not surprising that except for one scale, all the α's are above 0.50 and for the scale measuring science variables, all are above 0.60. It will be recalled, too, that the English Freedom and Social Benefit factor (054, 064) was the only factor with two variables where one of them had a low loading. So although the correlation between the two variables is significant ($p = 0.001$), being a two-item scale made the α value low.

A comparison was made between the cluster of variables as measured by the RG and those measured by the questionnaire. The correlation between the measures on these two instruments is given in Tables 4.18A and B for Science interest/preference and Science ease.

Table 4.18A Correlation between Science Interest as measured by RG and Science Preference as measured by Questionnaire

SUBJECT	SYMBOL				
	Interest	Preference	N	r	p
Biology	037	100	100	0.322	0.001
Chemistry	039	101	88	0.553	0.001
Physics	035	102	82	0.550	0.001

Table 4.18B Correlation between Science Ease as measured by RG and by the Questionnaire

SUBJECT	SYMBOL		N	r	p
Biology	047	111	130	0.135	ns
Chemistry	049	112	106	0.406	0.001
Physics	045	113	99	0.230	0.01

There were comparatively very few pupils that responded both to the RG and to question 1 and 2 on the questionnaire. It is the RG scales that are used for the analysis in Chapters 6 and 7. A comparison of the two scales in establishing the association between interest in or preference for a subject and the number of sciences intended to be chosen (NBSC) and also ease of subject and NBSC, is given in Tables 4.19A and B.

Table 4.19A Association between Interest (RG), Preference (Questionnaire) and NBSC

SUBJECT	Interest (RG)				Preference (Questionnaire)			
	SYMBOL	N	r	p	SYMBOL	N	r	p
Biology	037	383	0.187	0.001	100	376	0.118	0.01
Chemistry	039	347	0.419	0.001	101	350	0.506	0.001
Physics	035	331	0.498	0.001	102	331	0.504	0.001

Table 4.19B Association between NBSC and Ease as measured by RG and Questionnaire

SUBJECT	Ease (RG) SYMBOL	N	r	p	Ease (Questionnaire) SYMBOL	N	r	p
Biology	047	383	0.003	ns	111	410	0.073	ns
Chemistry	047	348	0.163	0.001	112	380	0.412	0.001
Physics	045	330	0.188	0.001	113	370	0.335	0.001

Table 4.20 Reliability Coefficient of Science Teaching and Homework Activity Scales

Science Teaching and Homework Scales	Symbols of items n = 3	α
TEACHING		
Biology	158, 161, 164 (R)	0.435
Chemistry	169, 162, 165 (R)	0.763
Physics	160, 163, 166 (R)	0.822
HOMEWORK		
Fetching material for class	167, 168, 169	0.619
Reading ahead of class	170, 171, 172	0.695
Supplementary reading	173, 174, 175	0.792
Revision exercises not for marking	176, 177, 178	0.859
Exercises for teacher marking	179, 180, 181	0.755

(R) Scoring reversed before being entered into scale

4.7.2 Science Teaching and Homework Factor Scales

It will also be recalled that it was only on the Biology teaching factor that there was a gender deviation - only the girls did not have any appreciable loading for the Biology practicals and Biology boredom variables. Hence on the main factor it was only the Biology teaching factor that had a low loading (the practicals variable) which is responsible for the comparatively very low α. It was also pointed out that the loadings on the Physics teaching factor were all high and nearly all of the same loading - high homogeneity. It is therefore not surprising, according to McKennell (1970), that the α value should be so high even with three items. For the α value for Biology teaching, it would have required 20 items, from the table provided by McKennell, to attain an α value comparable to that for Physics with three items too. For the Homework scales it was only the Reading ahead of class factor for the girls that did not have this activity for Physics loaded on it, and hence had a low loading for the main factor. On the main activity factor only the Reading ahead of class and the fetching materials for class activities had comparatively lower loadings, that is, none of the loadings exceeded 0.7. They are, not surprisingly, the only two Homework scales with α less than 0.75 as shown in Table 4.20. The 'revision exercises not for marking' activity whose loadings were similar to those for Physics teaching, as was also pointed out, are the only two scales with α above 0.8.

