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THE RELATIONS BETWEEN ABILITIES IN

GRAMMAR SCHOOL SUBJECTS

AND THEIR BEARING UPON

SCHOOL ORGANISATION

(M.ED. THESIS, 1948.)

by

A.G. ELLIS.

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A.G.E.

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INTRODUCTION.

The following are the aims of the present study :-

- (1). to consider the groupings of children and the organisation of curricula at the secondary stage;
- (2). to investigate the relations between abilities in school work, with special reference to the Grammar School;
- (3). to suggest improvements of the internal organisation of secondary schools, based on the findings of the investigation;

The study is divided into three parts corresponding to the three aims.

In Part 1 (Chapters 1 and 2) the problem of organisation is discussed against its background of official recommendation, experiment and controversy. The conclusions reached may be summarized thus : the classification of pupils requires great flexibility of organisation, allowing for a series of courses which are adaptable to individual needs. This end may be served by research upon the relations between abilities.

In Part 2 (Chapters 3 to 6) these relations are described as revealed by statistical research. Chapter 3 contains a brief outline of factor theory, with special

reference to the work of Professors Spearman, Thomson and Thurstone. This account is merely meant to show such general tendencies of technique and conception as are relevant to the investigation of scholastic abilities. Chapter 4 is a review of research on the abilities of English and Scottish school children. Chapter 5 describes a new investigation based on School Certificate marks, which leads to a certain postulation of ability factors. The statistical evidence is summarized and an interpretation suggested in Chapter 6.

Part 3 (Chapter 7) deals with the application to school organisation of the findings of Part 2. The construction of a core-and-options programme is discussed. The methods proposed are illustrated by an outline scheme for a three-form entry boys' grammar school. This provides for both the grouping of subjects in keeping with the research results and for wide individual choice. Finally, some possible benefits which may be derived from the use of the methods advocated are briefly noted.

A short chapter summary follows each chapter.

Appendices A and B refer to the organisation of the past two years in the Grammar School of Queen Elizabeth, Wakefield. Appendix A consists chiefly of a reproduction of an article in which I described the Wakefield scheme and which appeared in the 'Times Educational Supplement'

of 16th November 1946. Appendix B contains an outline of the technique of framing and working the scheme.

The Bibliography is not intended to be exhaustive. It contains the titles of works referred to in the text and those of others which it was found useful to consult. It is divided into four sections dealing, respectively, with (1) School Organisation (2) Factor Theory, (3) Research Reports and (4) Statistical Analysis and Related Mathematics. References in the text are by section, author and year (followed, if necessary, by a distinguishing letter). Thus ' 3 Burt 1917 ' refers to Sir Cyril Burt's 1917 publication listed in Section 3. Again '2 Thomson 1935 b' refers to Professor G.H.Thomson's second work published in 1935 that appears in section 2.

Where references are made to daily or weekly periodicals, the date of publication is given in the Bibliography and, where necessary, also in the text.

PART 1. THE PROBLEM OF SCHOOL ORGANISATION AT THE SECONDARY STAGE.

CHAPTER 1. The Grouping of Pupils.

It is now generally accepted that the function of education is to help each member of the community to realise his best potentialities in and through that membership. The White Paper of 1943 on 'Educational Reconstruction' announced the Government's purpose 'to provide means for all of developing the various talents with which they are endowed and so enriching the inheritance of the country whose citizens they are' (paragraph 1) while their concern for the individual child was expressed in the words 'The keynote of the new system will be that the child is the centre of education' (paragraph 27). The Education Act of 1944 laid down that the schools should 'afford for all pupils opportunities for education offering such variety of instruction and training as may be desirable in view of their different ages, abilities, and aptitudes' (clause 8).

The realisation of these aims presents a problem one feature of which is that educational needs tend to diverge as the pupils grow older. This divergence is both of degree and ^{of} kind. Pupils become more and more separated in their capacity to learn and also in the things which they need to learn if their individual development is to be best served.

Sir Cyril Burt has stated that 'From the point of view of educational organisation, one of the most important facts revealed by intelligence tests is the wide range of individual differences, and its steady expansion from year to year. At the age of 5, children are spread out between the mental ages of about 3 and 7 - a total range of four or five years. By the age of 10 the range has doubled; and probably goes on enlarging until the end of puberty. Older children, therefore, differ far more widely in intellectual capacity than younger children. During the infant period they can be grouped together without much regard to their different degrees of mental endowment. At the age of 8 or 9, however, to put together in a single room all those who are of the same age, would be to organise a class that was extremely heterogeneous. By the age of 10, the children of a single age group must be spread over at least three different standards. And by the age of 12 the range has become so wide, that a still more radical classification is imperative. Before this age is reached children need to be grouped according to their capacity, not merely in separate classes or standards, but in separate types of schools' (1 Min. 1931. p. 258) .

The principle of re-grouping at 11 plus into schools of different types had been recommended, five years before the publication of this statement, by the Hadow Committee (1 Min. 1926. pp. 173, 174) This principle was accepted

by the Spens and Norwood Committees, who stressed the differences in kind of the provision required for the education of adolescents. Indeed, both these Committees were anxious to make clear their opinion that the choice of one type of secondary education rather than another for any child should be made on the basis of what was the best type for him rather than what he was qualified for (1 Min. 1939. pp. XXVIII to XXXIV, and 1 Min. 1943a p.14.) Both were concerned that equality of status should be accorded to the different types of post primary schools; it was the Spens Report that recommended the three main types of such schools (Grammar, Technical and Modern) (1 Min.1939 pp. XXVII and XXXV) and the Norwood Report that moved the emphasis from the school to the child by using the term 'secondary' to refer to the stage rather than the type of education (1 Min.1943a pp.1 to 5). While leaving aside the question of whether their differences were of kind or degree the Norwood Committee recognised the existence of three main groupings which had 'established themselves in general educational experience' and which corresponded to the three main types of secondary school (loc.cit). The implicit suggestion 'that individual differences among pupils are chiefly due, not so much to an innate, all-round capacity entering into every form of mental work, but rather to qualitatively different aptitudes producing qualitatively different types' was severely criticised by Burt, who held

that 'The one thing which the analysis of mental measurements has demonstrated beyond all doubt is the supreme importance during childhood of the general factor of intelligence' (1 Burt 1943 p.131) adding (op.cit.p.140) that 'During school years the restrictions on the type of education from which any particular child can profit are imposed, not so much by lack of special aptitude, as by the limits in amount of general intelligence with which he has been endowed at birth'.

What has been generally accepted is that the realisation of fundamental aims requires at least the beginning of distinctive treatments at about the age of 11. Differences of both kind and degree have been recognised. Disagreement has been expressed, however, on the relative weights to attach to quantitative and qualitative differences. Both types of difference would appear to necessitate the existence of different types of secondary school or of different courses within secondary schools.

The basis or bases of classification of pupils for these various treatments has been a fertile source of controversy, complicated by social questions. On the one hand, the Norwood Report has been criticised for sacrificing the individual to society; its avowed aim 'to help each individual to realise the full powers of his personality ... in an through active membership of a society' (1 Min.1943 pp..vlll) transgresses against 'the autonomy of the personality'

and forgets that 'education must be for the individual's own sake and for no ulterior purpose whatsoever' (1 T.E.S.unsigned, 1943 Sept.25). On the other hand, the same Report has been condemned for repudiating ' the social theory of education' and 'accepting' a theory which concentrates on the individual child' (1Huxley 1943). While one person advocates the 'fitting of schools to given levels of intelligence' (1 Philpott 1947) another maintains that to do this would be to create anti- social barriers of intellect, and recommends the common school (1 Hill 1947).

It is held that the common school 'can provide three essentials for each child's individual culture - a wide variety of subjects, a large and highly specialised staff, and a "setting" system for all school subjects' (1 Hill 1947) It would thus seem that a better fitting of the school to the child is possible in the common school, where classification can be varied according to individual abilities and readily changed in response to observed needs. Opinions differ, however, on the method of classification to be adopted even within such a school. While it seems to be generally assumed that secondary schools when not of single grammar, technical or modern type will combine two or more of these types 'in clearly defined sides' (1 Min 1947a) some writers prefer a vocational basis for classification (e.g.1 Earle 1946 b). Yet again it has been represented that any division of pupils into vocational 'streams' must tend towards

an undesirable 'social, or at least occupational, stratification' (1 Giles 1942).

One may ask, how then is classification of secondary pupils to be carried out, in face of these conflicting demands of educational efficiency and social solidarity? It may be that there has been too much concentration on 'types', 'groups' and 'streams', with a tendency to forget the variety which exists within the individual himself, a variety which resists any facile allocation to type and which qualifies him for membership of several groups or streams at once. Bearing in mind the peculiar heredity of each family and the child's varied environment of home, neighbourhood and school, it will be seen that the pattern of developmental influences and innate capacities of each child is unique. This is certainly no basis for ceasing to distinguish between one child and another and therefore failing to provide variety of educational treatment; but it does provide a sound reason for making diagnosis both individual and gradual. A strong case rests for the common or multilateral school, apart from questions of social solidarity, merely on the difficulty of diagnosing abilities and aptitudes at 11 plus.

The well-voiced concern of the grammar schools, however, lest the advent of multilateral schools should undermine the high standards of scholarship which they have always set before them, is sincere and worthy of respect. There is a genuine fear lest the more practical and less

academic activities which are suitable for the majority of children should crowd out of existence the more specialised studies traditionally engaged in by the most able. These specialised studies, whether of classics or science, of history, literature or modern languages, are felt by grammar school teachers to correspond both to the ingenium of their ablest pupils and to the contribution which those pupils can best make to society in later life. That highly specialised academic studies are not suitable even for a large number (perhaps a majority) of pupils in grammar schools would be readily acceded to by many of their teachers, but this admission, though it points the way to curriculum reform, strengthens the arithmetical argument against the multilateral, or at any rate the common school. According to this argument, a common school of sufficient size to render advanced and specialised instruction economic would be too big for humane administration. Conversely, the estimated ratio of 1:6 of 'grammar' to other 'types' would, in a school of normal size, make such instruction impossible. (Cf. 1 James 1947 a and b). The Ministry of Education circular 144 on 'Organisation of Secondary Education' recommends, for a suitable balance between different courses, 1,500 to 1,700 as the normal minimum population of a multilateral school (i.e. according to the Ministry's definition, 'one which is intended to provide for all the secondary education of all the children in a given area

and includes all three elements in clearly defined sides'. But it was this immensity, and the consequent tendency to impersonality of relationships within the school which deterred the Spens Committee and caused the Norwood Committee to regard secondary schools of combined types as experimental (1 Min 1939 pp.XX and 291; 1 Min. 1943 a. p.19).

(These considerations proved insufficient to discourage the London County Council from accepting the common multilateral school as the basis for its secondary provision and to prevent the Council's finding real merit in the very size of such schools).

It may be agreed that the multilateral secondary school has many advantages, both educational and social, to offer provided that (1) its establishment does not entail a reduction of educational facilities as compared with the single-type schools which already exist or might be provided, and (2) its size can be limited to a maximum consonant with real personality of relationships and community spirit.

One method which may achieve both these objects for a bilateral school appears in at least one County Development Plan: the method, meant to apply to a rural area with a town centre, divides the given area A, say, into two parts, a central area B and periphery. All the grammar school pupils from the whole area A and

the modern school pupils from the smaller area B are to be placed in one bilateral school at the centre, the numbers being arranged to be approximately equal. The additional modern schools required are to be placed in the peripheral area. By this compromise method of organisation, full grammar and modern school facilities corresponding to a given size of school can be provided in a bilateral school of twice the size. By a simple extension of this method, a three-type school with equal facilities and of three times the size of a single-type school can be organised. This may be contrasted with the ten-or eleven-form entry suggested as a normal minimum, including two technical and two grammar school streams in the Ministry of Education Circular 144.

The same effect will tend to be produced by any scheme which increases the availability of alternative courses within the school. Flexible arrangements making possible not merely a choice of streams but a choice of courses within each stream or the combination of courses from two or more streams may make available facilities that, with rigid streaming, could be provided only in a school several times larger. Furthermore, this principle of flexibility will apply to any secondary school which is large enough to have two or more parallel forms in each year, whatever its type-composition.

It may, perhaps, be claimed that on the organisation of workable schemes of the kind suggested rests not only the optimum use of the facilities of the individual school, but also the reconciliation of those who fear stratification to a system of grouping according to ability within the multilateral school. For classification according to ability in, say, language study may not coincide with a new ability-classification for science, while ability-groupings for aesthetic and practical activities are almost certain to differ considerably from those for the more verbal and analytical work. What flexibility and re-classification will not do, of course, is to increase the proportion of any given group of children who are capable of engaging in the most advanced study. Where capacity exists, however, a system of choice may make possible an alliance of interest and ability which would otherwise not occur.

As an illustration of what might be done by multiple classification, i.e. classification of the same pupils on two or more separate bases, let us assume that the children of one year in a school are divided on some one basis into three forms A, B, & C, and on another basis, without regard for the first grouping, into three 'sets' 1, 11 and 111. Let the children be in forms for one part of the week and in sets for the rest of the week. There will thus be three working groups (which we

will call 'classes') in being at any one time. The week's work will fall into two blocks of synchronised periods with courses corresponding to classes as follows :-

<u>FORM</u>	<u>COURSE.</u>	<u>SET.</u>	<u>COURSE.</u>
A.	a.	I.	1.
B.	b.	II.	2.
C.	c.	III.	3.

Let us suppose that the six courses a,b,c, 1,2,3 are all different, if not in subjects, at least in their treatment. Then the double classification makes possible the following nine choices for the total week's work.

a + 1,	a + 2,	a + 3,
b + 1,	b + 2,	b + 3,
c + 1,	c + 2,	c + 3,

Since we have assumed that these classes are working at any one time, three teachers only are required at a time, as when the pupils are taught always in forms.

This is only one possible arrangement. The numbers of classes and courses can be varied, nor is it necessary for the forms and sets to be equal in number, if staffing and accommodation permit an increase in the number of classes for a part of the week.

If a practical scheme can be worked out on these lines within the individual school, whatever its single or multiple type, the possibility of applying 'the multilateral idea' (1 Min.1939 p.XXXV) without large

numbers will become much more feasible.

The system of multiple classification just outlined is only an application to groups of subjects of the familiar 'setting' of single subjects. With the latter, however, the synchronised courses are all the same subject and the necessary synchronisation entails an equal expenditure of time by each class on each subject so 'setted'. This does not provide for as much variation of course from one group of pupils to another as does the former method. By increasing the number of periods within a synchronised block the number of subjects involved can be increased and variety of subjects, time-allowance, and treatment obtained. For example, in a Grammar School providing Classical, Scientific and Commercial courses the a, b, and c of the illustration above might form a block of 13 synchronised periods (i.e. 13 periods for each class, coinciding in time), with subjects and period-allotments as below:-

a. = Greek (5) Maths (4) General Science (4)

b = Maths (5) Physics (4) Chemistry (4)

c = Maths (4) General Science (4) Commercial Subjects (5)

These three courses presuppose three distinct interests in the pupils and hence three different approaches to the subjects put down. It will be observed that Latin has not been included in the classics course -

(a): the idea of that is to place Latin in some other course belonging to another block of synchronised periods,

and thus make it available to the non-classical pupils who take b or c.

These broad groupings will, it is suggested, yield a much closer correspondence between school studies and both interest and projected careers than is likely under a system of either distinct streams or single-subject sets. The heterogeneity of classes may be expected to be something between that obtained under the two other respective systems. Two definite advantages appear to lie in (1) the mixing of working groups and (2) making common interest at least a part-basis of grouping,

The questions still remain to be answered:

- (1) What school subjects go best together to form the various courses?
- (2) How are the abilities of secondary school pupils related to (a) individual subjects and (b) groups of subjects which might compose the various courses referred to in question (1)?and
- (3) How do these abilities develop as the pupils grow older?

On the answers to these questions there will depend the satisfactory organisation of the secondary school whether of single or multiple type, making possible the realisation of the 'four essential requirements' of 'any satisfactory plan for differentiating pupils', viz .

- (1) the 'early discovery of special abilities',
- (2) such discovery to be based upon 'skilled observation over a period of time',

- (3) 'room for the rectifying of errors of judgment or failure on the part of pupils to fulfil promise'

and

- (4) avoidance of rigidity and allowance 'within limits for individual choice'.

(1 Min.1943. a. page.16)

CHAPTER SUMMARY.

The educational aim of the optimum development of each individual is confronted by the fact of a divergence of needs which is both of degree and of kind. Different writers and official reports lay varying emphasis on the two aspects of the divergence, but there is general agreement that it is sufficiently great by the age of 11 plus to require variety in educational treatment, necessitating the existence of separate types of secondary school or of courses within secondary schools.

The problem of the classification of children for those different types of educational treatment has been complicated by the existence of conflicting opinions on the social implications of differentiation. The common secondary school has been represented as avoiding social and intellectual stratification, but has also been opposed as tending either to a reduction of academic standards or to an impersonality of relationships consequent upon its size.

It is possible, however, by an arrangement which does not include all the secondary pupils of an area in the same school, to institute bilateral or multilateral schools which offer wide facilities without excessive size. Tending to produce the same effect is any scheme of internal school organisation which is sufficiently flexible to allow a

wide choice of courses. Classification of the same children on two or more bases will make possible better ability-grouping. If the courses for which separate classifications are used each cover several subjects, variety both of studies and of time-allowance for the same study can be secured, making possible a closer correspondence of subjects to interests and projected careers. These advantages will apply irrespectively of the school's type.

If the best use is to be made of the multiple classification method of school organisation, it is necessary to know what subjects go best together to form the various courses and how the abilities of secondary school pupils are related to them.

The tendency of recent years to relate the aims of education more closely to the needs of individual pupils has been accompanied by the attempt to classify pupils more carefully according to ability or type and to plan for them a variety of courses, different in content and method, but equal in status. The need for reform in secondary education was not regarded by the Hadow, Spens and Norwood Committees merely as a need to select pupils more carefully for courses already existing and unquestioned; the existing courses themselves, with the best possible selection of pupils, were held to be largely out of keeping with the requirements of the pupils for whom they were intended (e.g. 1. Hon 1926 p.103; 1 Min.1939. pp. 141 to 146; 1 Min.1943. pp. 9 to 15).

Most of the criticism, both of official Committees and of private persons, has been directed against the grammar schools. This was to be expected, in view of the facts that these were the only schools catering for children from 11 to 16 and over, and that their well recognised status and traditions provided a clear target. That is not to say that the criticism has been unmerited. Also if the experience of the grammar schools is to be taken as any sort of guide for curriculum building in the new types of secondary school, the weakness as well as the strength of the grammar school structure must be sought.

In general the complaint has been that secondary education has been governed by considerations external to the child's own development. Teachers have, in fact, in one way or another imposed something upon the child rather than brought to fruition what was in him. The claims of subjects, of examinations, of 'the good of the school' and of 'the good of society' have been sometimes pressed to the oblivion of the claims of the individual child.

One does not need to accept these criticisms wholly and without question in order to give heed to the truth which they contain. The Norwood Report is appreciative of the aims self-imposed by the old established Grammar School (and accepted by the pre -1944 Secondary School) when it says (pp.6,7) 'The distinguishing feature of the Grammar School .. lies in the intellectual ideal which it upholds as best suited to a particular group of pupils ...the mind suited by a Grammar School curriculum is interested in learning for its own sake ... In considering what is appropriate the Grammar School has immediate regard for the full development of the mind of the pupil with which it is concerned and for the contribution which such a mind when developed can make to soecity ... Yet, though it is concerned to do justice to the kind of pupil committed to it, it realises that the whole personality cannot be expressed in terms of mind, and while carrying out its special responsibilities it discharges also

those duties to its pupils which it shares with other forms of education. It has believed that it fulfils its special responsibilities best in the interest of individual and society by introducing the pupil to the main departments of human thought and activity... In short, the Grammar School upholds an ideal of disciplined thought promoted by an introduction to the main fields of systematic knowledge, which is valued first for its own sake and later invoked to meet the needs of life'. The Report goes on to point out how during the present century the curriculum of the Grammar (or Secondary) School has broadened; starting with great emphasis on the more formal studies of Mathematics, Latin and French, it gradually included and gave growing importance to History, Geography, English and Natural Science, and finally found a place for Art, Music and Handicrafts; some of these schools have gone further and provided commercial courses in Shorthand, Typing and Book-keeping. But each school can supply only a selection from this variety. The Report can truly remark 'It is not easy to say what curriculum is typical of the Secondary School of today' (p.8)

It cannot, then, be said that the Grammar School has not made an effort both to fulfil its self-imposed task of providing systematic intellectual education in a widening field and to minister to its pupils' aesthetic and, sometimes, vocational needs. It might be added that a prominent place has also been given by many schools to religious and physical

education. Indeed, one of the criticisms often heard is that too much has been attempted, 'the curriculum is too diffuse in some directions and too narrow in others .. too many subjects are carried up to the same level ... the timetable is overcrowded and congested, and leaves too little time to consider and discuss the wide implications of the subject matter with a consequent limitation of the ability to think...' (Views quoted in the Spens Report p.145)'... the subjects themselves are too many, new subjects clamour for admission and are admitted, though fitted in with difficulty; the result is congestion of the time-table and confusion of aim, too much being attempted and too little being performed'. (Views quoted in the Norwood Report, p.10).