4.7.3 LEI Factor Scales

The alpha values are given in Table 4.21. Here also it is the factors that had gender deviations that have had the very low α. The boys never had a Physical Environment factor and so deviated completely from this scale with the result that the 'formality' variable, accommodated with the 'environment' variable on this scale, had a very low loading. Both the boys and the girls did not have the 'behave' variable loaded under the

Teacher-inspired factor - the boys did not have it loaded acceptably anywhere. So the 'behave' variable too had to be accommodated, although it had a very low loading, with the 'speed' variable, which did not have a high loading, on the Teacher-inspired factor. The accommodation of the 'formality' variable with the moderately high loading of the 'environment' variable and that of 'behave' with 'speed' reduced the homogeneity for each scale. Both being two-item scales, such values for α were inevitable. It was either to drop these items at the expense of a sensible scale or retain them at the expense of reliability and homogeneity.

Table 4.21 Reliability Coefficient of Learning Environment Factor Scales

LEI derived scales	Items	Symbols of items	α
Social fabric and structure	4	002, 006, 008, 009	0.622
General attitudes toward learning	6	001, 007, 010	
and being taught		011(R), 012(R), 013(R)	0.535
Approach to Science Instruction	2	017, 018	0.591
Physical Environment	2	005, 003	0.342
Competitiveness	1	015	
Teacher-inspired	2	004, 016	0.220

(R) = Scoring for item reversed before being entered into scale

Table 4.22 Reliability Coefficient of Second Order HSPQ Factor Scales

Second Order HSPQ Factors	Items	Symbols of Items	α
Super ego strength	4	Q3, G, C, -F(R)	0.450
Anxiety/Stability	2	Q4, D	0.458
Toughness/Gentleness	2	-I(R), E	0.289
"Classical" Extraversion	2	H, A	0.214
"Non-classical" Extraversion	2	-Q2(R), O	0.213

(R) = Scoring for item reversed before being entered into scale

4.7.4 HSPQ Second Order Factor Scales

From the results shown in Table 4.22 all the alpha values are below 0.5, and the last three 2-item scales are very low, although the correlations between them are all significant: -I, E ($r = -0.169$, $p = 0.001$); H, A ($r = 00.120$, $p = 0.002$); -Q2, O ($r = -0.119$, $p = 0.002$). For the other scales where separate factor analyses were performed for the sexes, low α's were invariably associated with factor scales where there were gender deviations. In the experimental work in this study, HSPQ was used as a dependent variable with NBSC and sex as independent variables. It was found that for all the traits except for H, J, O, Q2 and Q3 there was a significant sex difference. All but for traits A ($p < 0.05$) and F ($p < 0.01$) were at the 0.001 level. With two-item scales any gender deviation is bound to affect the homogeneity and hence the reliability, as has been the case for the other scales discussed.

It was said at the beginning of this chapter, that apart from establishing, through factor analyses, the nature of the derived scales, certain "technical" aspects of their performance would then be examined. This has been done by calculating their reliabilities. With regard to the established instruments, namely HSPQ and LEI, the reliabilities obtained for the derived scales do not warrant their use in preference to the original scales. Hence it was decided to retain the use of the original scales for this study also.

4.8 Summary

A factor analysis on the scores for the 21 variables thought to influence pupils in their choice of a subject produced seven factors. There were some deviations from these factors for boys and girls when another factor analysis was done separately for the sexes. Notable differences were that a separate factor emerged for teacher liking for girls apart from the quality of teaching and availability of textbooks, grouped together for the Teacher Liking and Teaching factor; that the girls also had no separate factor for career requirements. With regard to liking for a subject, for boys this was associated with their perceived ability; for girls it was associated with the general usefulness of a subject later in life.

Scores for the Repertory Grid items were subjected to factor analysis and a rationalisation of the cluster of the 40 variables revealed that Science subjects grouped together for Interest, Freedom and Social Benefit. For Ease, they divided into the Physical Sciences and Biology. All the other subjects were grouped together as subject factors except for English which was divided into Interest and Ease, Freedom and Social Benefit.