What is really called in question, what leads to the 'congestion' and 'confusion' is the traditional grammar school conception of education, not its sincere and often successful effort to express it in practice. It is its systematic and therefore frequently compartmental treatment of knowledge, its faith in the educative effect of imparting such systematised knowledge, and its readiness to accept the examinations of University Boards as suitable criteria for assessing the knowledge and therefore the education gained, that are assailed.

In the forefront of this conception stands the 'subject' the unit of systematic knowledge. The Spens Report refers

(pp.158,159) to the attack on 'subjects': 'Intellectual growth, it is urged, should be nourished not upon these dead materials docketed and classified in text-books, but by presenting the scholar with problematic situations to be dealt with by means of ideas and methods which may now have the historical character, now the mathematical, now the physical or biological. These ideas and methods are to be acquired as the need for them emerges, without reference to the logical categories to which they belong.' The Committee find this view, however, not wholly acceptable. While favouring the 'project' and 'problem' methods they cannot place their whole reliance upon these because they do in fact adhere to what has been described above as the grammar school conception of education. They declare the 'essence' of their 'general doctrine' to be 'that the school "subjects" stand for traditions of practical, aesthetic and intellectual activity, each having its own distinctive individuality; and we hold that the profit a pupil derives from them does not come from casual or episodic contacts, but by his being, so to speak, put to school to them, and so getting to make their outstanding characters part of the equipment and habit of his mind. If this is to happen, the subjects must be pursued as such.....'

The Council for Curriculum Reform in their Interim Report 'The Content of Education' (pp. 44,45) quote the above passage and acknowledge the existence of 'subjects'

in this sense and the profit 'both to individuals and society' to be gained by their study, but assert 'that they exist in this sense only if the full range of such a study up to at any rate University degree standard be understood.For those children who are going on to such higher study we agree that the study of subjects as such should emerge from the general studies of the school at a particular point... But the implication that the general body of secondary students can become in any real sense scientists, historians, or linguists seems to us fantastic'.

The Norwood Report refers (p.61) to 'a tendency to regard subjects as having claims in their own right both absolutely and in relation to others without real regard for the supreme consideration, which is the special needs and special aptitudes and abilities of the pupils themselves'.

Again Mr.H.L.Jacks writes ('Total Education', p.72) 'Education, indeed, has become subject-ridden, now have we paused enough to ask ourselves exactly what we mean by a "subject" or wherein this differs from our object'. He deprecates the 'mere juggling with subjects' in an effort to produce the good worker, the good citizen or the good man. What is required is a 'whole experience' which means to him 'to enable children to correlate in an individual whole all their experiences in study, in recreation, in a common life, and in the realms of the spirit; to cultivate in them

single-mindedness, as well as like-mindedness and open-mindedness: to present to them the knowledge of material, moral and spiritual things as one and not as three; to inform their education with coherence and continuity - from subject to subject, from work to play, from class to class, from school to school, and from school to work...'. What is needed, in other words, is an integration which has both its external and internal aspect. All the experiences which are presented to the child should appear relevant to each other and also relevant to the child's own expanding awareness both of his environment and of his own need to be related to it. In this process of integration the forging of links between subjects may be a beginning, but only a beginning; it is not an end in itself.

The danger of a narrow conception of curricular-integration being accepted with forgetfulness of its purpose in terms of the up-building of personality, is noted by the Norwood Committee who 'think it difficult to find any principle of what is called integrating the curriculum if it is to take place round a subject or a group of subjects, still less round a single idea' (Norwood Report, p.61). (Evidently this Committee disagrees with the authors of the Spens Report, who say, (p.173) '...For the majority of pupils we think that the school itself

should adopt a unifying principle in its curriculum, and we recommend that it be found in the teaching of English and that assembly of subjects which are often loosely spoken of as the English subjects'). The Norwood Committee continue their comment thus: 'If anything is to be integrated, it is not the curriculum that must be integrated, but the personality of the child, and this can be brought about, not by adjustment of subjects as such, but by the realisation of his purpose as a human being, which in turn can be brought about only by contact, with minds conscious of a purpose for him' (p.61).

Now it is precisely this integration of the personality of the child, this 'realisation of his purpose as a human being', which the public schools and grammar schools would claim as the ideal which they have always set before themselves. They would, further, claim to have sought to achieve this 'in and through active membership of a society' (Norwood Report p.VIII). And this 'purpose as a human being' has been held to find expression in a 'good life' which has sought 'the good of the school' and 'the good of society' through service. It can be said that this idealism has been an imposition on the boys and girls educated under its influence, and this is true in the sense that the idealism has come 'from above' rather than being a natural outgrowth of the pupils' own development. But if the whole conception

of the proper development of the young personality (i.e. a selective development - cf Norwood Report, p.VIII) and its fruition in the good life is bound up in a certain pattern of attitudes and relationships, the teachers who hold this conception would, in their own eyes, fail in their duty if they did not seek to impose this pattern upon their pupils.

This ideal of the individual good life achieved through service of the communal good has held sway alongside the rule of subjects. It is doubtful, however, how much the intellectual discipline of subjects has contributed to the wider purpose. The latter day criticism that the Grammar School's curriculum is unsuited to the needs of many of its pupils and that struggle and frustration result from its use (aggravated by external examinations) strongly suggests that curriculum-arrangements which do not correspond to pupils' needs will tend to undo the good effect of other aspects of school life. And one way to break the tyranny of subjects might be to remove, where practicable, the barriers between them; to allow them such an inter-penetration and mutual interpretation as will correspond more closely to the unanalysed concrete experience of the child. The Norwood Committee, though finding no single principle of curriculum-integration, nevertheless deplore the 'specialist minds' created by 'specialist

claims' and advocate the 'more careful tilling' of the 'common ground' of subjects, which 'is the seed-bed of sound learning' (Report pp.52, 64).

This idea of curriculum-integration is not without support in many quarters. Mr.P.H.Rooney puts the case thus: '....the next task before the headmasters and staffs involves a change of outlook based on the conception of the curriculum as a unity, or at least as a number of simple unities welding into intelligible wholes the existing masses of unrelated material ... Psychology asserts roundly that the best education is the one which gives the power to see most relations between things, and the best mind is the one which has the power to reduce these relations to the fewest general principles. It is true that we cannot create that power where it does not exist, but we can provide conditions in which it may flourish. The curriculum as it stands... is an open invitation to the child to develop a "compartmental mind". (E. Rooney 1944 quoted by J. Jacks 1946, p.76). Again, the 1944 Report on 'The Post Primary School Curriculum' issued in New Zealand by the Thomas Committee, asserts (p.11), that 'The course of any pupil viewed as a whole, should have a measure of unity, and within that unity there should be even more closely integrated subordinate unities'. In 1926 Dr.E.G.Sleight wrote 'The curriculum may also suffer considerably owing to the absence of a proper co-ordination

of the various subjects. We aim at a very remote and inaccessible ideal in trying to produce in our pupils unity of thought; none the less it is necessary to work in that direction. Growing unity of purpose may lead to some degree of thought unity, and the curriculum should be framed to further both ends'. (1 Sleight 1926,p.107).

The usual form taken by proposals for integrating the curriculum has been that closely related subjects should be combined into 'areas of study', five or six of these areas or a selection from each forming a basic course or 'core', to be supplemented by other areas or single subjects giving scope for individual choice and known as 'options', or 'periphery'. 'The core of the curriculum is that minimum content which it is necessary for everyone to have in order to be able to live a satisfactory life in a modern society. The periphery contains the rest. Some of this may be common to groups who are to follow the same or similar occupations; some of it is the field in which personal interests develop... The basic minimum will be the native language, mathematics, the natural sciences, and the social sciences... health education...nutrition...physical training... creative and aesthetic activities...social and moral education'. (1 Curriculum Reform, 1945, pp..17,19,20).

The core-and-options curriculum is implicitly approved in the Spens Report (pp.151,173). It affirms

its authors' belief (already noted) that the English subjects should supply the unifying principle the absence of which is 'the principal weakness of the secondary curriculum' (a belief which is nullified by the Report's devotion to 'subjects' according to the Council for Curriculum Reform, who sadly remark 'the apple turns out to be an orange, segments but no core' (1 Curriculum Reform, 1945, p.46). The Report goes on to recommend (p.157) for (presumably all) adolescents 'religious and moral teaching and training in the care of health, bodily efficiency and grace, manners and social organisation', to which it adds (1) Letters, that is the use and appreciation of language, including at least some study of the native literature; (II) some forms of Art, including Music, the most universal of the Arts; (III) Handicrafts, taught with emphasis either on the aesthetic aspect, as in weaving, carving, handwriting, or on the constructional aspect, as in carpentry and needlecraft; (IV) Science, including mathematics as the science of number, time and space. To these must be added History and Geography.'

Jacks suggests six main 'areas of activity' as the basis of the curriculum: (1) physical; (2) social - through 'the arts of expression' and 'an active responsibility for the common good'; (3) imaginative - literature, art; (4) creative; (5) scientific; (6) spiritual (1 Jacks 1946, p.81).

Dr.F.C.Happold describes his own conception of

Basic Culture, which he has used as the foundation of his curriculum at Bishop Wordsworth's School, as divided into five elements.

1. Social studies, the introduction of the boy to his heritage and environment, a synthesis of history, geography, economics and sociology.
2. Aesthetics, those studies with a definite emotional and aesthetic appeal, including literature, and drama, art and music.
3. Science, a synthesis of biology, chemistry, physics, astronomy and geology, designed to enable a boy to appreciate life processes and understand the scientific world in which he lives.
4. Handwork, essential for all for its intrinsic value and also as a corrective to the tendency to over-emphasize the intellectual.
5. Language study, the study of at least one language other than one's own.

At the stage of Basic Culture their content was conceived as limited in scope, something less than and different from the existing general course up to School Certificate. Super-imposed and dependent on this foundation course of Basic Culture, studies carried to a higher stage were envisaged, varying according to the special aptitudes of different boys, literary and linguistic, mathematical and scientific, artistic and manual' (1 Happold 1943, pp.59,60).

Further support for the core-and-options scheme might be quoted from Miss Catherine Fletcher (Report of the Annual Conference of the English New Education Fellowship, 1945), Miss Olive A. Wheeler ('Times Educational Supplement', 19th February, 1944) and the New Zealand Thomas Report (1944), which makes it the basis of a proposed reorganisation of the Dominion's school Certification system.

Again, the necessity for the adaptability of the curriculum to the child, suggesting that the core itself should not be too rigidly conceived, has been expressed. As Dr. F. H. Earle has written (1 Earle 1944, p.97), 'The fundamental question in every school is, not whether the study of any subject... is cultural or useful or beneficial to human beings in general, but whether it is so, in deed, for the individuals who, here and now, present themselves for instruction'.

Hence, whatever organisation is established it must be such as to envisage variation within itself. As to his 'fundamental question' raised in the quotation given above, Earle says, 'there is, admittedly, a fairly constant general answer on broad lines, but the view urged here is that the actual answers must vary from school to school and even from year to year. This implies a much more flexible organisation than any we have yet contemplated. Provision must be made for each pupil to choose, with guidance, a programme of work which will, at one and the same time :-

- (1) enable him to derive from it many valuable and essential 'liberalising' influences;
- (2) give scope for the development of special talents and abilities;
- (3) make use of the incentive natural at this stage of development.

.....We must allow for the fact that the individual is not equally apt in all forms of activity.' (1 Earle 1944, p.97).

The Spens Report speaks of 'differences in aptitude' justifying a choice between subjects, and refers to those pupils who suffer from 'a "blind spot" which prevents them from gaining any good from some particular form of instruction' (p.157). To put the point positively, a wide field of choice may enable a pupil to find just that activity which will enable him to experience greater achievement than will any other. As Jacks says in 'Total Education' (p.65), 'The greater the variety in our curricula, in our repertoire of games, and in our hobbies and societies, the greater will be the chance of every child finding something that he can do well and thus banishing that diffidence which curses the life of so many adolescents'. If an educator is one who helps people who are immature to realize their potentialities' (1 Stanley 1945, p.26) he will surely seek to maximise the concurrence of ability and interest, and will plan accordingly. (Cf 1 Pinsent 1944, 1. Jeffreys 1946, 1 Hardman 1947).

The emergence of special abilities and interests may be expected to take time, and to require prolonged observation by his teachers to discover any pupil's real bent. It has been suggested in the Spens (p.182) and Norwood (p.18) Reports and elsewhere that the period from 11+ to 13+ should be regarded as this period of diagnosis. After that stage the optional activities should come more to the fore. 'These optional studies may mean further work in any one of the fields already mentioned (i.e. the native language, mathematics, the natural sciences, and the social sciences, health education and creative and aesthetic activities).. It is clear that this specialisation will increase with the years and that the common core will decrease, but the latter should never entirely disappear' (1 Curriculum Reform, 1945, p.20).

On the other hand the options chosen by any pupil may represent a distinct break with his previous studies, and may only serve to give variety and personal interest to his course without ever dominating it.

Perhaps more important than the provision of many different subjects is the provision of different courses in the same subjects. These courses will require to differ in time-allowance, in syllabus and in treatment (cf. l. Ballard, 1936, p.37; 1 Curriculum Reform 1945, p.48; 1 Ministry, 1947b). In order to avoid a stereotyping of the curriculum and the imposition of an unnecessary

uniformity upon the pupils, both the Ministry's Pamphlet No.9. on 'Secondary Education' (1947) and the earlier Norwood Report (p.78) contemplate the occasional dropping and resumption of a subject. This might be done with advantage where continuity of treatment is not essential (as it is for example to foreign languages) and where such a break makes possible an organisation giving greater flexibility and more scope for choice.

By these means it may be possible to relate the education to the child as to make all his activities coherent and significant to him both as an individual and as a member of a community.

It is obviously with such aims as these in view that the various suggestions have been made for the content of a basic course, supplemented by options. The need, discussed in Chapter 1, for grouping subjects into alternative courses, each occupying a part of the available class-time, in order to allow for flexibility of classification, finds an ally in the need to group related studies into subject areas.

What still needs to be known, for the purpose of efficient organisation and of a fuller understanding of the child is how the developing abilities, interests and aptitudes of adolescents correspond to the various areas of study and activity. If it be proposed, for example, to link mathematics and some branches of natural science

into one synthesis, it is well to know whether there is any psychological predisposition on the part of the pupils to accept such a grouping. If, also, two or three different treatments of a given study-area be contemplated, there will be an advantage in knowing whether the difference of degree of the pupil's abilities in this area are simply explicable in terms of general ability or whether some distinctive mental factor seems to be operative in this field. In short, the examination of the findings of research into the relations between scholastic abilities may be of great help in organising the curriculum to give both flexibility and coherence.

CHAPTER SUMMARY.

The search for better methods of classifying pupils for different secondary school courses has been accompanied by the attempt to improve the courses themselves. This attempt has arisen largely out of the conviction that the existing curriculum, or at any rate its treatment, in the grammar schools was inappropriate to a great many of the pupils of those schools, and still more in need of revision if it was to serve as a guide for curriculum making in the new types of secondary school now coming into being.

While strongly imbued with the sense of educating 'the whole man' and of training in habits of communal service, the grammar schools have taken a view of adolescent education which is over-intellectual. Their attempt to accommodate their range of subjects to the growing requirements of their pupils has led to congestion of the time-table.

The 'subject', while defended by the Spens Committee, has been attacked from many quarters, and the demand has frequently been made that barriers between subjects should be broken down and that 'subject-areas' of wide scope should be built up. Views differ as to the degree of integration possible or desirable within the curriculum. While retaining the traditional subject divisions, the Spens Committee were in favour of emphasising the applications from one field to others (p.160) and recommended the unification of the

curriculum about a central core, for which the English subjects should serve. The Norwood Committee, also approving mutual interpretation of subjects, failed to find any single principle of curriculum-unification, and stressed the fact that the important thing to integrate was the personality of the child.

Certain writers have advocated the construction of a basic course or core composed of subject areas covering the main fields of human thought and action, to be supplemented by optional studies. The adoption of such a plan necessitates great flexibility of organisation. The options might consist of further study in some area already treated less intensively as part of the basic course, or they might be entirely new subjects. In any case, varied treatment of the same subject-area for different groups of pupils appears to be desirable, involving variation of time-allowance and syllabus.

However, this course may be arranged, to each pupil it should be coherent and should be relevant both to his personal needs and to those of the community.

The considerable agreement shown among official and unofficial bodies and individual educationists on the nature of the basic subject-areas goes far to determine the contents of the synchronised courses suggested in Chapter 1. The investigation of the relations between scholastic abilities will show what psychological support

there may be for the subject-groupings which
have been suggested.

PART 2. STATISTICAL EVIDENCE AND ITS INTERPRETATION.

CHAPTER 3. Factor Theory.

It is generally agreed that the classification of secondary school pupils should take account of aptitudes and interests as well as general ability. A conception which may be more apposite and fruitful than that of a single general ability is that of several distinct abilities or ability-factors possessed in different degrees by each individual. These abilities, it is suggested, may be distinct in the sense of appearing in different individuals in such various relative strengths as to suggest no correlation between them from one individual to another. This would not preclude their overlapping in function and thus producing general correlation between performances. Moreover, since any activity is likely to express sentiments, appetites and strivings as well as the mere capacity to perform, these several abilities may be complex structures containing affective and conative as well as cognitive elements.

It may be helpful to consider the hypothesis that such a pattern of broad abilities is possessed by each child, and that each ability tends to be associated with a particular group of activities. The findings of the relevant research

must be reviewed in order to decide whether, and if so in what form, this hypothesis is tenable.

The investigation of the relations between abilities has usually taken the form of an analysis of test-performances. The correlations between test-scores have been computed and these have been examined to discover what linkages between tests might be revealed.

Early investigators such as J. McK. Cattell (3 Cattell 1890) C. Wissler (3 Wissler 1901) and H. A. Aikens and E. L. Thorndike (3 Aikens and Thorndike 1902) applied mental tests to students and found but slight correlation between them, though Wissler found considerable correlation (.30 to .75) between the different subjects of his testees' college course. Professor Charles Spearman, considering college students to form too homogeneous a group to exhibit a wide scatter of intelligence-ratings, worked with groups of school children. In 1904 he produced his momentous paper 'General Intelligence Objectively Determined and Measured', in which he declared his discovery of 'hierarchical order' in his tables of correlation coefficients. This he interpreted as being due to the different tests being saturated to different degrees with one General Factor, which was the source of all correlation between the tests, except such as might be engendered by close similarities of form or content. The degree of independence of each test was represented by its degree of saturation with a

specific factor pertaining to the ability^{*} tested by that particular test but no other test of the battery.

This theory was contested by Thorndike, who was so struck by the apparent absence of any factor common to all of our tests that he wrote in 1909 'One is almost tempted to replace Spearman's statement by the equally extreme one that there is nothing whatever common to all mental functions or to any part of them.' (3 Thorndike 190, p. 218). This view was modified later, however. Although in his 'Principles of Psychology' he had regarded the mind as an aggregate of countless particular capacities, partly independent, and requiring to be separately trained, in 1910 he put forward the view that there were three levels of mental activity making for differences of correlation between different types of ability ('Illustrations of Psychology' p. 191). His three levels were characterized by sensitivity, association and an lyric (or dissociation): performances belonging to the same level would inter-correlate more highly than performances belonging to different levels. The higher correlations of performances of the same level were regarded as being due to their 'similarity, not of 'content' or material, but of 'form' or activity.

* The word 'ability' is here used to refer to the narrow range of functions called into play by each particular test.

Sir Cyril Burt's early work, as he himself says, 'was chiefly directed towards showing that the "highest common factor was exhibited", not only (and not most clearly) in the simple sensory processes, such as Cattell and Spearman had tested, but also (and still more clearly) " in the more complex mental processes, especially those demanding logical thought" ' (2 Burt 1940, footnote p.4.). His tests applied to schoolboys led him to report the apparently large part played by attention in the application of intelligence, and concluded '... it is one feature or function of attentive consciousness in particular which forms the basis of Intelligence -- namely, the power of readjustment to relatively novel situations by organising new psycho-physical co-ordinations' (3 Burt 1909, p.168).

Spearman and his associates continued to develop the theme of Two Factors, seeking both to clarify the presentation of their theory and to devise ever more rigorous tests of its validity. In their paper on 'General Ability, its Existence and Nature' (1912) Hart and Spearman stated (p.79) that 'all the facts indicate unanimously, that the correlation arises through all the performances, however different, depending partly on a General Common Factor.... The fact of correlation existing between quite different intellectual performances seems to be fundamentally identical with the fact that

any such performance inhibits quite different simultaneous ones. Both phenomena are explicable by conceiving that every performance depends partly on some common fund of energy. This, then, is the required 'General Factor'. And, as if replying to Kurt's conclusion quoted above, they added 'Explanation by "attention" seems inadequate'.

In this and several subsequent works Spearman gave tests of the existence of one general factor in a battery of tests. As a deduction from Yule's formula for partial correlation

$$r_{ab.g} = \frac{r_{ab} - r_{ag} \cdot r_{bg}}{\sqrt{\{(1-r_{ag}^2)(1-r_{bg}^2)\}}}, \dots (1) \text{ (Yule 1898)}$$

if a and b are uncorrelated apart from g, $r_{ab.g} = 0$

and hence $r_{ab} = r_{ag} \cdot r_{bg}$, ----- (2)

whence for any four tests' abilities a, b, c, and d

$$\frac{r_{ab}}{r_{ac}} = \frac{r_{bd}}{r_{cd}} \text{ ----- (3)}$$

or $r_{ab} \cdot r_{cd} - r_{ac} \cdot r_{bd} = 0$ ----- (4)

The left side of equation (4) being termed the 'tetrad difference' or simply 'tetrad', this equation is sometimes called 'the tetrad equation' and, when used to test the existence of a single factor common to all the tests, 'the tetrad criterion'.

The liability of the correlations to 'sampling error' rendered necessary some test of the closeness of satisfaction of the tetrad criterion which might show the existence of a 'g'. This test was provided in various forms by Spearman, working with Hart and Holzinger. In their 1912 paper Hart and Spearman proposed the correlation of columns of the matrix of correlations derived from a battery of tests. In later works (e.g.2 Spearman 1925 and 1927 b Appendix) two other criteria were put forward, namely, the standard error of the individual tetrad difference and that of the entire distribution of tetrad differences derived from the correlation matrix. Spearman recommended in 'The Abilities of Man' that the histogram of tetrad differences should be compared with a normal distribution of the same area and standard error (op.cit.pp. 142 - 149).

These techniques were used by various workers to test the existence of g. Brown had, in 1910, applied psychological tests to six groups of school boys and girls and college students and had failed to find hierarchical order (3 Brown 1910, p.313). Hart and Spearman worked over the data of Brown, Thorndike and other investigators, claiming that their inter-columnar method showed support for the Two Factor Theory (2 Spearman 1912). Twenty years later, Brown applied the criterion of the standard error of all the tetrad differences to some of his 1910 results (for boys between 11 and 16) and came to the conclusion that they did, in fact, 'support the existence of a central intellectual factor (g)' (2 Brown 1932,

p.174).

While during this period some workers were obtaining results which satisfied one or other of the two-factor criteria, others were finding it impossible to account for their results without postulating factors linking groups of tests, some factors being so extensive as to amount almost to additional general factors.

An arithmetical or number factor (n) was reported in several studies (e.g. 3 Collar 1920 and 3 Rogers 1923) while a verbal factor (v) appeared in others (e.g. 2 Kelley 1928 and 3 Stephenson 1931 a,b,c.). Dr. A.D. Alexander found evidence of both n and v as well as a perceptual factor (F) (3 Alexander 1935). A space-perception factor (K) was found by Brown and Stephenson and others (2 Brown and Stephenson 1933 and, e.g. 3 Housai 1935 and 3 Smith 1937), F.J.J. Wise suggesting that F and K were identical (3 Wise 1940). Other investigators reported the existence of general factors other than g, such as perseveration (P) and Oscillation (O) representing respectively 'the inertia and the variability in rate of use of the basic mental energy' (which rate, rather than the energy itself, was suggested by Spearman in 1931 as constituting g - 2, p.154) and factors of Will, Temperament, Cleverness and Purpose (e.g. 3 Hebb 1915, 2 Cattell 1919, 3 Cattell 1933, 3 Managon 1933, 2 Heyburn and Dyer 1939).

The coming into prominence of group factors was assisted by the work of Thomson. By means of artificial experiments with playing cards and dice he constructed 'test' scores which were the results of pre-arranged overlapping group factors, and was able to show that the various Spearman criteria could all be satisfied without a g (2 Thomson 1916, 1920, 1927). He also produced a theory of his own which was bound (in spite of Thomson's own denial) to appear as a rival to Spearman's theory. Thomson's Sampling Theory conceived the function of a test to be that of sampling innumerable bonds in the testee's mind; different tests made different selections of mental bonds; positive correlation between tests could be accounted for by the overlap of their selections of bonds; negative correlation could be accounted for only by postulating negative bonds or interference factors in the mind.

The existence of grades of difference between correlation coefficients (whether truly equal or not) would, Thomson considered, render inevitable a tendency to the possibility of hierarchical arrangement. The fact that correlation coefficients do not, in practice, tend to zero but are usually positive, was taken to imply 'that interference factors among the mental bonds' are in the minority' (4 Brown and Thomson 1925 pp. 198, 199).

With this view of mental functioning, Thomson was inclined to favour a group-factor interpretation of abilities and to cast doubt not only upon the general factor but also upon any postulation of group factors which seemed to have only a mathematical basis: the same measurable result could be obtained from an infinity of causes. (2 Thomson and others 1924; 2 Thomson 1935 a, b,). Psychological evidence must be called in to support the mathematical. It was the absence of group factors which was, to Thomson, 'the crux of Professor Spearman's theory' (4 Brown and Thomson 1925, p.189) (Cf. 2 Thomson 1927a, p.235).

Spearman's reply (2 Spearman 1927a) was to the effect that , on the contrary, his school could 'claim to have originally discovered group factors', but that none 'of appreciable magnitude' could exist when the tetrad criterion was satisfied. As to the possibility of a large number of overlapping group factors operating rather than one general factor, Spearman asserted that both might co-exist and referred to the possible composite nature of g itself which had been noted in his very first paper on the subject (2 Spearman 1904) and repeated later (2 Spearman 1912)¹/₂

In his 'The Abilities of Man' of the same year (1927) Spearman gave a technique for calculating 'specific correlation' i.e. the correlation of two tests due to

factors other than g , by means of 'reference values', i.e. correlations of the tests concerned with other tests 'distinct from each other as also from the pair under comparison' except through the mediation of g . (2 Spearman 1927 b, p.223 and Appendix p.XVI.)

The time was ripe, by the fourth decade of the century, for the formulation of an entirely new approach to the problem of mental factors. This was given in a geometrical conception in which test scores were seen as vectors drawn from a point in generalised space; the factors were axes and the factor loadings the projections of unit test-vectors on the axes. The configuration of axes varied from one method of analysis to another. With Hotelling n tests were referred to n 'principal axes' of symmetry (4 Hotelling 1933 and 4 Thomson 1939 chapter V). Thurstone chose v common-factor axes and n specific-factor axes for n tests (2 Thurstone 1935 and 4 Thomson 1939, chapters II, X, XVI, and XVIII.); thus Spearman's two-factor conception is a special case of Thurstone's, with $v = 1$ and all axes orthogonal.

For $v + s$ orthogonal axes the relations between individual ability-measures, factor-loadings and individual factor-measures are given in matrix notation by

$$M = LF \dots \dots \dots (5)$$

where $M = n \times N$ matrix of ability-measures in n tests for N individuals,

$L = n \times (v + n)$ matrix of loadings of n tests with
 $(v + n)$ factors.

$F = (v + n) \times N$ matrix of factor-measures in $(v + n)$
factors for N individuals;

and, since the factor-loadings are direction-cosines,

$$\begin{aligned} l_{11}^2 + l_{12}^2 + \dots + l_{1(v+n)}^2 &= 1 \\ l_{21}^2 + l_{22}^2 + \dots + l_{2(v+n)}^2 &= 1 \\ &\dots \dots \dots (6) \end{aligned}$$

etc. to

$$l_{n1}^2 + l_{n2}^2 + \dots + l_{n(v+n)}^2 = 1$$

where $l_{i.j}$ = loading of test of ability i with factor j .

(Cf. L. Somerville 1929 p.76 equation (7.1))

If the first v factors are the common factors (for which some of the l 's may be zero) the remaining n factors will be specific and therefore for each element of the matrix L all but one of the l 's corresponding to these n factors must be zero.

The correlation of the tests of abilities a and b is given by

$$Corr_{ab} = l_{a1} l_{b1} + l_{a2} l_{b2} + \dots + l_{av} l_{bv} \dots \dots (7)$$

regarding the first v factors as the common factors.

This equation interprets the correlation coefficient as the cosine of the angle between the two test-vectors concerned.

(Cf. L. Somerville 1929. p.76. equation (7.2).)

Thurstone's technique of computation is an extension of a method used earlier in a study by Sir Cyril Burt (3 Burt 1917). What he does, in effect, is to treat his matrix of correlations as a series of superimposed hierarchies, extracting one general factor after another until no more significant factor loadings remain. Since each common-factor axis passes through an average or centroid position of a system of unit vectors corresponding, first, to the given correlations, then to the subsequent residuals, Thurstone calls this method the 'Centroid Method'.

As essential supplementary part of Thurstone's technique is to rotate the reference frame of common-factor axes into psychologically meaningful positions. He rejected Hotelling's method because (1) it leads necessarily to negative loadings, (2) its 'principal axes' are frequently difficult to interpret psychologically, and (3) an alteration in the battery alters the position of the axes (3 Thurstone 1938, pp.90, 91.) Thurstone seeks a configuration of common-factor axes which gives positive or zero loadings; he keeps it orthogonal unless psychological interpretation necessitates that the axes should be oblique. His ideal of all positive loadings with at least one zero for each test he calls 'simple structure'. (2 Thurstone 1935 p.p.151, 154 and 3 Thurstone 1938 pp.8, 10, 71, 73).

The most extensive application of this method (or,

indeed, of any method of factor analysis) is described in Thurstone's 'Primary Mental Abilities' (1938). 57 psychological tests were applied to 240 students, who, apart from sixteen who were over 25, ranged in age from 16 to 25. Rejecting as insignificant all factors having loadings less than .40, Thurstone found no general factor but the following group factors:

S (visual or spatial) in 13 tests - influence noted on Syllogisms about relative ages and on Verbal Classification

P (perceptual) in 9 tests -- 'a facility in perceiving detail that is embedded in irrelevant material' (p.81);

N (number) in 8 tests -- 'Occasionally this ability is found to be extremely conspicuous even at an early age, and it seems then to be more or less independent of other abilities ... Of interest for this problem is the frequent occurrence of considerable mental ability in the verbal factors combined with what seems to be a blind spot for numerical and logical relations' (p.83);

V (verbal relations) in 13 tests -- 'concerned with ideas and meanings' (p.85);

W (words) in 6 tests - 'fluency in dealing with (single and isolated) words' (p.84);

M (memory) in 5 tests;

I (distinguishing a rule or principle for each item of a test) in 5 tests .. Number Series most highly saturated with I;

R (restrictive problem factor) in 7 tests .. highest saturation in Arithmetical Reasoning;

D (deduction) in 4 tests .. highest saturation in False Premises and Reasoning.

Thurstone thus claims to have evolved a technique capable of demonstrating the existence of any pattern of mental factors and to have established, by its use, nine primary abilities (of which S, N and V were already universally accepted). The factorists of Spearman's school claim to possess in the tetrad criterion and the partialling formula of Yule an analytical method which not only makes plain the dominance of the central intellectual energy but also illustrates by its discovery of group factors the specific uses to which this energy may be put. But Burt, though accepting the factors, will not agree with their interpretation by either Thurstone or the Spearman group; he says of factors '..they are not "primary abilities" , "unitary traits", "mental powers or energies". They are principles of classification described by selective operators.' (2 Burt 1940, p.227) To him 'Factors specify not unitary qualities but systematic patterns; not active entities, but relations between what we loosely call the mind and what we vaguely call its environment; i.e. they specify systems of relations between two sets of relational systems'. (op.cit.p.251). Thomson in 1949 wrote ' I myself lean at the moment more towards Spearman's

g and his later group factors than I do to Thurstone's, since they seem to me more in accord with the ideas of my own Sampling Theory. On that theory g is as it were the whole mind, and tests are part of g, not g part of the tests. And were that mind entirely undifferentiated, structureless, g would be the only factor we need. As the complexity of the mind, and the complexity of the upper brain, is organised (partly by the maturing of hereditary bonds, mainly I fancy by education and life) and intergrated into "pools", "clusters", call them what you will, so additional factors, additional descriptive coefficients, are needed. It seems to me at present wise to retain one coefficient to express the general depth starting from which the integration, the deepening into subpools, has gone on. But I am not sure, and think the wiser course is to await further papers from workers in Thurstone's school'.

(2 Thomson and others 1939, p.106).

It may be concluded, then, that despite the rivalry of several factor-conceptions and the existence of numerous methods of analysis, there is a general tendency to regard test-performances as related to one another in distinctive groups. The overall linkage attributable to one general factor is a matter of dispute, though the idea of the 'central intellective g' is suggestive as the starting point of mental development.

That this development requires the postulation of group factors is agreed. The hypothesis of several broad abilities each associated with a particular group of activities may be considered to receive general support from the more fundamental ability-research. It seems not unlikely, then, that such abilities will be found in related groups of scholastic studies.

CHAPTER SUMMARY.

The hypothesis of several distinct abilities, rather than a single general ability, possessed by secondary school children, should be examined. If it could be established that such abilities exist and that they are associated each with some recognisable branch of school activity, this would clarify both the classification of pupils and the arrangement of school subjects in psychologically linked groups.

In 1904 Spearman announced his Theory of The Factors, which has been the subject of much experiment, several different criteria, and considerable controversy. According to this Theory, correlation between tests exists as a result of one and only one factor common to them -- the general factor g . It was soon discovered that g needed to be supplemented by group factors common to some, but not all, of the tests of a given battery.

Various investigators now began to report their findings of group factors, such as the number factor (n) the verbal factor (v), the practical factor (P), the space perception factor (K), and character and temperament factors (W and C), as well as new general factors of perseveration (P) and oscillation (O).

Thomson showed by artificial experiments that the 'hierarchical Order' of correlation coefficients, which was supposed to demonstrate the operation of a single common, general, factor, was obtainable through the existence of several overlapping group factors. His own conception of mental activity was expressed in his Sampling Theory.

A new technique of factor analysis, based on a geometrical interpretation of factors and using a method of computation due to Burt, appeared about 1930. The best known, and perhaps the most effective, form of this new technique was evolved by Thurstone. Thurstone's method makes no assumptions as to the generality or restriction of factors, but seeks to establish a 'simple structure' of factor-axes, if possible orthogonal, avoiding negative loadings and maximising the number of zero loadings. Thurstone has used his method in a very extensive research to find the number, verbal and space-perception and six other group factors.

Different factorists maintain different conceptions of factors. While Thurstone speaks in terms of primary abilities, Spearman's school refers to mental energy whose central fund is g and whose avenues of dissipation are the specific and grouped abilities corresponding to specific and group factors. Thomson regards g as the

'general depth' of the mind from which integration into 'subpools' is developed, largely by experience. Burt insists that factors are not concrete entities but principles of classification useful to signify patterns of relations between mind and environment.

However conceptions may vary, it seems fair to say that the general tenor of ability-research has been such as to support the hypothesis of broad abilities associated with particular groups of activities.

The purpose of the present chapter is to review British investigations of scholastic abilities in order to see what evidence they afford of the psychological linkage of subjects. Reference will be made to the investigations which have the following bibliography references: 2 Spearman 1904, 3 Webb 1915, 3 Carey 1915 and 1916, 2 Garnett 1919, 3 Burt 1917, 3 Burt 1939, 1 Burt 1943, 3 Stead 1926, 3 Wilson 1933, 3 Russell 1934, 3 Earle 1936, 3 Ormiston 1939. In addition, some correlations based on 1941 School Certificate results, kindly supplied by Mr. A. J. Moakes of St. Paul's School, will be noted. A further investigation will be newly reported in the next chapter.

A full description of each of these researches does not seem to be necessary, nor would treatment in chronological order be most appropriate. The reports will simply be drawn upon to state special findings or to illustrate points of argument.

In the very paper in which he first proposed the Theory of Two Factors, Spearman illustrated the hierarchical order of correlation coefficients by quoting results which he had obtained by testing the pitch discrimination of twenty-three preparatory school boys of 9.5 to 13.7 and

correlating the results with those of the boys' school examinations. When the school marks were also correlated among themselves, the following results were obtained ;

TABLE 1. SPEARMAN, CORRELATIONS.

	1.	2.	3.	4.	5.	6.
1. Classics		.83	.78	.70	.66	.63
2. French	.83		.67	.67	.65	.57
3. English	.78	.67		.64	.54	.51
4. Maths	.70	.67	.64		.45	.51
5. Pitch	.66	.65	.54	.45		.40
6. Music	.63	.57	.51	.51	.40	

The order of the subjects is, on Spearman's theory, the order of decreasing saturation with g and of increasing dependence upon the specific factor.

Dr. Carey applied a number of psychological tests to various groups of children, aged 7 to 14, and correlated the results with each other, with school examination marks and with the teacher's estimates of the children's ranking for Scholastic Intelligence, Practical Intelligence, Mainstake and Social Status. The number of children taking each test varied, but for many of the tests the numbers were reported to exceed 150. All the testees were drawn from four classes of girls and one of boys of a London County Council Elementary School. Carey estimated correlations with g to be as follows :-

TABLE 2. CAREY, CORRELATIONS WITH G.

Scholastic Intelligence.	.75
Psychological Test: Antonyms.	.71
do. do. Jumbled Sentences.	.59
Examination Marks.	.59
Painstaking.	.54
Practical Intelligence.	.52
Psychological Test: Auditory Memory.	.52
do. do. Visual Discrimination	.50
do. do. do Memory.	.47
do. do. Auditory Discrimination	.39
do. do. Verbal Memory.	.37
Social Status.	.37
Psychological Test: Tactile Discrimination.	.00

(extracted from Table XV, 3 Carey 1915 and 1916, vol.8.p.89; two other correlations, for Drawings (.42) and Holes (.22), were included by Carey, but it is not clear what kind of tests these represented and so they have been excluded from Table 2 above).

The high positions allotted to the first and fourth of this list are what one would expect; the second and third are common elements of intelligence tests.

What is worthy of note is that Painstaking ranks fairly high. This is, no doubt, partly explicable by the fact that the teachers who estimated the painstaking quality

of each pupil would tend to be prejudiced in favour of those who were actually successful in school studies. Apart from this consideration, however, it is interesting to note that, after partialling out the estimated effect of g, Painstaking showed the following specific correlation:

TABLE 3. CAREY, SPECIFIC CORRELATIONS WITH PAINSTAKING.

Social Status	.51
Scholastic Intelligence.	.47
Examination Marks.	.31
Verbal Memory.	.25
Drawings.	.23

The specific correlations of Painstaking with the other tests were insignificant.

The strong connection of Painstaking with home conditions and the teachers' estimates of ability to succeed is noteworthy. Correlations of Scholastic Intelligence with the various school subjects were reported as below:-

TABLE 4. CAREY, CORRELATIONS WITH SCHOLASTIC INTELLIGENCE.

History.	.93 ±	.168
Science (i.e. Nature Study & General Science.)	.77 ±	.069
Composition.	.75 ±	.038
Arithmetic.	.72 ±	.037
Reading.	.70 ±	.043
Geography	.63 ±	.054
Spelling.	.60 ±	.056

Writing.	.43 ±	.073
Painting.	.40 ±	.061
Needlework.	.22 ±	.090

In a second investigation, working with children of the same age-range (7 to 14) drawn from four elementary schools, Carey inter-correlated the examination marks in school subjects of about 500 children. Unfortunately, the investigation was marred by variability of the population, as before; she reported that the numbers taking the examinations in Geography, History and Science were 'much smaller' than the rest.

Carey found that subjects fell into three closely linked groups :-

- (1) Geography, Science, History, Arithmetic;
- (2) Composition, Reading, Spelling;
- (3) Writing, Painting, Needlework;

The agreement with the correlations of Table 4 is fairly good. The motor factor suggested by Carey for group (3) is a postulation which agrees with both sets of results, while her small verbal factor (group (2)) and smaller unnamed factor (group (1)) are admissible as overlapping factors in Table 4. It is worth noting that the subjects of the second investigation form a hierarchy with average correlations in decreasing sequence for the order given, except that Composition breaks the arrangement with an average correlation second only to that of Geography: which suggests overlap of the same

factors in both investigations.