The Science Teaching and Home Work variables, constituting question 8 of the Pupils' Questionnaire (Appendix 10) gave, on factor analysis, 8 factors: 3 school work factors with subject differentiation and 5 homework factors with Activity differentiation rather than Subject differentiation.

Differences between boys and girls on the factors showed that for girls enjoyment of Biology was not strongly linked with any activity, and that the boredom variable related more to Science in general, especially to Chemistry. It was apparent from the cluster of the variables that a boy who enjoyed Chemistry very much was more motivated to it than a girl; but it was the girl who very much liked or enjoyed Physics who was far much more motivated to it than the boy.

Scores for some Pupils' Questionnaire variables, namely those of questions 1,2,3 and 5 respectively Preference for, Ease of, Severity of marking of and Forecasting marks for subjects, were submitted to factor analysis by question number. Here, too, the Sciences clustered together for Preference but separated - Physical Sciences and Biological Sciences - for Ease. As these analyses were performed for the total third form sample, they served as a cross-validation of the groupings for the Repertory Grid analysis performed for and responded to by only pupils from the single sex schools. General Science or a Combined Science had a separate factor for Preference and for Ease. The groupings of the variables in the Subject Marking Forecast analysis was similar to those of the Ease of subject analysis, but different from those of the Severity of Teacher Marking. Hence indicating that the ease or difficulty of a subject was perceived by these pupils independently from the leniency or severity of the marking.

A factor analysis on the Learning Environment Inventory scales, hitherto treated as relatively independent, produced six factors. A separate factor analysis done for boys and girls showed a few deviations from the main factors. Instead of the Physical Environment factor comprising the variables Formality and Environment, which the girls had, the boys had a separate Goal Direction factor comprising the Goal Direction variable. On the Approach to Science Instruction factor, consisting of the Explore and Authity variables, the boys had a very high loading for Explore and the girls for Authity. The Behave, Difficulty and Environment variables

did not load acceptably for boys on any factor. It emerged from the cluster of the variables that apathy in Science classes was to be associated more with the rapid rate of progress of the class, especially for girls, but more so for boys if the teaching was not of the exploratory type and the goals of the class were not made clear.

As a result of criticisms made of the too many factors originally extracted by Cattell especially for the 14 to 17-year old group, scores (excluding those for the 10 items for the Intelligence Factor) for the HSPQ items were submitted to a factor analysis for the entire third form sample, resulting in the extraction of five factors. There was a close similarity between traits identified under these five factors and those identified in similar studies mainly in UK and the USA where five factors had been extracted.

The reliabilities of the factor scales found in terms of Cronbach's α showed that where there were no gender deviations from the scales, the α values were generally above 0.60. But for scales with gender deviations α values were generally below 0.50 and, depending on the deviation, much lower. The α values for all the Second Order HSPQ factor scales were all very low.

CHAPTER FIVE

The Principals' Questionnaire

The findings from the questionnaire (Appendix 9) described in Chapter 3, will be reported in this chapter.

The questionnaire was sent to all Principals (124) whose schools were known to go up to at least the fifth form. It was intended to obtain information about the curricular structures within which subject choices were made in the schools, and later to be able to select the sample schools for this study.

The report will concentrate on Science choice. First, the stages when subject choices are made in the schools is presented. Then the science education provided up to the choice point in the schools, and if this is the same for all pupils in the school, as well as the teaching period designated to science teaching in the first three years will be discussed. The Science subjects provided for choice in the two years preceding the GCE O-level/SC and which ones are compulsory, will be reported. The process of subject choice will then be discussed with respect to the factors Principals consider in advising pupils, the accessibility of Science subjects to pupils, the choice mechanism that is in practice in the schools, and the role of the teacher Principals consider to be the main source of advice and information to pupils about subject choice. Comparisons will be made between the two types of school, mixed sex schools (MSS) and single sex schools (SSS), in all these discussions. The last section, (V), Pupil's Motivations in the Choice of Subjects, will be discussed in Chapters 6 and 7 respectively, together with what the pupils themselves said.