Burt reported in 1917 the results of tests in the ordinary school subjects administered to 120 children aged 10 + to 12+ from two schools and three classes (either Standard V or Standard VI) in London. The order of decreasing average correlation was as follows :-
Composition, Science, Arithmetic Problems, Geography, History, Reading Comprehension, Dictation, Writing Speed, Reading Speed, Handwork, Arithmetic Rules, Drawing, Writing quality (extracted from 3 Burt 1917, p.52. Table A.)
The agreement of this order with that given by Casey (second investigation) for almost the same subjects is close, with Composition and Science placed highly in both lists and the motor-co-ordination subjects at the end. The closeness of the observed correlation coefficients to a hierarchical pattern, with the chief deviations (as occasioned, e.g, by a high correlation between the two Arithmetic tests) 'where, on other grounds, we should expect them to occur' induced Burt to 'conclude that performances in all the subjects tested appear to be determined in varying degrees by a single common factor' (op.cit.p.55).

Burt calculated first-factor loadings by the summation method (described in 3 Burt 1917, footnote p.53 and in 2 Burt 1940 appendix) calling them correlations with the 'Hypothetical General Factor'. He found these to

agree very closely with the average correlations of the tests with teachers' marks for 'General Educational Ability'. Smaller agreement was found between the factor-loadings and the correlations of the tests with teachers' marks for 'General Intelligence'. Burt concluded 'We may, therefore, identify this hypothetical general factor with General Educational Ability; and conclude provisionally that this capacity more or less determines prowess in all school subjects'. (op.cit.p.55).

He found it necessary, however, to explain the existence of the too large observed coefficients by postulating group factors. After partialling out the general factor, he found 25 out of 78 specific correlations to be significant (with 9 of the significant ones negative, and so related as to suggest that Groups (1) Arithmetical, (2) Manual, (3) Linguistic, and (4) Composition (including History, Geography, Science and Composition) (op.cit.pp. 58, 59).

Referring later to this study (in 3 Burt 1939, p.47) Burt suggested the following factors, with the accompanying comments:-

- 6 (1) an arithmetical factor;
- (2) a manual factor;
- (3) a linguistic or verbal factor, which may perhaps be separated into two types -
 - (a) an elementary or verbal (as in reading and spelling), and

(b) a literary or informational (as in composition and essay subjects).

Corresponding to these, it was suggested, were certain convenient sub-classifications of children, justifying to some extent the practical teacher's belief in so-called "types", and grouping the more anomalous cases into instances of specific disability or specific ability in this or that limited direction.

These 1917 results were confirmed by a more extensive research reported in the second paper just quoted. This covered the same subjects as before and was applied, by similar tests, to 613 elementary school boys of 10 +. Burt analysed the inter-correlations by three different methods, namely (1) the Group Factor method, (2) the General Factor (summation) method, and (3) the General Factor (least squares) method. (All are described in an appendix to Burt's 'The Factors of the Mind'). The three methods yielded analogous results, the only difference in the conclusion from that reached by the 1917 research being that the sub-division of factor (3) suggested above appeared not to be justified by the new data.

A point emphasised by Burt was what he called the 'cyclic overlap' of factors'. Among the "verbal" subjects, the more mechanical (reading and dictation) seemed to form one cluster, and the informational (composition, history, geography and science) a second, yet one of the reading tests was not so closely related to the other reading

test as it was to composition; similarly, science fell almost mid-way between the informational group of subjects and the arithmetical group, and writing almost mid-way between the verbal group and the manual. This phenomenon (which reappeared in many other tables) I designated "cyclic overlap"; and it was noted that, if the "group factors" themselves overlapped (as this feature seemed to imply), then the divisions between the various groups of tests could not be very sharply drawn'. (3 Burt 1939, p.52).

These various findings came from tests applied to children between 10 + and 12 +. It is of interest and concern to those engaged in secondary education to know what the relative roles of general educational ability and the various group factors will be as the children grow older. Burt has said that the 'relative influence of the more general capacity is greater in earlier years as contrasted with later' ('Mental and Scholastic Tests', p.266, repeated in 'The Factors of the Mind', footnote pp.225,226, and in 'The Education of the Young Adolescent', p.132) and has tabulated (Table I, 1 Burt 1943) the percentage contributions to mental test variance which he estimates as due to General, Verbal, Arithmetical and Manual Factors at various ages, as follows :-

TABLE 5. BURT, FACTOR CONTRIBUTIONS TO TEST VARIANCE.

Factor.	Age 8 +	Age 10 +	Age 12 +
(1) General	52.1	35.6	27.8
(2) Verbal	7.3	9.3	10.7
(3) Arithmetical	3.1	3.0	13.4
(4) Manual.	2.5	5.9	6.5

If these figures may be taken to indicate a tendency which continues beyond the age of 12, we may expect the influence of general ability to decline and that of group and specific abilities to increase during the years of adolescence.

In 1934 Mr. J. B. Russell reported a follow-up enquiry designed to show 'the relation of intellectual, temperamental and other qualities to success at school'. In his paper Russell showed the similarity of I.Q. ranking for 28 pupils in a Junior Scholarship examination to their final order after five years in a secondary (grammar) school. These pupils were divided into two groups, 16 attending one secondary school and 12 another. For these children (and others for whom other comparisons were made) a record was kept both of scholastic progress and of character and temperament assessments made by their teachers. This record was used, together with the pupils' School Certificate results, to determine a final order of the children concerned in each school. If the influence of general educational ability and, therefore, presumably of intelligence,

progressively declines we should not be surprised to find weak correlation between I.Q. rankings made in 1925 and final orders made in 1930. What was actually found, however, was that for the 16 children in the first group the rank-difference was below 3 for 7 of the children and 5 or more for only 5 of them, while for the second group of 12 children the rank-difference was below 2 for 7 of them and 5 or more for only 3 others. Case studies given by Russell reveal that each large rank discrepancy between I.Q. and final order was accountable in terms of strong or weak character and temperament traits. The correlations between the two rankings were given as 0.56 ± 0.115 for the first group and 0.54 ± 0.137 for the second.

Russell also compared the School Certificate results alone with the I.Q.s of the 52 children who came within his full investigation and who completed their School Certificate course and took the examination within the five years. Here again he found a marked correspondence, and a correlation of 0.53 ± 0.065 . At the same time he had to note that three pupils of the lowest I.Q. group (100 to 109) achieved results in their School Certificate examination comparable with those of the I.Q. group 130 to 139, all three being highly praised by their teachers for Persistence, two for Profoundness of Comprehension and one of these and the third for Attention and Quickness of Comprehension. Again, 12 pupils in the follow-up were regarded as sufficiently intelligent to enter upon a secondary course but failed to sit for the School Certificate

examination within five years; three left school too early; two had unfavourable home conditions, and the rest were assessed lowly for academic interest, intellectual qualities or temperamental traits.

The results supplied by Mr. A. J. Moakes do not show strong correlation between intelligence and examination marks. The Cattell Grade 2 Intelligence Test was given in December 1939 to 97 boys who were to sit for the School Certificate examination in July 1941. The product-moment correlations based on balanced distributions into 10 grades are given below. The numbers taking the different subjects varied as shown.

TABLE 6. MOAKES. CORRELATIONS WITH INTELLIGENCE.

<u>SUBJECT.</u>	<u>r.</u>	<u>N.</u>
Mathematics.	.65	97
Additional Maths.	.53	37
English Language.	.50	97
Physics and Chemistry	.36	20
French.	.35	97
English Literature	.32	97
Geography.	.30	18
History.	.26	61
General Science.	.23	38
Latin	.22	67
Greek	.21	23

Comparing these correlations with their standard error ($\frac{1 - r^2}{\sqrt{N-1}}$), we find those for Mathematics, Add. Maths, English Language, French and English Literature to be more than three times their standard error, while that for History is rather more than 2 S.E. for Physics-and-Chemistry, Geography, General Science and Latin between 1 S.E. and 2 S.E. and for Greek almost exactly 1.S.E. Hence, these figures, show a definite relation between the intelligence test and six of the subject tests while the connection for the other subjects is uncertain, chiefly due to smallness of population.

The order given by Hoakes's list is, on the whole, not surprising in view of Carey's (Table 4) list and that of Burt (History finding a much lower place in the lists of both Burt and Hoakes than the leading position accorded by Carey). What is quite surprising about Table 6 is that Latin and Greek are together at the bottom. It will be recalled that Classics headed Spearman's list (Table 3). This unexpected result serves to point two morals: firstly, that no valid general result can be induced from one particular example; secondly, and conversely, that no general rule must be expected to apply in each individual case. In other words, investigations concerning the mental factors and subject-linkages in school work must be as widespread as possible if their findings are to have wide applicability, but such widespread research will not

absolve practical teachers and administrators from minute observation of the peculiar needs of the children with whom they have to deal when making their applications.

In 1939 Daisy Ormiston reported a research in which she had sought to discover what mental factors were operating for two groups of children taking Junior Scholarship examinations and one group taking a School Certificate examination. Her method consisted of four parts :-

- (1). 20 psychological tests were applied to 100 elementary school children of 10 or 11 and the results analysed. 'From this analysis it was hoped to find the factor loadings of the tests used, and ultimately to find tests highly loaded with the factors detected which would be sufficiently pure tests of these same factors as to serve as axis tests for rotations for the respective factors'.
(3 Ormiston 1939, p.p. 165, 166).
- (2). A number of these tests, including the axis tests, were applied to candidates for the Junior Scholarship (during the week before their examination) and for the School Certificate (during the week after their examination).
- (3). The test scores and examination marks (obtained later from the authorities) were inter-correlated,

(These factor-tests were slightly changed in different stages of the investigation, as will appear).

Using the above tests as final axes, Ormiston obtained the following factor loadings for District A (120 children, mixed, taking the Junior Scholarship examination)

TABLE 7. ORMISTON. J.S. (A) LOADINGS. AGES. 10.11 to 11.11.

	<u>g</u>	<u>n</u>	<u>v</u>
Arithmetic	.541	.409	.076
English	.466	.227	.535
Intelligence Test.	.803	-.143	.575

TABLE 8. ORMISTON. J.S. (A) LOADINGS. AGES. 9.11 to 10.11.

	<u>g</u>	<u>n</u>	<u>v</u>
Arithmetic	.434	.550	-.007
English	.116	.481	.505
Intelligence Test.	.391	.320	.437

As the children came from different schools, Ormiston suggested that 'As a result of this, a small factor arising from differences in teaching and attitude to work seems to have arisen' (op.cit.p.169). For the younger sub-group, she noted that 'although the average scores of the children from different schools were quite similar in the tests which were independent of teaching, the average scores differed to the extent of 10% in Arithmetic and

12% in English in the examination results' (op.cit.p.170). As to the analysis-factor (or factors) likely to be affected by this heterogeneity, Ormiston reached the

following questionable conclusion: 'This additional loading would naturally fall into the first factor involving teaching taken in the analysis, after the g factor, which is presumably independent of teaching, had been removed. Accordingly, n is a composite factor including this special number ability and the factor due to differences in teaching'. (op.cit.p.169).

For District B (300 children, aged 10 to 12, taking the Junior Scholarship examination) factor-loadings were as follows. (It will be seen that more papers were set in this examination).

TABLE 9. ORMISTON. J.S. (B) LOADINGS.

	<u>g.</u>	<u>n.</u>	<u>v.</u>
Mental Arithmetic.	.69	.03	.02
Mechanical do	.61	.10	.45
Problem do	.72	.13	.07
English Composition.	.48	-.40	.49
do Comprehension.	.69	-.31	.11
Intelligence Test.	.82	-.47	.20

For these loadings factor-tests were as before, except that English Composition was now used as the v-axis. On this occasion, v was taken to be the factor affected by the variation of school-standard. The reasons for this change from n to v are not stated in Ormiston's paper, but must, on the reasoning quoted

above, mean that for this last group v-loadings were extracted immediately after those for g. Ormiston made no comment on the presence of negative loadings, which are especially marked in Table 9.

She estimated the relative importance of the different factors as follows :-

TABLE 10. ORMISTON. RELATIVE IMPORTANCE OF FACTORS (JUNIOR)

	<u>g.</u>	:	<u>n.</u>	:	<u>v.</u>
District A. ages 10.11 to 11.11	3	:	1	:	2
do. 9.11 to 10.11	1	:	1.5	:	1
do B. ages 10 to 12	15	:	1	:	5

(Values obtained by adding the positive loadings for each factor).

The spatial factors S_1 and S_2 , found to be present in the psychological tests, were found to 'hardly function in Arithmetic, English and Intelligence Papers of the authorities'.

Turning to the Senior Group (those children taking the School Certificate examination) Ormiston divided the examination subjects taken into three groups (Language, Number and Spatial) and applied separately to each group the methods of the previous stage of the investigation.

For the Language Group the 'Non-Verbal Analogies Test' was used for the g rotation in order to escape any verbal tendency' (op.cit.p.215). The verbal factor was chosen to coincide with the Finnish Words Test, as before.

Two new factors now put in an appearance: 'x' found only in Verbal Analogies, History, English Literature, and English Language, and 'y', not in the psychological tests but present in Latin and French. Loadings are given below:-

TABLE 11. ORMISTON. S.C.LOADINGS, LANGUAGE GROUP.

	<u>g.</u>	<u>v.</u>	<u>x.</u>	<u>y.</u>
French	.762	-.042		.140
English Language.	.685	.284	.299	
Latin	.670	-.349		.135
English Literature	.544	-.046	.480	
History.	.424	-.182	.438	

For the Number Group the g-rotation was through Verbal Analogies, the n-rotation through Mechanical Arithmetics, while 'The third factor, before rotation, was greatest in Algebra, and not present in any of the Psychological Tests (i.e. from the context, the three tests Mechanical and Non-Mechanical Arithmetic and Verbal Analogies), and accordingly rotation was made through this subject, the resulting factor being termed x' (op.cit.p.216).

The following were the loadings:-

TABLE 12. ORMISTON. S.C.LOADINGS. NUMBER GROUP.

	<u>g.</u>	<u>n.</u>	<u>x.</u>
Arithmetic.	.573	.377	.229
Algebra	.214	.643	.371
Geometry	.275	.333	.695

The Spatial Group, consisting of Geography, Geometry, Botany, and Art, was analysed along with the psychological tests Verbal Analogies, Paper Formboard, Paper Folding and Spatial Imagery, rotations being through the first three tests. Loadings follow.

TABLE 13. ORMISTON. S.C.LOADINGS. SPATIAL GROUP.

	<u>g.</u>	<u>S₁.</u>	<u>S₂.</u>
Geography.	.311	.419	.420
Geometry.	.275	.330	.711
Botany.	.230	.507	.006
Art.	- .266	.756	.150

In her factor-interpretation, Ormiston admitted some indeterminateness in the location of axes, (op.cit. p.220) though claiming this to be small in the g-factor (for which Verbal Analogies, with a g - loading of .886, was used for each analysis except that of the Language Group) x, she suggested, was 'a factor involving character or attitude to work' (op.cit.p.217) adding in a footnote: 'This suggestion is made on the grounds that x is found in the examination papers yet not in the tests, that in the preliminary work ... a trait estimated by the teachers as "persistence" had been noted and that such a factor had been suggested by the work of Alexander: Brit.Jour. Psych., Mon.Supp XIX; Wilson: Brit. Jour. Educ. Psych., vol.III, 1933; Flanagan: 'Factor Analysis in the Study of Personality'. Whether these grounds are adequate may be doubted, x had

been obtained in two separate analyses, namely, of the Language Group and the Number Group. Why these two separate factors should be identified with each other is not clear. There seems to be as much reason to call the Latin-French factor 'x' instead of 'y' and to identify this new x with the x affecting the mathematical subjects. Of y Orniston said that it might be 'some special factor which is involved in translations to and from a foreign language'. The negative loadings in v were ignored except to refer to 'the absence of the so termed "verbal" factor' from Latin. The negative loading in g of art (-.266) received the comment 'Art is shown to be independent of g' (op.cit.p.220). One is left with a strong impression that rotations to axes giving positive loadings, with interpretations in terms of characteristics possessed by heavily loaded subjects, might have given a very different pattern of factors and loadings.

In her summary Orniston gave g as the factor contributing most to success in school work in all subjects considered except Art, with x (the character factor) second in importance. Her estimate of the relative importance of all the factors named, making for success in the School Certificate examination, was as follows :-

TABLE 14. ORNISTON. RELATIVE IMPORTANCE OF FACTORS (SEMIO)

g	:	x	:	S ₁	:	n	:	S ₂	:	v	:	y
=17	:	9	:	7	:	5	:	4	:	1	:	1

(Values obtained by adding the positive loadings for each factor).

These results suggest a greater number of operative factors at the School Certificate stage than at that of the Junior Scholarship. Both this and the increased relative weight of the number factor agree with the findings of Burt quoted above (Table 5).

The importance of character and temperament in school work, placed second to *g* by Ormiston, is in keeping with the work of Russell, reviewed above. He found that 'Attention and Persistence .. are of fundamental importance' and that 'Wider differences' between the Final Order and the test (i.e. I.Q.) are often due to temperamental or health factors'. (3 Russell 1934. p.311).

Dr.H.G.Stead had come to a more definite conclusion in his work of 1926. As a result of scholastic, mental and motor tests and character ratings by their teachers, applied to 235 boys and 25 girls between the ages of 11 and 14, Stead found a central moral factor, acquired and capable of development, supplementing a central emotional factor and a general intellectual factor, both innate. His method was to note the average correlations between pairs of groups of tests and ratings (mental, scholastic and character) and to note the effect on each pair of partialling out the third group, also to correlate the motor group with each of the others. His conclusions on the relations of the first

three groups, leading to the factor-postulation, already quoted, were (3 Stend 1926, p.207)

- '(1) That whatever factor (or factors) causes the correlation between mental and scholastic ability, such factor (or factors) does not enter into "character".
- (2) That whatever factor (or factors) causes the correlation between scholastic ability and character, it is practically independent of mental ability.
- (3) That the correlation between mental ability and character, is due entirely to the correlation of each with scholastic ability'.

Stend was guided to his conclusion about the developmental moral factor by the previous work of Dr. W. Webb and Dr. J. C. H. Garnett. Webb, working with students of an average age of 21, had found a general factor which he called 'persistence of motives' (the 'will' factor) (3 Webb 1915) and Garnett, working over Webb's material, had declared the existence of a factor 'cleverness' or a 'tendency to associate by similarity', while re-naming Webb's factor 'purposefulness' (2 Garnett 1919).

The motor factor Stend found progressively to diverge from the rest except for one additional group of 17 secondary (grammar) school boys of 14 to 15 years, a

result which agrees with the earlier findings of Osney and Burt.

It seems true, then, to say that while general educational ability (of rather wider connotation than 'general intelligence') plays an important role throughout the first five years of secondary school life, other factors, not at first noticeably present, come more into prominence in the later stage. Not only do the number, verbal and spatial factors develop, but others, like the narrowly linguistic y of Orniston, tend to appear. Furthermore, traits of character and temperament, with persistence especially important, have an effect which increases with the passing of time.

These conclusions will now be reinforced by brief notes of two more investigations. Dr. F. L. Earle, seeking data by which to identify specific and group abilities, inter-correlated form-orders for different subjects of the curriculum of his own multilateral secondary school (Winkfield High School). The populations varied from 19 to 41 and no uniform tendency for correlations to increase or decrease from one year to another can be observed in his tables (3 Earle 1936, pp.122 to 132). Neither does the grouping of the subjects vary markedly from one type of course to another. The courses followed were:-

- ' A. A General Course including one Modern Language and Latin.

- B. A General Course with one Modern Language but with Handwork instead of Latin.
- C. A Commercial Course with French (girls only).
- D. A Domestic Course with no Modern Language (girls).
- E. A Technical Course with no Modern Language (boys)'.
(op.cit. p.26).

Plans were correlated for three years and for every type of course in each year, with the exception of course D's being omitted in the third year.

Correlations showed linkage between the following subjects:-

- (1) English and History for each form except IC and II.B;
- (2) Geography and Science, except for two first-year and one second-year E forms;
- (3) Mathematical Subjects, a high correlation being found wherever two or more of the subjects Arithmetic, Algebra and Geometry were taken, except for one second-year E form;
- (4) Shorthand, Typing, Book-keeping and Arithmetic for the second- and third-year C classes.

Cross-linkage may be detected. Mathematics and Science tend to be highly correlated, also History and Geography with Geography fairly well correlated with all other subjects except Art. Art has low correlations with all other subjects. The subjects of each group correlate almost as well with those of each other group as with one another,

so that specific correlation over and above that due to general ability cannot, from these results, be said to be marked, except in group (3).

Mr. J. H. Wilson's investigation, reported in 1933, was designed to discover 'Group factors among abilities involved in a school Certificate examination' and was thus similar to Crmiston's senior research of six years later. The methods of analysis differed from those of Crmiston and the results covered different subjects. Wilson calculated g-loadings by Spearman's reference-values method (2 Spearman 1927b, appendix p. XVI) as did Crmiston as a first step in his analysis. He then obtained other factor-loadings by a combination of partialling (Chapter 3, equation (1)), estimating and calculating by equations (6) and (7) (Chapter 3). For reference tests he used sets of subjects giving small tetrad differences with one another and with the other subjects, except when finding the g-saturation of English. This subject he found to give outwardly high specific correlations with all other subjects. Nevertheless in order to obtain its g-loading, Wilson assumed no specific correlation between English and Geography, and none between English and any of the mathematical subjects, despite results showing, after the first tentative partialling-out of g, specific correlation between English and Algebra, Arithmetic and Geometry to the extent of 8, 7 and 4 times the probable error of correlation, respectively, (3 Wilson 1933, p. 74. Tables III and IV).

Wilson's investigation was concerned with three groups of subjects. Marks were obtained for all candidates taking these combinations in the Northern Universities Joint Matriculation Board's School Certificate examination of (presumably July) 1929.

The first group of subjects (371 candidates) gave factor-loadings as below (op. cit.p.80).

TABLE 15. WILSON. LOADINGS. GROUP 1.

SUBJECT.	COMMON FACTORS.				SPECIFIC FACTOR.
	σ .	e_1	e_2	e_3	
English	.611	.341	.715		0
History	.686	.728			0
Geography	.756				.655
French	.575		.249		.779
Algebra	.591			.798	.387
Arithmetic	.579			.476	.614
Geometry.	.575			.544	.613

Wilson attributed factor e_3 (mathematical) to transfer of methods from one mathematical subject to another, appeared to expect e_2 and suggested that e_2 was due to 'special conditions brought to play in the examination papers, perhaps depending upon some particular training or attainment or interest' (op.cit.p.82).

For the second group of subjects, dealt with as before, the following factor-loadings were given (op.cit.p.85)

(Number of candidates = 110)

TABLE 16, WILSON, LOADINGS, GROUP 2.

<u>SUBJECT.</u>	<u>COMMON FACTORS.</u>				<u>SPECIFIC FACTOR.</u>
	<u>g.</u>	<u>e₁</u>	<u>e₂</u>	<u>e₃</u>	
English	.585	.700			.410
Algebra	.563		.700		.439
Geometry	.629		.367		.685
Botany	.606				.796
Art	.372			.800	.470
Needlework	.257			.303	.918
French	.392	.310			.866

e_2 is the e_3 found before, the mathematical factor; e_1 is apparently what was for Group 1 designated e_2 , the language factor; while Art and Needlework now appear to form a new related group.

The third group of subjects, taken by 77 candidates, gave the following loadings (op.cit.p.102).

TABLE 17. WILSON, LOADINGS, GROUP. 3.

SUBJECT.	COMMON FACTORS.				SPECIFIC FACTOR.
	σ .	e_1	e_2	e_3	
English	.285	.447			.847
French	.581	.403			.707
Arithmetic	.541		.438		.718
Algebra.	.610		.794		0
Geometry	.838		.210		.504
Chemistry	.817				.576
Art	.186			.556	.810
Handicraft	.262			.657	.707

Linkages for repeated subjects are as already found.

A new linked pair appears in Art and Handicraft.

The results for the three groups are fairly consistent with one another, except for the drop in the g loading of English in Table 17. Wilson points out that '...in all cases but one the partial correlation of the subject with the common or general component is less than that with its other elements. Success in the various subjects of the examination depends more upon specific abilities than upon general capacity.' (op.cit. p.106).

Wilson's and Orniston's School Certificate investigations were both concerned with the same problem, but were separated in time and involved quite different

pupils and different examinations. Added to these considerations, the techniques of analysis, though alike in some respects, differed in others. It would be surprising, therefore, if differences in their findings were not obvious. Wilson covered a greater range of subjects and covered them more intensively by repeating some of them. By not including Latin Wilson was unable to detect the foreign language factor found by Ormiston; on the other hand, two of his analyses gave a linkage between English and French which did not appear in Ormiston's research. Both found an English-History factor. For both, most subjects were heavily loaded with g, with Art an exception for both. Wilson found Mathematics and Chemistry to possess heavy g-loadings, however, while Ormiston's g-loadings for Algebra and Geometry were slight, and science (apart from Botany) was a notable absentee. Wilson's loadings were all positive, while five of Ormiston's (including the g-loading of Art) were negative. Ormiston claimed to find a character or attitude factor, and Wilson suggested special training or interest as the possible basis of one (the English-History) factor.

Enough has, perhaps, been said to indicate the chief factors which have appeared in research on the school work of children between 10 and 15 years of age.

There is considerable agreement in the various findings, suggesting a gradual development of factors of both a cognitive and conative-affective kind. The cognitive factors which supplement the general factor may be detected, as shown by the work of Carey, Burt, Ormiston and Earle, as soon as the child reaches the secondary stage, though the next five years tend to bring these factors more fully into play and to bring others into view which are not noticeably present in the early years. The usual grammar school subjects appear to fall into clearly marked but overlapping groups. A similar tendency, though not so marked, was found by Earle among the subjects of Commercial, Domestic and Technical secondary courses.

The cognitive factors revealed as operating at the end of the School Certificate course (chiefly due to Wilson and Ormiston) were based, as already noted, upon an acceptance of a dominating g and upon assumptions about reference-values in calculating g - and other loadings which are hard to justify. Accordingly, it seems desirable that new research should be undertaken, checking the work on ability-relations without assuming a g and without assuming beforehand any specific linkage (or absence of it) in the subjects concerned. Such a research will be described in the next chapter.

CHAPTER SUMMARY.

Spearman (1904) found that inter-correlations between the subjects of a preparatory school group formed a hierarchy, with foreign languages in the lead and Music at the bottom. Carey (1915 and 1916, and Burt (1917 and 1939) did not obtain pure hierarchies with children of 7 to 14 and 10 to 12, respectively, and had to supplement g with other factors. Carey's linked groups of subjects may be termed

- (1) Informational, including Arithmetic, heavily loaded with g ;
- (2) Linguistic or literary, moderately loaded with g ;
- (3) Manual, slightly loaded with g .

Burt had similarly three main groups, not quite the same as Carey's: the first was Arithmetical, the second Manual, and the third a combination of Carey's (1) and (2). The factors corresponding to these groups were taken by Burt to supplement the general factor, which he regarded as broader than g and which he termed 'General Educational Ability'. Factor-overlap was noted by both Carey and Burt. Carey also found that the estimated trait of Persistence correlated highly with both social status and Scholastic Intelligence as assessed by teachers knowing the pupils.

In 1943 Burt published figures to show the decline in dominance of the general factor in mental tests applied

to children from 8 + to 12 +, with a corresponding increase in the influence of verbal, arithmetical and manual factors. This suggests what may be a tendency continuing during adolescence and affecting all school activities.

In a follow-up study of 64 children for five years of secondary school life, Russell (1934) found a remarkable consistency of Junior Scholarship I.Q. results with final orders, but also found that scholastic success was dependent upon character and temperament traits, of which Persistence and Attention were the most important.

Some unpublished figures for School Certificate candidates of St. Paul's School (1941) show, on the other hand, weak correlation between examination marks and scores made in an intelligence test taken a year and seven months previously. Mathematics and English language are exceptions.

Stead (1926), applying scholastic, mental and motor tests to children of 11 to 15, and receiving character assessments from their teachers, came to the conclusion that two central factors of wide effect were operating in addition to g : these were an emotional and a moral factor.

Rank-correlations obtained by Earle (1936) for subjects examined form by form in his own multilateral secondary school show similar linkages for three different

years and five different courses. An English-History group, a Geography-Science group, a Mathematics group and a Commercial group may be detected, though high cross-correlation between Geography and other subjects, especially History, is common. These specific linkages are not outstanding, however, except between mathematical subjects. The correlations of Art with other subjects are exceptionally low.

Two studies of School Certificate results by slightly different methods are due to Wilson (1933) and Ormiston (1939). In a previous investigation Ormiston had found factors g, n and v in Junior Scholarship examinations, the factors n and v appearing, however, to be affected by a 'school' factor due to differences of teaching and of the children's prevailing attitudes. These factors were again found by Ormiston in her work on School Certificate results, but they were now supplemented by additional factors, linking (1) English with History (Cf. Earle), named by Ormiston a character or attitude factor, (2) French with Latin, and (3) Geography, Geometry, Botany and Art (two spatial factors). Wilson's research, covering three groups of subjects, with repetitions, revealed, in addition to g, an English-History factor (Cf. Earle and Ormiston), an English-French factor, a Mathematics factor and linkages between Art and Needlework and Art and Handicraft which may

indicate one manual factor. As with both Earle and Crmiston, the correlations of Art and other subjects were found to be generally low.

The examination subjects chosen by Wilson as yielding reference-value correlations for the estimation of the g -loadings of the rest, on the grounds that they had no common element other than g , are open to question. Similarly, Crmiston's psychological tests, serving as 'pure' tests of g , n , v , s_1 and s_2 and determining rotations, are somewhat unconvincing. New research, making no preliminary assumptions about the nature of the factors to be extracted, seems desirable.

CHAPTER 5. A NEW ANALYSIS OF SCHOOL CERTIFICATE MARKS.

In furtherance of the second of the three aims set forth in the Introduction, an analysis has been made of certain marks obtained in the Northern Universities Joint Matriculation Board's School Certificate examination, held in July 1945. The immediate object was the same as that of Wilson (1933) and Ormiston (1939), namely the investigation of the mental factors operating in a School Certificate examination. The differences between the new analysis and the former ones are of subjects and of analytical methods.

The marks of two distinct groups of boys have been used and thus, in fact, a combination of two analyses obtained.

Group 1 consists of 208 boys, being all the boys from 16 schools chosen at random and taking the following 9 subjects: English Language, English Literature, History, Geography, French, Mathematics, Physics, Chemistry and Art;

Group 2 consists of 198 boys, being all the boys from 17 schools chosen at random and taking the following 7 subjects: English Language, English Literature, History, French, Latin, Mathematics and General Science I. (Two separate papers,

known as General Science I and General Science II were available, but as many candidates took only the first paper the second was ignored).

No cognizance has been taken, in either group, of whether the candidates came from a boys' or a mixed school, nor of whether other subjects were taken in addition to those being investigated.

Two sets of subjects were chosen in order to increase the range of the research. They were selected to overlap to the extent of five subjects in order -

- (1) to note corroboration or variation of factors disclosed from one set to the other, and
- (2) to assist factor interpretation by noting the effect of subject variation on the loadings of factors common to the two sets.

The present investigation is an attempt to find out how different subjects are linked into related groups, and, by measuring the degree of linkage, to hazard an interpretation in terms of mental factors. It has consequently been considered necessary to choose groups of pupils who were homogeneous as regards sex and, as far as possible, the type of school course followed and the school stage reached, with age as nearly constant as the last requirement would allow it to be. The choice of all boys offering the same minimum combination of subjects

in the same School Certificate examination may be held to approximately fulfil these requirements. As special relations may conceivably exist between the subjects of the curriculum in one school owing to the emphases peculiar to the teaching in that school, it has seemed desirable to spread the investigation over a large number of schools. Heterogeneity of schools, locality, teaching method and abilities of pupils has thus been assured, and it is hoped that the random samples chosen will be sufficiently large to make the heterogeneity in these respects correspond closely to that in the whole population of School Certificate candidates.

A possible objection to this procedure must be stated and considered at once. A generally high level of marks in two subjects or a generally low level of marks in two subjects for the same school will tend to produce high correlation between them, while high and low levels occurring together will tend to reduce correlation. These two opposing influences will tend to balance one another, but in fact the former is the stronger, as may be observed by examining Tables 18 and 19. The question is whether this tendency for high levels of marks to occur together in one school and low levels to occur together in another will produce an effect on the inter-correlations which is illegitimate in this research.

The maximum mark in each subject was 300.

To render the marks manageable, they have been considered to fall into 30 intervals of 10 and

a score of 0 to 9 was regarded as 0,

" " " 10 " 19 " " " 1,

" " " 20 " 29 " " " 2,

(continued on p.101)

and so on, with, finally, 290 to 299 regarded as 29
(there being no score of 300).

Tables 18 and 19 give, in terms of the new unit, the mean scores (\bar{x}) for all the schools in the two sets of subjects, the deviations (d) of these means from the subject-means of the whole distribution and the average of the absolute values of these deviations ($Av. |d|$) for each school. Several facts emerge from an examination of these tables.

(1) There is an apparent tendency for each school to give nearly-all positive or nearly-all negative deviations (e.g. Schools 4, 9, 10, 11, 12 in Table 18 and Schools A, B, E, F in Table 19); this is especially true of the schools with the largest numbers of candidates, for which the means are more significant.

(2) This tendency of deviations to be positive together or negative together is especially marked in certain groups of subjects, e.g.

(Table 18) History and Geography (14 schools out of 16),
Physics and Chemistry (" " " " ");
(Table 19) French and Latin (13 " " " " 17),
Mathematics and Latin (" " " " "),
French " and " (11 " " " " ");
(both tables) English Literature and History (23 schools
out of 33).

This feature is emphasised by certain schools which have large positive or negative values of d in these groups (e.g. Schools 3 and 16 for History and Geography, School 15 for Physics and Chemistry and Schools A and C for French, Latin and Mathematics).

- (3) Certain schools show marked strength or weakness in isolated subjects or in subjects not showing linkage throughout the tables, e.g.

School 3, strength in French;
 " 13, " " History, French and Art;
 " E. weakness in " and Latin;
 " F. strength in Mathematics and General science;
 " G. " in Latin;
 " H. " in " and History;
 " I. " in History.
 " L. weakness in Mathematics;
 " N. " in General science;

- (4) $Av. |d|$ is small (under 2) for 16 out of 33 schools and for 5 out of 8 of those schools with over 20 candidates.

- (5) $Av. |d|$ is large (over 3) only for schools with 7 or fewer candidates, with the exception of School 9, for which every d is negative, showing a low general standard of attainment.

As pointed out above, the effect of (1) will be to produce for all subjects positive inter-correlations which can be traced to the individual schools and which may exceed what would have existed if all the pupils had been educated under equal conditions. The effect of (2) will be similar to that just stated, but applying to particular groups of subjects instead of to all. (3) will tend to reduce correlations except for subjects which are exceptionally strong or weak together. (4) and (5) suggest that the larger values of $Av. |d|$ are due to the larger influence in the smaller entries of the strengths and weaknesses of individual candidates. The further implications of the differences of school means will be discussed after the total correlations (that is, for deviations of scores from their general means) have been given.

The subject-marks, reduced in the manner described above, have been correlated by the product-moment method with Sheppard's corrections for grouping, i.e. by use of

$$r = \frac{\sum x y}{N \sqrt{\left\{ \left(s_x^2 - \frac{h^2}{12} \right) \left(s_y^2 - \frac{h^2}{12} \right) \right\}}} \dots (8) \quad \text{(4 Kelly 1928, p. 168, Formula (100)).}$$

where r = correlation,

x, y = deviations of scores of the same individual from their means,

Σ = summation for all individuals in the sample,

N = the number of individuals in the sample,

s_x, s_y = standard deviations of x, y ,

h, k = group intervals for x,y in terms of the units used in measuring x,y.

As in this case h = k = 1, it was convenient to use equation (8), with the aid of scatter-diagrams, in the alternative form

$$r = \frac{\sum x^2 + \sum y^2 - \sum z^2 \dots \dots \dots (9)}{2 \sqrt{\left\{ \left(\sum x^2 - \frac{N}{I_2} \right) \left(\sum y^2 - \frac{N}{I_2} \right) \right\}}}$$

where z = x~y.

The inter-correlations for the two groups of pupils are given in Tables 20 and 21. Each set of subjects appears in the order of decreasing average correlation.

TABLE 20: SUBJECT INTER-CORRELATIONS (TOTAL), GROUP 1.

	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. Physics.		.657	.491	.634	.341	.354	.414	.322	.305
2. Chemistry.	.657		.504	.568	.441	.417	.387	.297	.199
3. Geography.	.491	.504		.366	.540	.455	.248	.281	.249
4. Mathematics.	.634	.568	.366		.321	.273	.419	.298	.138
5. History.	.341	.441	.540	.321		.505	.331	.284	.122
6. English Literature.	.354	.417	.455	.273	.505		.326	.422	.127
7. French.	.414	.387	.248	.419	.331	.326		.465	.177
8. English Language.	.322	.297	.281	.298	.284	.422	.465		.021
9. Art.	.305	.199	.249	.138	.122	.127	.177	.021	

SIGNIFICANCE TESTS.

1. σ_r test, where $\sigma_r = \frac{1 - r^2}{\sqrt{(N - 1)}}$

when $r > .260$, $r > 4\sigma_r$...every r except $r_{37}, r_{29}, r_{39}, \dots r_{89}$.

$4\sigma_r > .249$, $.248 > 3\sigma_r$... r_{37}, r_{39} ,

$3\sigma_r > .199$, $.177 > 2\sigma_r$... r_{29}, r_{79} .

$2\sigma_r > .138$, $.127$, $.122 > \sigma_r$... r_{49}, r_{69}, r_{59} .

$\sigma_r > .021 > 0$ r_{89} .

2. Fisher's z test (4 Fisher 1934, p.185).

$z = \frac{1}{2} \{ \log_e (1 + r) - \log_e (1 - r) \} = r + \frac{r^3}{3} + \frac{r^5}{5} + \dots$

$\sigma_z = \frac{1}{\sqrt{(N - 3)}} = \frac{1}{\sqrt{205}} = .070$ (as $N = 208$).

$z > 4\sigma_z$ every z except $z_{37}, z_{29}, z_{39}, \dots z_{89}$.

$4\sigma_z > z > 3\sigma_z$ z_{37}, z_{39} .

$3\sigma_z > z > 2\sigma_z$ z_{29}, z_{79} .

$2\sigma_z > z > \sigma_z$ z_{49}, z_{69}, z_{59} .

$\sigma_z > z > 0$ z_{89} .

TABLE 21. SUBJECT INTER-CORRELATIONS (TOTAL), GROUP 2.

	1.	2.	3.	4.	5.	6.	7.
1. Latin.		.741	.495	.579	.368	.310	.280
2. French.	.741		.520	.566	.274	.271	.137
3. English Language.	.495	.520		.480	.433	.249	.330
4. Mathematics.	.579	.566	.480		.304	.357	.211
5. English Literature.	.368	.274	.433	.304		.363	.488
6. General Science.	.310	.271	.249	.357	.363		.323
7. History.	.280	.137	.330	.211	.488	.323	

SIGNIFICANCE TESTS.

1. σ_r test.

When $r > .265$, $r > 4\sigma_r$... every r except r_{36}, r_{27}, r_{47} .

$4\sigma_r > .249, .211 > 3\sigma_r \dots r_{36}, r_{47}$.

$2\sigma_r > .137 > \sigma_r \dots r_{27}$.

2. Fisher's z test. $\sigma_z = \frac{1}{\sqrt{(N-3)}} = \frac{1}{\sqrt{195}} = .072$ (as $N = 198$).

$z > 4\sigma_z \dots$ every z except $z_{25}, z_{26}, z_{36}, z_{27}, z_{47}$.

$4\sigma_z > z > 3\sigma_z \dots z_{25}, z_{26}, z_{36}$.

$3\sigma_z > z > 2\sigma_z \dots z_{47}$.

$2\sigma_z > z > \sigma_z \dots z_{27}$.

From these tables certain facts may be observed at once.

- (1) All the correlations are positive and nearly all are significant.

- (2) In neither table do the correlations form a hierarchy, though there is an approach to hierarchical order in the top half of each table.
- (3) Certain groups of subjects are more highly inter-correlated than the rest, e.g.
- (a) in Table 20.
 - (i) Physics, Chemistry, Mathematics,
 - (ii) History, Geography, English Literature,
 - (iii) English Language, French;
 - (b) in Table 21.
 - (i) Latin and French, with Mathematics fairly close,
 - (ii) History and English Literature.
- (4) These groups merge into one another in a manner suggestive of Burt's 'cyclic overlap'.
- (5) The correlations of Art are all low; in fact, the correlation of Art with any second subject is less than that of the second subject with any other.

To return to the question of the differences between school means, Prof. E. F. Lindquist points out (4 *Linguist* 1940, p.220) that differences of attainment in different schools can lead to anomalous results when scores from these schools are treated as forming one distribution for the purpose of computing correlations.

He suggests (p.221) that differences between the mean scores of schools should be eliminated by analysing the variance of each test into its 'between schools' and 'within schools' components and by similarly treating the covariance of each pair of tests, and hence computing the correlation 'within schools' (i.e. by eliminating the 'between schools' components). 'This correlation could then be interpreted as the average of the correlations that would be found in the separate schools The correlation within schools may be considered as equivalent to that which would have been found had all pupils been taken from a single school'. (p.221).