A statistical analysis of the response rate of the questionnaire by region and by school type, is given in Appendix 11. There was a response

rate of 45.2% from the whole country with the percentage response rate from each of the four regions being respectively 42.1, 44.4, 44.8 and 50.0. Thus the response rate was independent ($p < 0.001$) of the regional division of the country, and, although not high, is acceptable in view of the fact that the enquiry was conducted 'from a distance'.

5.1 Choice Point: the Year of Science Choice

From Table 5.1 it is seen that almost all pupils embark on studying their chosen courses or subjects at the beginning of the fourth year. Only two schools did not have their subject choice either at the end of the second or third year. One of them did it in two stages: some subjects at the end of the second year and others, including the Science subjects, at the end of the third year. In the other school subject choice was done during the second term of the fourth year. Therefore, as far as it affects Science subjects, in 96.4% of all the schools pupils embark on their chosen courses in the fourth form.

Table 5.1 Percentages of Schools Offering Subject Choice at different stages

Choice Point	All Schools (56)	MSS N=33	SSS N=28	SSS:Boys N=13	SSS:Girls N=10
	P E R C E N T A G E S				
End of second Year	3.6	6.1	0.0	0.0	0.0
End of third Year	92.9	90.9	95.7	100.0	90.0
Other stage	3.6	3.0	4.3	0.0	10.0

MSS = Mixed Sex Secondary Schools

SSS = Single Sex Secondary Schools

SSS:Boys or Girls = Boys' or Girls' SSS

5.2 Science Education prior to the Choice Point

This section of the questionnaire was intended to elicit information about how the Sciences were taught, that is, whether as separate subjects or integrated, and whether a common curriculum was provided up to the choice point.

In all the schools science was taught as separate subjects (ie. Biology, Chemistry and Physics) or as a General Science course with recognisable biology, chemistry and physics elements) or as an Integrated Science course. The Integrated Science course that is taught in Sierra Leone is the Core Course Integrated Science (CCIS). However, the science course that is provided prior to the choice point in secondary schools is either to start with the separate Sciences or General Science (or CCIS) in Year 1 and continue until subject choices are made, or start with General

Science (or CCIS) in Year 1 and change to separate Sciences in Year 3 before subject choices are made. Table 5.2 shows the science education that is provided prior to the choice point by the schools. Considering all schools, General Science (or CCIS) is the popular science course. But while it is also very popular in mixed sex schools, a General Science course in the first two years followed by the separate Sciences, is popular in the single sex schools.

Table 5.2 Science Education prior to the Choice Point

Science Course prior to Choice point	P E R C E N T A G E S All Schools (56)	MSS N=33	SSS N=23	SSS:Boys N=13	SSS:Girls N=10
Separate Sciences: Biology, Chemistry and Physics	16.1	12.1	21.7	38.5	0.0
General Science or CCIS	51.8	66.7	30.4	30.8	30.0
General Science (or CCIS) in Forms 1 and 2, followed by separate Sciences in Form 3	32.1	21.2	47.8	30.8	70.0

The teaching of the separate Sciences in the first two years of secondary schools is fairly recent. About 20 years ago (Sawyerr, 1967) General Science was the only science course followed by schools in the Western Area of Sierra Leone (assumed to be an indication of the general trend in the country) in the first two years of secondary education. This monopoly has now been broken by a separate Sciences course and the relatively new integrated course, CCIS. Nevertheless, a General Science

course is still studied at some stage in Form 1 to Form 3 by 58.9% of all schools compared with 48.2% for a separate Sciences course and 26.8% for the Integrated Science course.

With regard to providing a common curriculum for all pupils up to the choice point, only one school did not respond to this question. Of the 55 schools that did, as far as science education was concerned, 96.4% of them offered a common curriculum to all the pupils. For the two schools that did not provide a common curriculum up to the choice point, one from the mixed sex schools and one from the girls' single sex schools, a common curriculum was provided for the first two years. But in the third year, because the classes were streamed, the "less academic" and the "academic" streams did not have the same science education before subject choice. In one case a General Science course was followed for the first two years and in the third year only the "academic" streams followed a separate Sciences course.