This method and interpretation assumes that the samples chosen from the different schools are sufficiently large (150 pupils from each of two schools, in Lindquist's illustration) and sufficiently alike in those pupil-characteristics which are being tested to render differences in mean scores either negligible (for equal conditions) or irrelevant to the research in hand. If the samples are very small, however, it is not clear that the differences between means should be eliminated, especially if we are interested in the relations between abilities of individual pupils rather than in comparing the relations between average abilities of supposedly equal groups. In the extreme case of one pupil from each school the single scores would be

the means and these could obviously not be expected to approach equality, nor would the differences be irrelevant. If the size of each group is increased, at what point do mean-differences become negligible? The answer to this question will depend partly on the standard of accuracy required and partly on the nature of the investigation.

When, as in the present research, the correlations of large numbers of pupils are being examined in order to find the tendencies in mental organisation of the individual, it will no doubt be instructive to compute two series of correlations (1) measuring deviations of scores from their general mean and thus ignoring school-differences, (2) measuring deviations from school means and thus eliminating school-differences. A comparison of the two series of correlations will then reveal the influence which the schools have on ability-relations (blurred, of course, by genuine individual differences). The flat contradiction of one series of results by the other, as illustrated in Lindquist's first example (p.220, diagram I) where significant positive correlation within schools coincides with significant negative total correlation, must be taken to show a correlation between schools which is opposite in sign to that between abilities, and the total correlations will then be discredited as indications of ability-relations. If, on the other hand, there is general agreement between the two series, the total correlations may be regarded as validated; they will, moreover, show the relations between abilities in the

fuller sense of 'total reaction to educational environment' and will not rest on the elimination of school-differences which may not be irrelevant.

In order to compare the single distribution (or total) correlations (Table 20) with the within-school correlations, Lindquist's method has been followed for the subjects of Group 1. The variance of each of the nine subjects has been analysed, using the formula

$$\sum_i \sum_j (x_{ij} - \bar{x})^2 = \sum_i \sum_j (x_{ij} - \bar{x}_i)^2 + \sum_i n_i (\bar{x}_i - \bar{x})^2$$

(10) (4. Weatherburn 1946, p.210, formula (3))

and the covariance of each of the thirty-six pairs of subjects has been analysed, using the formula

$$\sum_i \sum_j (x_{ij} - \bar{x}) (y_{ij} - \bar{y}) = \sum_i \sum_j (x_{ij} - \bar{x}_i) (y_{ij} - \bar{y}_i) + \sum_i n_i (\bar{x}_i - \bar{x}) (\bar{y}_i - \bar{y}) \dots (11)$$

(4. Weatherburn 1946, p.227, formula (17)),

where x_{ij} and y_{ij} are scores of the j th member of the i th school-group,

\bar{x} and \bar{y} are general means,

\bar{x}_i and \bar{y}_i are school means,

\sum_j indicates summation for all members of any one group,

and \sum_i indicates summation for all groups.

n_i = number in i th group.

The within-schools correlation is given by

$$r_{xy} = \frac{\sum_i \sum_j (x_{ij} - \bar{x}_i)(y_{ij} - \bar{y}_i)}{\sqrt{\left\{ \sum_i \sum_j (x_{ij} - \bar{x}_i)^2 \cdot \sum_i \sum_j (y_{ij} - \bar{y}_i)^2 \right\}}} \dots (12).$$

Correlations given by this formula are as follows:

TABLE 22: SUBJECT INTER-CORRELATIONS (WITHIN SCHOOLS), Group 1.

	1.	2.	3.	4.	5.	6.	7.	8.
1. Physics.								
2. Chemistry.	.597							
3. Geography.	.443	.439						
4. Mathematics.	.549	.502	.293					
5. History.	.164	.336	.468	.341				
6. Eng.Lit.	.169	.287	.369	.121	.452			
7. French.	.318	.352	.293	.286	.290	.299		
8. Eng.Lang.	.274	.280	.260	.242	.181	.416	.450	
9. Art.	.243	.152	.252	.090-	.063	.077	.109	.015

26 of the 36 correlation coefficients i.e. those over .182, are significant at the 1% level (4 Lindquist 1940, p.212), 4 of the remaining 10, i.e. those between .139 and .182, are significant at the 5% level, while that of English Literature with Mathematics and those of Art with all subjects except Physics, Chemistry and Geography are below the 5% level of significance.

The order of decreasing size of average correlation is Chemistry, Geography, Physics, Mathematics, French, English Literature, History, Eng.Language and Art.

The groups of highly correlated subjects ($r > .4$) are as follows:

English Language - English Literature,

" " - French,

History - English Literature, History - Geography,

Geography - Physics, Geography - Chemistry,

Mathematics - Physics - Chemistry.

These groupings agree closely with those shown by Table 20.

The two series of correlations may be further compared by transforming both series into Fisher's z where

$$z = \frac{1}{2} \log_e \frac{1+r}{1-r} \quad \text{---} \quad \text{(cf. Fisher 1934, p.135)}$$

and comparing the differences between corresponding

values of z with the standard error of $z = \frac{1}{\sqrt{(N-3)}}$ = .070.

These values are given in Table 23.

TABLE 23: COMPARED VALUES OF Z , GROUP 1.

$Z_G = \frac{1}{2} \log \frac{1+r}{1-r}$ for deviations from the general means.

$Z_S =$	"	"	"	"	" school "		"			
					Chem.	Geo.	Math.	Hist.	Eng. Lit.	Fr.	Eng. Lit.	Fr.
Physics.	Z_G		.787	.538	.748	.355	.370	.440	.334	.305
	Z_S		.688	.475	.617	.165	.171	.329	.261	.291
	$Z_G - Z_S$		.099	.063	.131	.190	.199	.111	.055	.067
Chemistry.	Z_G			.555	.645	.473	.444	.408	.306	.202
	Z_S			.471	.552	.350	.295	.368	.284	.153
	$Z_G - Z_S$			.084	.093	.123	.149	.040	.018	.049
Geography.	Z_G				.384	.604	.491	.253	.289	.254
	Z_S				.302	.508	.387	.302	.219	.258
	$Z_G - Z_S$				.082	.096	.104	.049	.023	.004
Mathematics	Z_G					.333	.280	.446	.307	.139
	Z_S					.355	.122	.294	.247	.090
	$Z_G - Z_S$					-.022	.158	.152	.060	.049
History.	Z_G						.556	.344	.292	.123
	Z_S						.487	.299	.183	.053
	$Z_G - Z_S$						.069	.045	.109	.186
English Literature.	Z_G							.338	.450	.128
	Z_S							.308	.443	.077
	$Z_G - Z_S$							.030	.007	.051
French.	Z_G								.504	.179
	Z_S								.485	.109
	$Z_G - Z_S$								.019	.070

English Language	}	r_G	.021
		r_S	-.015
		$r_G - r_S$	.036

$r_G - r_S$ represents the increase in correlation due to the differences of school means. It is positive for all but three pairs of subjects and where negative it is insignificant.

$r_G - r_S > \sigma_{r_2}$ for 16 out of 36 pairs of subjects and

$r_G - r_S > 2\sigma_{r_2}$ " 6 " " "

every $r_G - r_S < 3\sigma_{r_2}$.

The general effect of the school 'factor' is to increase the correlations. History and English literature show a marked tendency to have their correlations with other subjects increased by the school factor. The elimination of differences between schools tends to accentuate the grouping of subjects noted in Table 20.

The differences between the two series of correlations for Group 1 did not seem sufficient to require a similar duplication of work for Group 2. The total (i.e. single-distribution) correlations for both groups of subjects have been factorised by Thurstone's Centroid Method.

After three common factors had been taken out of the first correlation matrix every residual correlation was

numerically less than $2 \sigma_r$ and all but three were numerically less than σ_r . The extraction of two factors from the second matrix was sufficient to yield residuals all numerically less than $2 \sigma_r$ and all but four numerically less than σ_r . The factor-patterns (unrotated axes) were as follows:

TABLE 24: COMMON LOADINGS, GROUP 1.

	<u>FACTORS.</u>		
	I_2	II_2	III_2
1. Physics.	.760	.360	.173
2. Chemistry.	.751	.210	.055
3. Geography.	.669	.069	- .339
4. Mathematics.	.665	.210	.301
5. History.	.624	- .177	- .298
6. English Literature.	.616	- .299	- .201
7. French.	.588	- .213	.283
8. English Language.	.520	- .376	.236
9. Art.	.299	.203	- .144

TABLE 25: CENTROID LOADINGS, GROUP.2.

	<u>FACTORS.</u>	
	I, 2	II 2
1.Latin.	.784	.307
2.French.	.725	.462
3.English Language.	.676	.082
4.Mathematics.	.686	.232
5.English Literature.	.607	- .370
6.General Science.	.499	- .220
7.History.	.504	- .456

The grouping of subjects can be seen more clearly in the plots of these loadings (Figures 1,2,3 and 7).

The following points are of special interest.

- (1) The close proximity of Physics, Mathematics and Chemistry in the three plots in which they occur (Fig. 1,2,3).
- (2) The close proximity of the languages in all four of these plots.
- (3) Similarly English Literature and History.
- (4) The similarity of arrangement of the two groups (a) Languages and Mathematics, (b) English Literature and History in Fig.2 and 7, which are derived from two different groups of children.
- (5) The circular arrangement in Fig.3, which both confirms

the groupings shown in the other plots and illustrates the merging of each group into another, again reminiscently of Burt's 'cyclic overlap'.

A possible interpretation of these factor-loadings is that the first factor in each analysis represents either *g* or General Educational Ability and that the other factors represent intellectual characteristics, such as mental organisation developed by habitual exercise, special interests or facets of the mind exhibited by different types of mental activity. On such an interpretation, the negative loadings present no difficulty, as the + and - represent logical oppositeness rather than functional opposition. With Burt we should have to describe such factors each as 'primarily a principle of classification and nothing more' (2 Thomson and others 1939, p.84, cf 2 Burt 1936, p.259 and 2 Burt 1940 pp.101-104).

However, sympathy with the point of view of Alexander ('!... our purpose is to resolve abilities into their true psychological factors' (3 Alexander 1935, p 3)) and Stephenson ('A factor must be a real and tangible entity, defined in terms of psychological needs, not a mere statistical artefact, however elegant the procedure by which it is reached' (quoted by Burt in 2 Burt 1940, p.212)) would necessitate an extra step in the analysis. It is precisely this desire for 'psychologically meaningful' factors which causes Thurstone to rotate his factor-axes.

The very idea of 'ability' is, further, so pregnant with positive connotation, that the search for real factors seems to imply the avoidance of negative loadings.

In the present research real factors have been sought by axis-rotations which (1) maintain orthogonality of axes and hence independence of factors, and (2) make all loadings positive in the final configurations. Rotation was first applied to the axes of the first analysis (Table 24 and Fig. 1,2,3).

Let the rotations be performed as follows :

- $$\left\{ \begin{array}{l} (1) \text{ axes } I_1, II_1 \text{ through angle } \alpha \text{ clockwise to positions } I_1', II_1'; \\ (2) \text{ " } I_1', III_1 \text{ " " } \beta \text{ " " } I_1', III_1'; \\ (3) \text{ " } II_1', III_1' \text{ " " } \gamma \text{ " " } II_1', III_1'; \end{array} \right.$$

Then the transformation matrix by which to post-multiply the matrix of loadings (Table 24) is

TABLE 26: TRANSFORMATION MATRIX. GROUP 1.

$$\left\{ \begin{array}{ccc} \cos \alpha & \sin \alpha & 0 \\ -\sin \alpha & \cos \alpha & 0 \\ 0 & 0 & 1 \end{array} \right\} \left\{ \begin{array}{ccc} \cos \beta & 0 & \sin \beta \\ 0 & 1 & 0 \\ -\sin \beta & 0 & \cos \beta \end{array} \right\} \left\{ \begin{array}{ccc} 1 & 0 & 0 \\ 0 & \cos \gamma & \sin \gamma \\ 0 & -\sin \gamma & \cos \gamma \end{array} \right\}$$

$$= \left\{ \begin{array}{ccc} C_1 C_2 & S_1 C_3 - C_1 S_2 S_3 & S_1 S_3 + C_1 S_2 C_3 \\ -S_1 C_2 & C_1 C_3 + S_1 S_2 S_3 & C_1 S_3 - S_1 S_2 C_3 \\ -S_2 & -C_2 S_3 & C_2 C_3 \end{array} \right\}$$

where $C_1 = \cos \alpha, \quad S_1 = \sin \alpha,$
 $C_2 = \cos \beta, \quad S_2 = \sin \beta,$
 $C_3 = \cos \gamma, \quad S_3 = \sin \gamma.$

The rotations were performed by the following steps.

- (1) In Fig.1, the axes I_1 , II_1 , were rotated graphically to trial positions I'_1 , II'_1 , making all new loadings positive.
- (2) The new loadings on I'_1 (trial position) were plotted against the III_1 loadings. This step revealed that it would be only just possible to enclose in one quadrant all the points plotted on this diagram (and thus obtain all positive loadings) if the new loading on I'_1 were first made as large as possible.
- (3) Accordingly, Fig.1 was adjusted to give a new rotation of axes which was to be through the least possible angle giving all-positive (or zero) loadings. This necessitated that the axis I'_1 (true position) should pass through English Language in this plot.
- (4) The new loadings on I'_1 (true position) were plotted against the III_1 loadings, to give Fig.4. It was found that a clockwise rotation through about $5\frac{1}{2}^\circ$ would give new axes passing almost exactly through Art and Mathematics. An arbitrary choice was made to direct the axis III'_1 through Mathematics. The new axes on this diagram were now I''_1 , III'_1 .
- (5) As two zero loadings (English Language on II'_1 and Mathematics on I''_1) and one near-zero (Art on III'_1), with all the rest of the loadings positive, had been

obtained, it was decided not to rotate the axes II' , III' .

These rotations entail that

$$(1) \tan d = \frac{\text{English Language loading with } II_1}{\text{ " " " " } I_1} = + \frac{.3756}{.5197}$$

(using four decimal places where three are given in Table 24)

whence $\alpha = 35^\circ 51'$:

(2) since the Mathematics loading on I_1' is zero

$$.6648 C_1 C_2 - .2097 S_1 C_2 - .3055 S_2 = 0$$

(using original loadings to four decimal places and post-multiplying by the first column of the transformation matrix, Table 26)

in which $C_1 = \cos 35^\circ 51'$, $S_1 = \sin 35^\circ 51'$,

whence $\frac{S_2}{C_2} = \tan \beta = 1.3843$ and $\beta = 54^\circ 9'$;

(3) since $\gamma = 0$, $C_3 = 1$ and $S_3 = 0$.

As it happens that $\alpha + \beta = 90^\circ$, $S_2 = C_1$ and $C_2 = S_1$.

Thus the transformation matrix reduced to

TABLE 27: REDUCED TRANSFORMATION MATRIX, GROUP 1.

$$\left\{ \begin{array}{ccc} C_1 S_1 & S_1 & C_1^2 \\ - S_1^2 & C_1 - C_1 S_1 & \\ - C_1 & 0 & S_1 \end{array} \right\} = \left\{ \begin{array}{ccc} .47471 & .58567 & .65700 \\ - .34300 & .81055 & - .47471 \\ - .81055 & 0 & .58567 \end{array} \right\}$$

The final loadings are given in Table 28.

TABLE 28: FINAL LOADINGS, GROUP 1.

	<u>FACTORS.</u>		
	I_1'	II_1'	III_1'
1. Physics.	.097	.737	.430
2. Chemistry.	.232	.610	.432
3. Geography.	.568	.448	.208
4. Mathematics.	.000	.559	.513
5. History.	.598	.222	.319
6. English Literature.	.558	.119	.429
7. French.	.123	.172	.653
8. English Language.	.184	.000	.658
9. Art.	.189	.339	.016

All these loadings are illustrated in Fig.4,5,6.

Turning to Fig.7, the plot for the second analysis, where there were only two factors, it was found that the subject-points would fit without difficulty into one **quadrant.** A rotation was decided upon which gave French a zero loading in the new first factor. As this also gave French a large loading (.860) in the new second factor, the choice helped to increase the similarity between the factors I_2' , II_2' for the second analysis and I_1' , III_1' for the first.

The rotation from I_2 , II_2 to I_2' , II_2' was through an angle θ clockwise where

$$\tan \theta = \frac{.7250}{.4619}, \quad \theta = 57^{\circ} 30'.$$

The transformation matrix by which to post-multiply the matrix of centroid loadings (Table 25) is

TABLE 29: TRANSFORMATION MATRIX, GROUP 2.

$$\begin{pmatrix} \cos \theta & \sin \theta \\ -\sin \theta & \cos \theta \end{pmatrix} = \begin{pmatrix} .53730 & .84339 \\ -.84339 & .53730 \end{pmatrix}$$

Multiplication gave the following results.

TABLE 30: FINAL LOADINGS, GROUP 2.

	<u>FACTORS.</u>	
	I_2'	II_2'
1. Latin	.162	.826
2. French	.000	.860
3. English Language	.294	.614
4. Mathematics.	.173	.704
5. English Literature	.638	.313
6. General Science.	.453	.302
7. History.	.635	.180

The occurrence of zero loadings for Mathematics in I_2' and English Languages in II_2' with .016 for Latin in III_2' make Table 28 represent an almost unique 3-factor - pattern for positive loadings. In his great research

on the 'Primary Mental Abilities' Thurstone rejects as insignificant 'in naming a factor' any loading below .4 (3 Thurstone 1938 p.79). Each of the factors given in Tables 28 and 30 has at least three loadings above this value, while the smallness of the other loadings shows a close approach to 'simple structure', especially in the former table.

The contrasting influences of the factors upon the examination marks in the different subjects can be seen more clearly from Tables 31 and 32, giving the contributions which they and the specific factors make to the variance of each test.

TABLE 31: CONTRIBUTIONS TO VARIANCE, GROUP 1.

	<u>FACTORS.</u>			<u>TOTAL COMMUNALITY</u>	<u>SPECIFIC FACTOR.</u>
	<u>I.'</u>	<u>II.'</u>	<u>III.'</u>		
1. Physics.	.009	.543	.185	.737	.263
2. Chemistry.	.054	.373	.186	.613	.387
3. Geography.	.323	.201	.043	.567	.433
4. Maths.	.000	.313	.263	.576	.424
5. History.	.358	.049	.102	.509	.491
6. Eng.Lit.	.312	.014	.184	.510	.490
7. French.	.015	.030	.427	.472	.528
8. Eng.Lang.	.034	.000	.433	.467	.533
9. Art.	.036	.115	.000	.151	.849

TABLE 32: CONTRIBUTIONS TO VARIANCE, GROUP 2.

	FACTORS.		SOCIAL COMPLEXITY	SPECIFIC FACTORS
	I' ₁	II' ₂		
1. Latin.	.026	.683	.709	.291
2. French.	.000	.739	.739	.261
3. Eng.Lang.	.086	.377	.463	.537
4. Maths.	.030	.495	.525	.475
5. Eng.Lit.	.407	.098	.505	.495
6. Gen.Sc.	.206	.091	.297	.703
7. History.	.430	.032	.462	.538

Factor I'₁ evidently influences Geography, History and English Literature almost exclusively (i.e. in the battery of tests applied to Group 1) and about equally. Factor I'₂ similarly affects History and English literature (Table 32) in the absence of Geography and, to a smaller extent, General Science. These two factors may therefore be regarded as identical. As the subjects associated with this factor are mainly informational, Burt (3 Burt 1939, p.47) has been followed in suggesting that

$$I'_{1,2} = I'_2 = \text{Informational Factor.}$$

Factor II'₁ is clearly associated with the scientific and mathematical subjects, pre-eminently with physics, and has a small influence on Geography, as might be expected in view of the scientific character of a part of the School Certificate Geography course. It might be regarded as

an informational factor dealing with things, in contrast to the human interest of the first factor, but the moderate loading of Mathematics suggests analytical or manipulative ability. Let us defer the naming of this factor until we have considered III'_1 and II'_2 .

These last two factors are definitely linguistic, but both have a considerable effect on Mathematics. III'_1 appears also to have a fairly small, and about equal, influence on Physics, Chemistry and English Literature. Its influence on History is smaller still and about equal to that of II'_1 on English Literature and General Science. It seems that we can almost, but not quite, identify III'_1 with II'_2 . It may be that the more linguistic orientation of Group 2 in contrast with that of Group 1 has produced a more analytical approach to language study, shown in the drawing-away of French, with Latin, from English Language (which has much the same loading in both III'_1 and II'_2). The more analytical approach suggested would also agree with the heavier loading of Mathematics in II'_2 than in III'_1 . That Mathematics should show a substantial loading with the linguistic factor is not surprising in view both of its analytical character and of its constant symbolisation and manipulation of symbols.

It seems reasonable to conclude that II'_1 , III'_1 and II'_2 are at once analytical and manipulative, the

first being concerned with the analysis and manipulation of things and of relations between things, and the other two being symbolic, with special application to languages. For brevity we may refer to

II'₁ as the Scientific Factor, and to

III'₁ and II'₂ as the Linguistic Factor.