5.3 Teaching Period allocation to Science teaching in Form 1 to Form 3

The maximum teaching period per week in all the schools varied, but 40 periods per week was the modal maximum period for all the schools. The maximum teaching periods, however, did range from 31 to 40 with 91.8% of all the schools in the 35 to 40 range. The time allotted to each period was either 35 or 40 minutes. Some schools had a combination of both - 40 minutes for the morning sessions and 35 minutes for the afternoon sessions. the number of teaching periods per day was either 7 or 8. Table 5.3 was based on the total teaching period of each school.

The Secondary Science Curriculum Review (1983) made the following recommendation for the minimum time to be allocated to science studies:

10% of total curricular time for pupils aged 11-13, and
15% of total curricular time for pupils aged 13-14, and about
20% of total curricular time for pupils aged 14-16.

It appears, therefore, that except in the girls' SSS, the curricular time given to the teaching of science, on average, in schools in Sierra Leone, is adequate; but it is still short of the 9 periods out of a school week of 40 periods (ie. 22.5%) recommended in the Report of the Royal Society (1982).

Table 5.3 Percentages of Total Teaching Periods Allocated to Science Teaching

Schools		P E R C E N T A G E S		
		FORM 1	FORM 2	FORM 3
All Schools	49	15.0	15.1	19.1
MSS	30	15.3	15.6	18.8
SSS	19	14.5	14.2	19.6
SSS:Boys	11	15.8	15.3	22.0
SSS:Girls	8	12.8	12.8	16.2

5.4 Range of Compulsory subjects required in the Sciences for Forms 4 and 5

In this discussion, unless specified, a science subject refers to any of the subjects listed in the questionnaire under Science Subjects, which, as pointed out in Chapter 3, were the subjects classified as science subjects by WAEC (1983). That is, in addition to Biology, Chemistry and Physics, which are the subjects considered as Science subjects for this study, these "additional science subjects" are General Science, Health Science and Agricultural Science. The Principals were asked to indicate the

subjects offered for studies leading to the SC/GCE O-level, namely in the fourth and fifth years; those taken as compulsory subjects, and if the choice of one science subject was required.

5.4.1 Provision of Science Subjects in Forms 4 and 5

Table 5.4A gives the percentages of all schools, mixed sex schools (MSS), single sex schools (SSS), boys' single sex schools (SSS:Boys) and girls' single sex schools (SSS:Girls), with the choice combinations that are provided for Biology, Chemistry and Physics in the fourth and fifth years. Table 5.4B shows the percentages of the schools where each of these subjects and General Science are provided for choice for the fourth and fifth year courses. It can be found in Appendix 13 that the provision of the additional WAEC science subjects in schools for the fourth and fifth years is independent of the number of Sciences, namely Biology, Chemistry or Physics, that are provided in the fourth and fifth years.

Just over two-thirds of all schools offer all the three Sciences (Biology, Chemistry and Physics) and less than ten percent of all schools do not offer Biology, Chemistry or Physics. Biology, Chemistry and Physics are offered only in these three combinations in all schools: all three, Biology and Chemistry only, Biology only. If the provision of a subject is a measure of the importance which schools attach to that subject, then the SSS attach a greater importance to all three Sciences than the MSS. Also that all schools consider Biology as the most important Science subject as it is the most popular subject provided, and that Physics is the least important as it is the least popular for provision in the schools. In all schools, however, each of the three Sciences is by far more popular than General Science after the choice point. The new integrated course, CCIS, is only offered in the first three years in secondary schools.

Table 5.4A Percentages of Schools Offering Science Subject Combinations in Forms 4 and 5

Science Subject Combination	All Schools (56)	MSS N=33	SSS N=23	SS:Boys N=13	SSS:Girls N=10
	P E R C E N T A G E S				
3 Sciences: Biology, Chemistry and Physics	67.9	60.6	78.3	92.3	60.0
2 Sciences: Biology and Chemistry	14.3	18.2	8.7	0.0	20.0
1 Science:	10.7	9.1	13.0	7.7	20.0
No Science	7.1	12.1	0.0	0.0	0.0

Table 5.4B Percentages of Schools offering Science Subjects in Forms 4 and 5

Subject	P E R C E N T A G E S				
	All Schools (56)	MSS N=33	SSS N=23	SSS:Boys N=13	SSS:Girls N=10
Biology	92.9	87.9	100.0	100.0	100.0
Chemistry	82.1	78.8	87.0	92.3	80.0
Physics	67.9	60.6	78.3	92.3	60.0
General Science	28.6	33.3	21.7	30.8	10.0

5.4.2 Compulsory Science Subjects in Forms 4 and 5

In Table 5.5 only science subjects that were specifically mentioned are listed. Most schools only indicated that one science subject was compulsory. But since these schools also offered the additional WAEC science subjects (Appendix 13) among the range of science subjects offered, it certainly meant that for certain pupils the one science requirement could have been either General Science or Health Science. Otherwise there was no point offering these subjects in addition to Biology, Chemistry and Physics, when the choice of General Science precluded the choice of any of the three Sciences, and Health Science; and also the choice of Health Science precluded the choice of Biology (WAEC, 1983). Especially as pointed out in the introductory chapter, schools do not have cause to cater for pupils staying in school to meet a statutory age requirement; and, as explained in Chapter 3, WAEC is the only Examining Board for schools in Sierra Leone. In the case, for instance, when it is given as Biology or

Health Science, it was indicated that Biology was compulsory for some streams and Health Science for other streams. This may well be the practice in many of the schools which just stated 'any science from the schools range of science subjects offered', that the 'any science' was Biology or General Science or Health Science. Agricultural Science could be taken along with any of the three Sciences, and WAEC (1983) recommends the study of Biology and Chemistry or General Science for pupils intending to pursue 'higher work' in Agriculture. It may, therefore, be inferred that in most schools offering the full range of Biology, Chemistry and Physics, and also offering General Science and Health Science, that the purpose is twofold. First, to give an opportunity to their less academic pupils to meet the one-science choice requirement. This may be particularly true for the mixed sex schools and the girls' single sex schools. This was why it was suggested in the previous chapter when General Science had a separate subject preference factor from Biology, Chemistry and Physics, that pupils might not rate General Science on the same status with the other three Sciences even though it had elements of all three. Secondly, to give an opportunity for some of their pupils who are interested in choosing each of the three separate Sciences, but whose inclination towards say Home Economics and/or commercial subjects, prevents them from being able to take all three Sciences because of the organisation of teaching. Hence the provision of General Science in the fourth and fifth years may meet the needs of such pupils.

Table 5.5 Percentages of Schools where the choice of a Science subject is compulsory for Form 4 and Form 5

Compulsory Science Subject	P E R C E N T A G E S All Schools (56)	MSS N=33	SSS N=23	SSS:Boys N=13	SSS:Girls N=10
Biology	35.7	21.2	56.5	61.5	50.0
Biology or Health Science	1.8	0.0	4.3	0.0	10.0
Physics or Chemistry	1.8	0.0	4.3	7.7	0.0
Any Science	57.1	75.8	30.4	23.1	40.0
Total: 1 Science	96.4	97.0	95.7	92.3	100.0
No Science	3.6	3.0	4.3	7.7	0.0

5.5 The Process of Subject Choice

The discussion of the results in this section will include the factors Principals considered important in advising pupils, the accessibility of subjects to pupils, the choice mechanism adopted in the schools and the role of the teacher providing the main source of advice and information about subject choice to pupils.

5.5.1 Schools' Advice to Pupils about Subject Choice

This section concerns the responses to III (4) of the questionnaire where Principals were asked to rate on a four-point scale how important

they considered certain factors in advising pupils on subject choice. A score of 4 was given for "high", 3 for "moderate", 2 for "low" and 1 for "not at all", in describing the importance attached to each factor. Table 5.6A provides the average ratings for each of the eight factors on the questionnaire in rank order of importance, based on the mean ratings. Six Principals wrote additional factors: two were on seeing that WAEC requirements were met, two for consideration of local job opportunities, one that Home Economics was to be considered as one of the subjects to be chosen (a girls' school), and one for a pupils to consider the facilities for the subject in terms of equipment.