It may be noted that no scientific factor is revealed by the presence of General Science in the second battery: this may be due to the less formal and analytical character of this subject than that of Physics and Chemistry. If this is true, General Science at once appears as a more suitable subject of study than Physics and Chemistry for pupils of no particular scientific ability.

All subjects show considerable dependence upon specific ability, which we may take to imply specific aptitude, interest or application related to the particular subject being studied. This is least true of the analytical subjects such as the foreign languages and the formal sciences and most true of General Science and Art.

CHAPTER SUMMARY

The marks of two groups of boys taking the N.U.J.M.B. School Certificate in July 1946 have been examined. In all, 406 boys, 33 schools and 11 subjects were involved.

The average marks in the different subjects tend to be positively correlated in each school, with this tendency especially strong for particular groups of subjects. The elimination of the differences between school means by the analysis of variance and covariance yields correlations that are, on the whole, slightly smaller than the total correlations but which show an almost identical pattern of subject-linkages. The factors to be extracted by analysis from the subject total inter-correlations are regarded as factors of total mental response to the various situations of subject learning.

The correlations show subject-linkages which are confirmed by the loadings of centroid factors. Plots of these loadings reveal the possibility of axis-rotations which will make all loadings positive. Fig.3. illustrates the 'oppositeness' of subject-groups

(1) Scientific and Literary,

(2) Linguistic and Artistic,

while at the same time showing a merging of groups reminiscent

of the 'cyclic overlap' pointed out earlier by Burt.

A series of rotations yield factors giving positive or zero loadings to all the subjects in both sets. These factors can be identified by their obvious association with certain groups of heavily loaded subjects. The factors may be named and subject-groups associated with them as follows:

- (1) the Informational Factor Geography, History, English literature and (to a smaller extent) General Science;
- (2) the Scientific Factor Physics, Chemistry, Mathematics and (to a smaller extent) Geography;
- (3) the Linguistic Factor French, Latin, English Language and Mathematics, with a small influence on English literature and the sciences.

The loadings suggest that what has been called the Linguistic Factor is capable of development by the increase of language-study, and that this development will show its effect on what are usually regarded as non-linguistic subjects such as Mathematics. This suggested developmental property may belong to each of the factors. If so, this fact is in keeping with the well-established divergence of abilities (e.g. Burt 'The Primary School' p.256, 1931) and the necessity of using more factors in the description of test-results for older than for younger

testees (e.g. 3 Crumiston 1939, as noted in Chapter 4, and 4 Thomson 1939, p.302).

French, Latin, Physics and Chemistry are less dependent upon specific ability for the subject than are the other studies. General Science, however, leans heavily on the specific factors, while ability for Art depends on it almost entirely.

CHAPTER 6: A SUMMARY AND INTERPRETATION OF RESULTS.

At the beginning of Chapter 3 the hypothesis was proposed that the individual child might be considered to possess a number of statistically distinct abilities, each in its own degree, and that each ability might be associated with a definite group of activities. It was also suggested that these essentially cognitive abilities might be affected by non-cognitive elements and that they might, in function, be found to overlap one another.

The hypothesis was proposed with a view to helping the solution of the problems of pupil-classification and subject-grouping at the secondary stage of education. It may now be reviewed in the light of the evidence adduced.

The broad conclusion which can be drawn from very numerous mental tests applied both to children and to adults is that such general positive correlation between test-results exists as to necessitate the conception either of a general factor of ability entering into all performances or of a complex of ability-factors either so wide or so numerous as to produce the appearance of all-over linkage. As investigators have increased the extent of their test-batteries or have introduced novel types of test the multiple-factor conception has gained ground, until, in addition to g , such factors as the number factor, the verbal

factor, the space-perception factor, the practical factor, and so on, have become firmly established. By Thurstone's work on tests applied to college students, the factor which itself seems to have been analysed out of existence, to be replaced by a perceptual factor, a logical principle factor, a restrictive problem factor and a deductive factor (3 Thurstone 1938 pp.79-87, referred to in Chapter 3).

All these tests from which the many factors emerge have been designed to be elemental; they deal with the elements of function out of which the abilities revealed in everyday activities are built. Thurstone names his factors 'primary mental abilities'. Now if such a complexity of elements exists, it is to be expected that the abilities shown in school studies will positively inter-correlate, but that their degrees of correlation will vary not only from one subject to another but also from one group of subjects to another, according as these several groups are more or less affected by different groups of primary factors.

The results obtained by investigating the inter-correlations of school studies make such an explanation in terms of primary factors feasible. Groups of linked subjects have certainly been found with almost uniform consistency. The factorial composition of each inter-related group of school subjects, in the sense of an analysis in terms of primary factors of each group apart from the rest,

awaits disclosure by further research, though Ormiston did attempt this in her work reviewed in Chapter 4. Sufficient has been established, however, to allow an interpretation of subject-abilities in terms of a few broad factors, which, though possibly not fundamental, have clear psychological meanings and are of indisputable practical importance.

It has been shown by Burt that what for practical purposes may be called general ability (in reality, perhaps, an inextricable combination of many primary factors) has a dominating influence in early years, but that its relative importance diminishes as that of other factors increases, until by the age of 12 + the verbal and arithmetical factors together exert an equal influence on school work (Chapter 4, Table 5). Ormiston's factorisation of Junior Scholarship results supports this estimate (Chapter 4, Tables 7 to 10).

Both Carey and Burt found that elementary subjects fell into linked groups, their groups being almost identical, while Burt was able to postulate for children of 10 + (3 Burt 1939) an arithmetical, a manual and a linguistic factor in addition to 'general educational ability'. It is worthy of note that his previous research on the same lines (3 Burt 1917), with slightly older children, had suggested to him that the linguistic factor might be better regarded as two, namely a verbal and an informational factor.

Continued inter-correlation of the same subject-groups during three successive years has been shown by Earle, as noted in Chapter 4. The children in this research ranged from 11+ to 14+ and were engaged in five different types of course in a multilateral school. All-over inter-correlation is marked in Earle's tables, but a slight tendency is perceptible not only for English subjects, Geography and Science, Mathematical subjects and Commercial subjects to show above-average correlation throughout but for these groups to diverge from one another as the pupils increase in age. As Earle himself says (3 Earle 1936, p.34): 'If there is a factor of general ability contributing to high marks in all school subjects its influence seems to be greater in the First Year than in subsequent years, except, perhaps among a small group of pupils who possess a high degree of this innate general ability. On the other hand, the influence of group factors... such as appear in English and in Mathematics... appears to be less in the First Year than in subsequent years'.

The three investigations of School Certificate marks which have been described continue the theme of 'subject-abilities' diverging from each other in groups. The notable groups with Wilson and Ombiston alike are English and History and the Mathematics group, confirming the findings of both Burt and Earle with younger children, together with

an English-French linkage (Wilson) and a French-Latin and a spatial group (Ormiston). g-loadings appear for all subjects in Wilson's and Ormiston's analyses (Ormiston's g-loading for Art being negative) and they are mostly large in Wilson's tables (Chapter 4, Tables 15, 16 and 17) and Ormiston's table for her Language Group (Chapter 4, Table 11). Incidentally, though loadings may be expected to vary from one investigation to another, a g which gives Art a loading of $-.266$ in Table 13 is hard to identify with a g which serves Art to the extent of $+.372$ in Table 16.

The possibility of factorial description without a g, suggested by Thurstone's work, is supported by the new analyses given in Chapter 5. The three broad factors (informational, scientific and linguistic) link together subjects of recognisably similar content-interest and technique. They show a close similarity to Burt's factors, used to describe his 1917 results. Burt's Informational Group consists of History, Geography, Science and Composition, corresponding, in the new investigation, to History, Geography, General Science (with a smaller loading) and English Literature. Burt's Verbal or Linguistic Group, consisting of elementary processes such as Reading and Spelling, appears to have expanded for the older children to embrace the foreign languages, English Language and (to a smaller extent) Mathematics. The parallel between

Burt's Arithmetical Group and the new Scientific Group is not so obvious, but the absence from Burt's tests of science apart from Nature Study (which is more akin to the General Science of the school Certificate course) may have prevented the appearance of an explicit Science factor which might otherwise have been detected (cf. Earle's correlations). In Table 28 the heaviest loadings of Mathematics, Physics and Chemistry occur in the same two factors, so there can be little doubt of the linkage of these subjects. The Manual Group does not appear in the new research, but the separateness of Art agrees with Burt's finding on this subject, as with those of Earle, Wilson and Craiston.

The cyclic overlap of factors pointed out by Burt is confirmed by Earle's correlations and by all three analyses of School Certificate marks.

The questions may be raised: To what extent are these factors be affected by traits of character and temperament? How are they influenced by the pupil's interests? The work of Corey, Stead and Macmillan has shown that scholastic success is partly dependent upon such qualities as attention and persistence. Stead found that 'mental ability' and 'character' were independent of each other, but that both made a contribution to 'scholastic ability'. In other words, children who excel in intelligence tests may fail in school work due to that their

teachers' assessments describe as undesirable character-traits, while others who do only moderately in intelligence tests may through 'attention', 'persistence', 'application' (and so on) do well in scholastic work. Complete agreement with this conclusion is shown by Russell, who illustrates the point with several case studies.

No doubt on this point is likely to be entertained by the practising teacher. It is more, however, than an additional fact to be set alongside our knowledge of ability-factors. These factors have been revealed by studies of the marks obtained in tests upon which 'persistence' and the other traits have had their effect. This suggests, firstly, that the 'abilities' revealed will not be purely cognitive and, secondly, that the factors extracted may be inter-correlated by some over-all factor or factors such as Stead's emotional and moral factors.

Burt's factors (after the first extraction) were independent of 'general educational ability' but it is not clear whether he regarded them as independent of each other. The methods of factorisation used by Wilson and Carleton suggest some correlation between all their factors, including g with the rest, and neither claimed that the factors were independent. But this fact is no evidence that uncorrelated factors might not have been found by a different technique. As to the results given in Chapter 5, for the

first group of boys the most feasible arrangement of factors is an orthogonal system, with all-positive loadings except for a zero (or practically zero) loading in each factor. Further, the zero loadings are in the three quite distinct subjects Mathematics, English Language and Art, and the three factors are each associated by heavy loadings with a recognisably related set of subjects. In other words, three recognisable factors exist which are mutually independent and none of them is common to all the subjects. There appears to be no general emotional or moral factor here. If, then, the feelings and strivings of the boys examined have had any effect upon their marks, this effect is not to be demonstrated in any additional factor, but is, in fact, indistinguishable from the effects of those factors already found. This suggests two things: (1) that there is no general factor comprehending the qualities of 'attention', 'persistence', 'application' and the like, but (2) that these traits are aspects of the ability that determines performance in each associated group of subjects. If the factors postulated are themselves complex structures capable of being further analysed, it might be shown by further research that much the same types of character-trait are elements of each, with, possibly, a central intellectual core uncorrelated with these traits. Such findings (which are at present only conjectures), with the suggestions made above,

would account for (1) the independence of 'mental ability' and 'character', found by Stead, (2) the partial dependence of scholastic success upon character and temperament, found by Carey, Stead and Russell, and (3) the common phenomenon of quite different and sometimes conflicting character-traits being evinced in different branches of school work. (Cf. the reference in Linn. 1917 a, paragraph 6, to children who 'are "conscientious", for instance, in some activities but not in others'.) If the transfer of character traits from one activity to another is within the categories comprehended by 'transfer of training', we may expect such transfer to occur chiefly as a result of the 'conscious generalisation' of particular attitudes into general principles of behaviour (Cf. 3 Henley 1919).

As to the influence of the pupils' interests on the factors, we may observe that no general interest factor linking the different groups of subjects appears. But such a factor would scarcely be expected. The statement of an interest is usually the statement of a preference, and so we should expect the effect of special interests to be to cause decreased correlation between dissimilar subjects and increased correlation of those which are similar (that is, in content or technique). Expressed interests may, as has been suggested for character-traits, be not truly additional to abilities, but only particular aspects of those abilities. Or, again, interest may be an independent

reinforcement of ability. In any case, various independent studies show some correlation to exist between expressed interests and scholastic success. Thorndike, for example, found for 140 college students a median correlation of .41 between interest-grades awarded to subjects by the students themselves and success-grades in the same subjects awarded to the students by their examiners (3 Thorndike 1921). An unsigned article in the 'Times Educational Supplement' refers to correlations between interest and attainment being 'of the order of + .25 to + .40 in the most recent surveys' (3 T.E.S, unsigned, 1945). Mr.R.A.Pritchard, in questionnaire research on preferences among different subjects, addressed to 47 secondary schools, analysed replies from over 8,000 pupils and found that 'There are two reasons which outnumber all the others in the pupils' answers. One is that the subject is interesting or uninteresting; and the other that the pupil can "do" the subject well or finds it difficult'. (3 Pritchard 1935, p.163.G.F.I Pincock 1944). He found also that where the 'difficulty' of the subject involved an operation such as the manipulation of figures or foreign words the reasons advanced against the subject generally involved lack of 'proficiency', whereas the 'content' subjects such as English, History and Geography were placed low, if at all, usually for lack of 'interest'. On the other hand, preference for a subject was usually on

the grounds of 'interest', excluding 'proficiency'.

Even the mathematical subjects were preferred for 'interest' rather than for 'proficiency', except Arithmetic, where 'proficiency' gained its sole clear lead (op.cit.p.234).

Pritchard comments 'There are obviously two types of interest - the one subjective and the other objective. In the mathematical subjects the interest is always subjective, in the process the pupil is conducting. In the literary subjects the interest is mainly objective, in the subject-matter presented to the mind. It is interesting to notice that in the results of this investigation, the subjects eliciting objective interest are all above the average of popularity, whilst those containing subjective interest only are all below that level'. (op.cit.p.234). The analysis of replies according to half-yearly intervals of age of the senders from 12½ to 16 showed very little variation of the order of preference, with

English placed 1st by girls throughout, and, on

average " 2nd " boys ;

History " 2nd " girls throughout, except for

a final 3rd and, on average, 3rd by boys;

Geography placed 4th, on average, by both girls and boys;

Chemistry placed 1st by boys throughout, except for

a final 3rd and, on average, 5th by girls.

Latin, Geometry, Algebra and Physics were the least popular subjects with both boys and girls. French, arithmetic and (for girls) Botany held an intermediate position.

(Cf Burt's list of preferences of children aged 7, 10 and 13 in 'The Primary School' (H.E.S.O. 1931). p. 276, in which practical activities are highly placed and in which girls of 13 place Reading and Composition next in the lead after Dancing and boys of 13 place Nature Study between Handwork and Drawing in their first three).

We may conclude, then, that interest may vary in its nature and that different types of interest tend to attach themselves, on the one hand, to informational ^{and} active subjects, and, on the other, to linguistic and mathematical-scientific subjects. As a guide to probable success, expressed interest must be regarded as only one element to be considered along with relevant character and temperament traits, test-results and, above all, the observed experience of the same or kindred activity. That is not to say, of course, that in classifying pupils for instruction or other activity expressed interests should be disregarded except as a partial guide to 'success': 'success' is itself only part of the objective in education. The effect of working together in groups formed on a common-interest basis may build up abilities which exist only in embryo before such

grouping takes place, apart from social results which may far outweigh success in the ostensible activity.

It would seem, then, to be a valid conclusion that the hypothesis proposed in Chapter 3 and repeated at the beginning of this chapter is tenable. School subjects do fall into psychologically linked groups. The grouping tends to become more definite as the age of the pupils increases. We may describe the grouping which occurs as the operation of distinct, and probably independent, factors. The subjects associated with these factors form informational, scientific, linguistic and, no doubt, other such as manual groups.

In their nature the factors, though covering the cognitive operations of learning, include the affective and conative elements of both learning and self-expression. Traits of character and temperament evinced by the individual are essential aspects of each of his abilities shown in school work, and appear to operate independently in each group of linked activities. Interests, which may be either objective or subjective, may be an additional aspect of the broad ability-factors postulated or may be independent of them. Their influence is selective, tending to increase the separation between the groups of subjects associated with the different factors.

These conclusions are based on the findings of many large-scale and small-scale investigations and represent

the pattern of observable tendencies which emerges.

If individual minds tend to work in the same ways, what is true in the average of many minds will tend to be true of each individual mind. But the tendency for the individual, once established, remains but a tendency. Prof. C. I. Hull has shown (3 Hull 1927 and 2 Hull 1928, pp.452.) that 'the extent of trait differences within the average individual was found to approach rather closely the amount of difference found in a normal group in respect of any single trait'. (2 Hull 1928, p.46). Such variability of the individual discourages any facile expectation that he will conform to any statistically established pattern.

The demonstrated tendencies, then, of school subjects to fall into groups may lead to the planning of curricula in accordance with such grouping, but provision should also be made, where possible, for individual pupils to follow a course which breaks the anticipated pattern.

A further limitation may be noted. The various research projects considered in Chapters 4 and 5 have been concerned with the work of children between the ages of 10 and 16 in pre-1914 elementary schools and in grammar schools, together with one multilateral secondary school. The conclusions, should, therefore, have a close bearing upon the organisation of the grammar school type of school work, on both the curriculum and on the classification of

pupils. In so far as they indicate the general tendencies of organisation of educational abilities in the minds of adolescents they will also show the main lines along which the education of adolescents should be organised. But on the newer types of activity developing in modern and technical schools these factorisations have nothing to say beyond the suggestion that future research may bring to light groupings and tendencies relevant to them.

CHAPTER SUMMARY.

Mental tests applied to both children and adults show such general positive inter-correlation that either a general factor or overlapping group factors must be postulated. The trend of research has been to establish the existence of group factors. The elemental character of mental tests leads researchers to describe the psychological factors extracted from their results as 'primary mental abilities'.

The complex of primary abilities revealed may be expected to lead to the positive inter-correlation of subject-marks in groups. This phenomenon is in fact found, with a tendency for inter-correlations to increase with any one group and to diminish between the subjects of one group and those of another. This tendency makes possible the description of secondary school marks in terms of broad factors which, though distinct from one another, may not be identifiable with primary abilities. The suggestion is made that each subject-group factor may be a complex structure of primary abilities and character and temperament traits. Interest may be another element in the same structure or it may be an independent reinforcement of it. Interest may be of either of two

kinds, objective or subjective. The former is the stronger and is expressed in the leading popularity with adolescents of activity subjects and those which are primarily informational.

The hypothesis of distinct abilities associated with groups of activities is regarded as more tenable by the evidence considered. These abilities appear to emerge from a common fund of general ability which is undifferentiated in early years. By the age of 12+ the influence of the number and verbal factors together is as great as that of the remaining undifferentiated general ability, and also by that age subject groups are distinguishable corresponding to these factors and a manual factor. The verbal factor shows a tendency to divide into two factors more distinctively linguistic and informational. Research with older children has shown that these divisions continue and become more pronounced until, at the School Certificate stage, abilities can be described in terms of uncorrelated factors, none of which is general, but all of which show some overlap with the rest.

The relations between abilities thus established are no more than tendencies for the individual, and any scheme of school organisation based on these relations must, as far as possible, allow for individual pupils to

depart from the expected pattern. The groupings of subjects found must not be taken to include subjects or activities not considered, but the research on which conclusions have been based has been sufficiently comprehensive to suggest that this kind of grouping will apply to all subjects and activities in secondary education. In particular, the bearing upon curricula and pupil-classification in the grammar school is alone.

PART 3 AND CHAPTER 7:

THE APPLICATION OF RESEARCH RESULTS TO SCHOOL ORGANISATION.

The discussion of Part 1 served to emphasise that two of the primary needs of the education of adolescents are flexibility and coherence. The former might be facilitated by the construction of a number of short courses, a selection from which would form each pupil's full curriculum. The achievement of the latter for each pupil might be helped by constructing these courses out of a number of broad unities composed of related subjects.

Certain of these unities together form a widely accepted basis of general education. Beyond this, their more advanced treatment offers, with other areas of study and activity, a field of choice.

The research into ability-relations which has occupied Part 2 was suggested by the need to establish what are the constituent subjects of the broad unities, not simply from the standpoint of complementary content but also from that of relatedness of pupils' reactions.

The psychological linkage revealed, superimposed on and developing out of the effect of general ability, has actually been found to show close agreement with relatedness by complementary content, as instanced by the mathematics-

science group, the language group and the informational or social-studies group. The postulated factors may be said to support the main curriculum-integrations suggested in Chapter 2, while their growing strength with the increasing age of the pupils suggests the desirability of the progressive differentiation of courses containing the corresponding subject-groups.