Table 5.6A Factors Considered by Principals as Important in Advising Pupils on Subject Choice

(ALL principals N ≈ 50 ± 3)

F A C T O R	Symbol	Average Rating
Pupil's performance in specific subject areas	602	3.82
Pupil's general academic performance in the past	601	3.64
Viability of subjects or subject combination for career entry or admission to further/ higher education	605	3.55
Pupil's interests and preferences, as expressed by him/her	607	3.51
Pupil's career aspirations (if known)	604	3.50
Your impressions of pupil's aptitudes	606	3.37
Pupil's likely chances of success in subsequent exams	603	3.26
Parental wishes and preferences (if known)	608	2.33

According to the mean ratings all the factors are of some importance but that the pupil's performance in the specific subject is ranked top and certainly of high importance. Consideration of parental wishes is ranked at the bottom and the rating is low. The other factors range in importance

from moderate to high. The low importance by Principals to parental wishes and preferences is reflected in their response to the question about whether the School sought to involve pupil's parents directly in the choice of academic subjects, where 81.1% of all schools said they did not.

Table 5.6B provides the mean ratings for the two types of school (MSS and SSS) for comparison. There is very good agreement between the two types of school both in the ranking and on the average ratings of the importance of the factors. Only on the rating for the consideration of parental wishes and preferences was there a significant ($p = 0.05$) difference between the ratings, but both types of school ranked this factor at the bottom anyway. This is also reflected in the response to the involvement of parents directly in subject choice. 90.6% of the MSS did not, compared with 66.7% of the SSS. Besides the last two factors ranked at the bottom, the girls' SSS Principals seem to rate all the other factors high. But compared with the boys' SSS Principals there are only significant differences on the ratings for 'viability of subjects or subject combinations for career entry or admission to further/higher education' and 'your impression of pupil's aptitudes' (both at $p = 0.05$). It seems girls' school Principals put equal importance to a girl's academic performance, the usefulness of the subject for career and further studies as well as their own impressions of the girl's aptitudes.

Table 5.6B Factors Considered by Principals in Advising Pupils on Subject Choice

Factor Symbol	AVERAGE RATINGS All Schools N=50 ±3	MSS N=30 ±2	SSS N=21 ±2	SSS Boys N=12 ±1	SSS Girls N= 8 ±2
602	3.82	3.80	3.86	3.85	3.88
601	3.64	3.65	3.64	3.54	3.78
605	3.55	3.55	3.55	3.25	3.90
607	3.51	3.50	3.52	3.46	3.60
604	3.50	3.47	3.55	3.42	3.75
606	3.37	3.32	3.44	3.17	4.00
603	3.26	3.26	3.25	3.25	3.25
608	2.33	2.13	2.67	2.45	3.00

Generally for all schools, the academic performance comes first, followed by considerations for career and further studies, then their impressions of the pupils aptitude and chances of subsequent exam success, before considering parental wishes.

5.5.2 The Extent of Access to Science Subjects

All schools reported a free access to the choice of Biology, Chemistry and Physics, where these subjects were offered. But in explaining where

access might be restricted, all schools required a "pass" grade, which was the case for all non-compulsory subjects, for a pupil to be allowed to choose these subjects. The "pass" grade varied from school to school even for the same type of school. Only in 5 schools (2 MSS, 2 SSS:boys, 1 SSS:girls) that is 8.9% of all schools, was a ceiling imposed on the choice of Chemistry and Physics because of 'laboratory facilities'. All the schools concerned resolved the situation by raising the 'pass' mark in these subjects. Since the schools expected Biology to be chosen it appears there was always adequate 'laboratory facilities' for Biology. Timetabling in no way seemed to affect the choice of Science subjects, because the classes were divided in the fourth and fifth years depending on the number of Science subjects chosen. Because one science subject was compulsory in almost all schools, and this in most cases was Biology, the choice of Chemistry and/or Physics meant being put in a Science class. In other words, any pupil who wished to choose all three Sciences could do so, since the restriction of obtaining a 'pass' was not unique to the Sciences and a ceiling also did apply to other subjects like typing, due to equipment facilicities. Nonetheless, if the percentage of those choosing a subject to whom it had been offered is on index of the extent to which choice is free from restrictions, then this will come to light in Chapter 6.

5.5.3 Choice Mechanism

The statements that Principals were to tick describing the best choice mechanism in their school are in Section IV(1), but are reproduced in Table 5.7A with the percentage response for all schools. The percentage response by school type is shown in Table 5.7B. On the whole schools seem to give their pupils free choice judging from the choice mechanism that is practised in most schools, and the choice mechanism that is most restrictive, the third one, is practised least. In the two types of school, it appears there is freedom of choice in more mixed sex schools than in

single sex schools.

Table 5.7A Choice Mechanism Used in All Schools

No.	S T A T E M E N T	Percentage
1	Pupils are essentially free to choose their subject(s) for study. Guidance is offered by the school/teachers, but this is not binding.	33.3
2	Pupils are free to choose their subjects for study, but are expected to make this choice in accordance with advice received from teachers.	27.0
3	Pupils are encouraged to express their preferences for different subjects, but the actual choice of a subject can only be made with the agreement of the school or the teacher concerned with that subject.	15.9
4	The School's policy is to advise pupils on what subjects or subject combinations to be taken.	23.8

Table 5.7B Choice Mechanism by School Type

Statement Number	P E R C E N T A G E S All Schools	MSS N=33	SSS N=23	SSS: Boys (13)	SSS: Girls (10)
1	33.3	36.8	28.0	3.33	20.0
2	27.0	26.3	28.0	26.7	30.0
3	15.9	7.9	28.0	20.0	40.0
4	23.8	28.9	16.0	20.0	10.0

5.5.4 The Main Source of Information and Advice to Pupils About Subject Choice

The school role of the teachers was provided in the questionnaire and Principals were to indicate the main source of information and advice to pupils about their choice of subjects. The results for all schools and school type are presented in Table 5.8. The Principals themselves are unanimous that the individual subject teacher is the main source of advice and information to pupils about subject choice, and they or their deputies and form teachers don't play much of a role in this area. One wonders whether the Principals were being modest in playing down their own role or they were giving what they considered was what their pupils felt. Nevertheless, the Principals seem to agree with the findings of Bardell et al. (1982) and Reid et al. (1974) when pupils were asked to identify teachers playing an important part in helping them choose their subjects.

Table 5.8 Main Source of Information and Advice to Pupils About Subject Choice

Main Source	PERCENTAGES All Schools	MSS	SSS	SSS: Boys	SSS: Girls
Form Teacher	11.1	13.5	7.7	13.3	0.0
Individual Subject Teacher	44.4	40.5	50.0	40.0	63.6
The Principal or Deputy Principal	12.7	16.2	7.2	6.6	9.1
Careers Adviser or Counsellor	31.7	29.7	34.6	40.0	27.3

5.6 Summary

In almost all the schools (92.9%) the choice point was at the end of the third year. Prior to the choice point 96.6 of all schools offered a common curriculum in Science education. This common curriculum was one of a separate Sciences (Biology, Chemistry, Physics) course, a General Science course, and an Integrated Science course (CCIS). But 40.4% of schools which started with either form of combined science course, switched on to a separate Sciences courses for the third year. The average % total teaching periods allocated to science teaching in the first three years of secondary education were respectively 15.0, 15.1 and 19.1.

All three Sciences, Biology, Chemistry and Physics were offered in 67.9% of all schools and only in the MSS was one of them not offered

(constituting 7.1% of all schools). 96.4 of all schools required the choice of a science subject (not necessarily Biology or Chemistry or Physics) but it was usually Biology, which was the most popular Science subject and offered in 92.9% of all schools. Apart from meeting the academic requirement for each subject, it was virtually possible for any pupil to choose all the three Sciences in the 67.9% of schools where they were offered. In advising pupils on subject choice Principals felt that the pupil's academic performance was the most important factor, and that the subject teacher was the main source of information and advice for pupils about their subject choice.