The work of Burt and others supports the recommendation of the Hadow, Spens and Norwood Committees that a break in school life should be made at about 11 to permit a new grouping according to type or degree of ability. The definite recommendation of Burt himself is that the basis of this grouping should be degree and not type of ability (1 Min.1931 p.258 and 1 Burt 1943 pp.131, 140). The importance, shown by Carey, Burt and Co.ister, of the verbal and numerical factors at this age supports the practice of many Local Education Authorities of testing English and Arithmetic as well as Intelligence in their Special Place examinations. This practice does not, of course, deny the additional value of the school record already widely used and strongly advocated in the Norwood Report (p.17). Whatever influence qualitative differences in ability may be allowed to wield in assigning children at 11 plus to different types of school or course, it seems necessary, as far as practicable, to

divide pupils within the type into streams in accordance with degree of ability.

It is this early streaming which makes it possible for the more able children to commence linguistic, scientific and technical studies which it is greatly to their advantage to start early and which, in their systematic treatment, will never be appropriate to the less able. Such streaming in schools embracing a wide range of intelligence need not, however, be rigidly adhered to. Opportunities of mixing need not be confined to 'out-of-school activities'. The adoption of the device of re-classification, whether in the form outlined in Chapter 1 or otherwise, would allow pupils engaged in different linguistic, scientific and technical studies to come together for literary and social studies, and, more especially, for aesthetic activities. The common core, suggested in a variety of forms, of religious, physical, social and aesthetic education, of the comprehension and use of the native language, of rudimentary mathematics and science, corresponds to common needs. Nothing met in the fore-going review of research suggests that such a basic course is not needed by all pupils; but the wide differences in general ability and the coming into prominence by the very outset of the secondary stage of numerical and verbal abilities suggest that a common treatment of even the elementary language, mathematics and science of the basic course would

be inappropriate. It seems necessary to distinguish, then, between 'common needs' in the sense of studies and activities required by all and needs for similar materials which will be shared by groups of children but not by all.

In the light of these considerations it might be best to arrange that the children of each of the first two years should remain in ability-groups for all linguistic, mathematical and scientific studies, though they might be mixed, without regard for ability, for other activities. In the literary and social subjects, as noted in Chapter 6, interest takes a leading part, the informational factor has scarcely started to develop apart from general ability, and, in any case, moderate class-heterogeneity for these studies is probably advantageous.

About 21 periods per week are suggested as a minimum at this stage for the common core. From 114 the common core might be supplemented, for those children who show signs of linguistic ability, by a foreign language (or, perhaps better still, by a 'languages' course in which the pupils are taught the dependence of English on Latin, Scandinavian and French). The very ablest children of a highly selected group might do two foreign languages, say French and Latin, or French and the 'languages' course. Similarly, technical studies or practical crafts could be used to supplement the basic course of other groups.

The first two years in the secondary school have been suggested as a period both of fundamental instruction and of diagnosis of special abilities and interests (1 Min.1939, p.182 and 1 Min.1943 a, p.18). The recent Report of the Secondary School Examinations Council, 'Examinations in Secondary Schools', recommends that 'Objective tests of various kinds should be set periodically within the secondary school and the results recorded in schoolrecords and used to assist in guiding pupils towards suitable courses of study or types of employment' (1 Min 1947 d, paragraph 10). Standardized mental and scholastic tests, such as those of Ballard and Burt, may be used, but there is a need for more specific ability tests (cf. 3 Earle 1936 and 3 Drew 1944).

The tendency which has been noted for abilities to become more differentiated as the child grows older should lead to the use of more bases of classification and to more scope for choice of subjects. The pooled general, verbal and arithmetical abilities may be a sufficient criterion of classification for the first two years; some would wish to see a double classification in the second year, so as to provide 'sets' for Mathematics and Science as well as retaining general and linguistic abilities as the criterion of selection for forms; but, in any case, the original groupings and the original basis of grouping must

be reviewed not later than the age of 13+. The trend of development suggested by the research reviewed in Part 2 lends support to the recommendation of the Lowry report (pp.18 and 70), and the practice of some authorities, to transfer pupils from one type of course or school to another, where necessary, at this age.

Normally at 13+ the more widely diversified courses should begin. In order to give full weight to the process of ability-divergence and to provide a field of choice for dissimilar interests, it is suggested that classification for scientific and linguistic studies should from now on be carried out separately. The informational subjects (Geography, History and English Literature), would also require separate pupil-classification if differences of treatment for different degrees of the corresponding ability were required. There is no doubt, of course, that learning will be quicker in any subject with a more able class; but the actual manner of presentation is not, it is suggested, likely to vary much in the informational group from one ability-level to another in the early stages. It is, also, held by some teachers of these subjects that some heterogeneity is advantageous, especially to the weaker pupils. How will content greatly vary unless ability-differences are wide. Re-classification for the informational subjects is consequently not recommended before the fifth year.

Where technical, commercial or other special types of subject are involved it may be necessary to re-classify for these. The principle of classification proposed is merely this: that where for any ability differences of degree demand differences of curriculum or of teaching method a new classification be made in respect of that ability.

It is now proposed to describe what the organization of classes and curricula might be under the operation of this principle, chiefly by reference to the subjects whose 3 groupings were shown in Chapter 5, and it will be assumed for purposes of illustration that the school concerned is a three-form entry grammar school for boys.

The first two years will be occupied chiefly by what has been described as the basic course for all secondary schools. To this French might be added for each form and Latin for the 2 form (specially chosen for high verbal ability plus general ability) in the first year; in the second year two forms might do Latin and the third a general language course (in addition to French) designed to teach the dependence of English upon foreign sources. The subjects and time-allotments might be as follows for a thirty-five period week.

TABLE 33: CURRICULUM, 1st YEAR.

FORM A: Religious Instruction (2), Physical Education (3), English (5), History (2), Geography (2), French (5), Latin (5), Mathematics (5), General Science (3), Art (2), Music (1).

FORMS B AND C: Physical Education (4), Music (2), Handicrafts (3), otherwise as A, but omitting Latin.

TABLE 34: CURRICULUM, 2nd YEAR.

FORMS A AND B: as A in 1st year.

FORM C: as A and B except replacing Latin (5), by 'Languages' (2), and Handicrafts (2) and increasing Music from (1) to (2).

At the start of the third year, it is suggested that classification into forms should be made on the basis of linguistic ability, judged by the teachers who know the boys, perhaps assisted by tests of special ability. At the same time a second classification of the same boys should be made on the basis of pooled abilities in Mathematics and General Science, the former being given about twice the weight of the latter owing to its closer association with Physics and Chemistry, with which it forms the scientific group. Under this scheme of double classification, classes for most subjects (chiefly non-scientific) would coincide with forms; mathematics and science classes will be named

'sets'. In the analyses which follow lines of the same colour enclose synchronised blocks of periods. History and Geography are shown as Social Studies in case an integrated course taken by one master in any given class is available.

TABLE 35: CURRICULUM, 3rd YEAR.

<u>FORM A AND B:</u>	Rel.Inst.(1), Phys.Ed.(2), Eng.(4) Social Studies (4), French (5), Lat.(5), Art (2), Music (1).	Sets 1 and 2: Maths (5), Physics (3), Chemistry (3).
<u>FORM C:</u>	Rel.Inst.(2), Phys.Ed.(3), Eng(5) Social Studies (4), French (5), Handicrafts (2), Art (2), Music (1).	Set 3: Maths(5), General Science (4), Handicrafts (2)

In this arrangement each boy may take either of the red blocks together with either of the green blocks. Thus, a good linguist who wishes to take a full science course will be in either the A or B form and also in either Set 1 or Set 2; a non-scientific linguist will be in Form A or B and Set 3; a boy of rather weak linguistic ability who is good at science will be in Form C and Set 1 or 2; a more general and practical course for the least academic boys is provided by Form C and Set 3. Consultation between teachers of related subjects should be a source of integration. In particular, the relation of foreign

languages to English should be dealt with under the language headings put down. This particular arrangement can obviously be applied in a two-form entry school. Its chief advantages are that (1) pupils are classified separately for two groups of subjects corresponding to distinct abilities, (2) allowance is made for the individual who is strong in languages or science or both, or weak in both. It scarcely needs to be added that the periods shown would be distributed through the week. A period in forms might be followed by two periods in sets, to be followed again by a period in forms. So long as the boys of any given year are all in forms or all in sets at any one time, the distribution of periods can be made at will. When the timetable is being made, care will be taken to reduce occasions of re-grouping to a minimum, as far as possible making them coincide with intervals such as the mid-morning and lunch-hour breaks.

In the fourth year, provision should be made, as recommended in the recent Report of the Education Policy Committee of the Headmasters' Conference (December, 1947), for a third foreign language to be taken by the boys who are specially gifted linguistically: German is suggested because of its value as an additional cultural link with Europe, especially in the fields of science and philosophy. If staffing and accommodation permit, a fourth science set

should now come into being for those pupils who have gone as far as they profitably can in formal Mathematics and who now require interesting exercises and applications of a more practical kind. The following arrangement is suggested.

TABLE 36: CURRICULUM, 4th YEAR.

FORM A:	Rel.Inst.(2),Phys.Ed.(2),Eng.(4), Social St.(4),French (4), German (4).	Set 1:	Maths (5),Physics(4), Chem.(4),Library (2).
FORMS B. and C.	Rel.Inst.(2),Phys.Ed.(3), Eng.(4), Social St.(4), French (4), Art (2), Music (1).	Set 2:	Maths (5), Phys (3), Chem,(3), Latin (4).
		Set 3:	Maths (5), Gen. Sc.(4), Latin (4), Handicrafts (2).
		Set 4:	Maths (3), Gen.Sc.(4), Handicrafts (4), Art (2), Library (2).

This arrangement allows future science and mathematics specialists to take up German if they are good at languages (Form A and Set 1). If they wish to retain Latin they will be in Set 2 and will have the choice of whether or not to take up German. Other linguists who wish to retain Latin but do not want a full science course will be in Set 3.

The least academic course is provided by Form C and Set 4. Eight different subject-combinations appear for the fourth year. If the two library periods of Sets 1 and 4 were synchronised, this arrangement would require 13 extra teacher-periods as compared with the normal three-forms arrangement, i.e. the call on man-power would increase in the ratio 118:105.

In order to prepare students of the social sciences for Sixth Form work, the fifth year might see a new grouping on the basis of ability in these studies. Three separate classifications will now be required: for forms on language-ability, for sets on strength in science and mathematics and for 'groups' (to introduce a new class-name) on ability in the social sciences. Keeping the arrangement of sets as for the fourth year, the following for forms and groups is suggested.

TABLE 37: CURRICULUM, 5th YEAR.

FORM A:	Rel.Inst.(1), Phys.Ed.(1), Eng.(4), French (4), German (4).	Group X:	Geography (3) History (3).
FORM B:	Rel.Inst.(2), Phys.Ed.(3), Eng.(4), French (4), Music (1).	Groups Y and Z:	Social Studies (6).
FORM C:	Rel.Inst.(2), Phys.Ed.(3), Eng.(5), Art (2), Music (2).		

It will be observed that French has dropped out of the programme of Form C: this is in keeping with the recommendation

of the Educational Policy Committee of the Home Office's Conference that 'The compulsory study of a foreign language is discontinued after four years'. (Report, p.10).

In the sixth and seventh years the numbers of pupils will be reduced. Immediately before the war pupils of 16 and over in grant-aided secondary schools amounted to 11.8% of those of 11 to 16 (1 Min.1939, p.96). The raising of the school-leaving age to 15 (and, perhaps, in the next few years to 16) and the new national policy in post-secondary education may bring about an increase in the sixth form population. Relative numbers of over-16's in the grammar schools will vary from district to district and from school to school. Hence a reliable estimate of likely numbers in the sixth Form of a three-form entry boys' grammar school is impossible. In the suggestions for the sixth and seventh years which follow it will be assumed that numbers are sufficient to allow each year's pupils to be divided, on average, into three classes.

By the time the sixth Form is reached, the groundwork of general education will have been laid and special abilities and interests should have declared themselves with sufficient clarity to enable each pupil to choose for his main studies informational or linguistic or scientific subjects. Each pupil should be able to choose three main subjects (not all of which he might offer to Principal

standard in the Higher School Certificate or Advanced standard under the proposed new regulations for the General Certificate of Education) and to devote about one-third of his time to studies outside his principal field. It is suggested that in a school following the various curricula already outlined for the first five years the following arrangement might be appropriate. Each pupil would be required to choose one subject from each of the first three columns given below and to attend a class for instruction in the subjects given in the fourth column (unless any of these was already being taken as a main subject, in which case the periods allotted would become private study periods). Periods shown in the same column (except in the fourth) are synchronised.

TABLE 38: CURRICULUM: 6th and LATER YEARS.

English (8)	History (8)	French (8)	Rel.Inst (2), Phys.Ed.(1).
Maths (8)	Physics (8)	Chemistry (8)	English (2), Social St (2),
Biology (8)	Latin (8)	Geography (8)	Gen.Sc. (1).
German (8)			Optional: Music (1), Art (2) or Handicrafts (2)

If two classes were formed for the first eight periods of

(Continued on page 163)

the fourth column, the equivalent of 32 periods for each of three classes would be filled in each year, together with the periods for optional music, Art or Handicrafts. Many usual combinations of subjects are provided for. Subject to the limiting factor of the maximum size of any class, the number of possible combinations of three main subjects is $4 \times 3 \times 3 = 36$.

This outline of possible arrangements for a three-form entry boys' grammar school serves as an illustration of what might be done to secure a flexible curriculum offering a wide choice between different contents and different treatments of groups of subjects shown by reference to be linked by factors of ability. An essential feature of the arrangements is the use of what in Chapter 2 was called 'multiple classification': classification on two or more bases for different groups of activities allowing choice to each pupil of several curricula. By combining this system of choice with the subjects generally recognised as forming the essential foundation of secondary education it has been possible to cover the requirements of a core-and-options programme.

It must be emphasised that such a programme does not presuppose anything unusual in regard to staffing and accommodation. As table 39 shows, a pupils-to-teacher ratio of 20:1 is assumed.

With little alteration what has been described could be made to apply to a two-form entry school. At each stage there would then be two forms and, from the third year, two or three sets: the number of combinations open to the Sixth Form would have to be reduced. For four or more forms at entry the field of choice could be much extended.

In a modern school the different groups of activities would differ from those used in the illustration, except for the basic course represented by the first two years' work, omitting Latin and, except perhaps for a top form, French. A technical school, similarly, would require various technical options in addition to the basic course, but the same method of rendering the different combinations available would apply. In a multilateral school the technique of multiple classification could be used both to give a wide choice of alternative curricula, some combining practical and academic subjects in novel ways, and to give a mixing of children foreign to the whole idea of rigidly segregated streams.

Mixed schools are accustomed to special groupings on a sex basis, for example synchronising domestic science for girls with woodwork for boys. The kind of organization outlined would merely extend the practice and multiply the bases of classification.

In short, the methods advocated seem to be applicable to any secondary school where there are enough pupils in any given year to form two or more classes.

From the use of the methods of school organization herein described certain benefits might be expected to follow, some of which have already been realized in one school in which those methods have been in use since September, 1915. In the first place, the time-table is adaptable to the abilities and interests of the individual pupil. The system of re-classification does not prescribe a pattern of abilities, but allows for independent variation in just those abilities in which research or experience has shown independent variation to be most common. Variation within the group of linked subjects is provided for by instituting courses in which one or two of the subjects, but not all, vary: e.g. while one science set takes Mathematics, Physics and Chemistry, another set will take Mathematics and General Science. The actual treatment of the subjects in each class will depend, of course, on the apparent needs and modes of reaction of the members of that particular class, and is a matter for the teachers in charge of it. It cannot be claimed that all conceivable variations of ability within the prescribed subjects are allowed for; it can be claimed, however, that there are fewer chances of mistakes in the difficult task

of guiding each child to the best combination of educative activities available for him in his particular school. And what is almost as important, if it be found after a time that his guidance was faulty, it is comparatively simple to change him from one set to another or from one form to another without dislocating his entire programme. (Cf. Howson's report, p.16).

In the second place, the system tends to increase the consciousness of the teachers that they are called upon to consider the needs and potentialities of each pupil and to act together as a team for his educational guidance.

At each time of promotion, say the end of a school year, the considered opinion of his teachers on the most appropriate series of classes for the ensuing year should be communicated to each pupil, with an explanation of what the various possibilities are from which a selection must be made. This can be done in a few minutes with each form. An opportunity should then be given for each child or his parents to ask for a different course. The short experience of the scheme in operation shows very few requests for a different course to be made; sometimes a boy's course is settled in an interview between parent and Headmaster. The third benefit which might be named is the resulting increase in mutual understanding between children, parents and teachers.

The variation of working groups helps to give

recognition to an isolated good ability. A boy is weak in languages and finds himself in a C form, but his strength in Mathematics and/or Science may justify his inclusion in set 1. In each class he will be placed with others with like ability and, probably, similar interests.

The association of each class with a particular course helps each teacher to think of his own work in relation to the rest of the course. Not only do promotions necessitate consultation between staff responsible for the same course, but there is a tendency for consultation on the day-to-day work to increase, with great possibilities for subject-integration and staff team-work.

CHAPTER SUMMARY.

The broad unities suggested in Part 1 as the elements of a curriculum which might be both flexible and coherent have been shown by research to be largely the same whether their constituent subjects be chosen for complementary content or psychological linkage.

The 'common core', advocated by many writers, should be the basis of the curriculum and should dominate it for the first two years of the secondary stage. The wide differences in general ability at 11 + and the coming into prominence at that age of numerical and verbal abilities require that children should be grouped according to degree of ability for all linguistic, mathematical and scientific studies, though they may be mixed, without regard for ability, for other activities. The common core should be supplemented by additional linguistic, technical or practical activities.

The first two years is a diagnostic period. There is a need for the fuller development of tests of special abilities. Those which are now available may be used to supplement the teachers' own estimates.

At 13 +, or, if possible, earlier, such transfers to other schools or other courses as appear desirable in

view of the shown abilities of the children should be made. From this age the progressive differentiation of abilities should be allowed for, and the following principle of classification is proposed: that where for any ability differences of degree demand differences of substance or of teaching method a new classification be made in respect of that ability.

The operation of this principle is illustrated in application to the organisation of classes and sessions in a three-form-entry boys' grammar school. After the first two years' basic course, the pupils of the third, fourth and fifth years are divided by reference to linguistic ability into 'forms' and by reference to mathematical and scientific ability into 'sets'. By synchronising forms and separately synchronising sets, each form and each set is made available to each pupil of the corresponding year. In the fifth year a new classification into 'groups' by reference to ability in social studies is made to provide a way for sixth form work in this field. Five years complete the general course. For subsequent years a wide choice of three main subjects is suggested, together with general studies occupying from one-quarter to one-third of the pupils' time. A time-analysis of the suggested organisation shows a pupils to teacher ratio no less advantageous than 20:1 to be sufficient, working about

thirty periods per week to each teacher.

The methods illustrated can be adapted to the special needs of different types of secondary school, with the exception of the single-form entry school.

Benefits which may be expected to result from organisation on the suggested lines are as follows:

- (1) differing abilities and interests are readily accommodated and transfer made where necessary;
- (2) the teacher's function as an educational guide is given prominence;
- (3) the periodic guidance and pupils' choice, with the opportunity for expressing parental wishes, make for increased mutual understanding;
- (4) the variation of working groups gives recognition to isolated good abilities and provides a basis of common interest and similar ability in each class;
- (5) the system tends to promote subject-integration and staff team-work.

APPENDIX A: AN EXISTING SCHEME.

Reference was made in the final chapter to one school in which an organisation on the lines those suggested has been working since September, 1946. The scheme in use was made public in an article that appeared in the 'Times Educational Supplement' on 16th November, 1946. The article is appended in order to show what considerations led to the adoption of the scheme and what actual arrangements were made.

In any real situation plans cannot be dependent only on theoretical considerations. The qualifications and practices of existing staff, the previous instruction of the pupils to whom a new plan is to apply, the physical limitations (such as the possession of only one gymnasium, one art-room and two laboratories for 540 boys) and the school's traditions, which are a part of its very life, - all these things must be taken into account in drawing up any practical scheme.

The Grammar School of Queen Elizabeth, Halesfield, where the methods were applied, is an ancient school with a strong classical tradition. For many years the boys had been divided into 'classical' and 'modern' streams. More recently, the growth of the school had necessitated

further options and differing combinations of linguistics, scientific, literary and social studies had arisen. By the autumn of 1945 it was felt to be necessary to review both the available courses and the method of pupil-classification. It was to a staff committee that, early in 1946, I proposed a scheme of multiple classification which, after some discussion and emendation, was accepted.

The arrangements described in the article reproduced below still stand, apart from small alterations made in September, 1947, in order, for example, to avoid lunch-hour periods (six of which were necessitated by the original plan), to include Geography in every pre-school certificate course, and to make Mathematics an alternative option to General Science for the classical set 1 in the 3rd and 4th Years. A new form, known as the Remove, was also instituted in 1947, to be placed in the middle of a five years course leading to the School Certificate; but as this form takes a common course, it does not affect the article here. A small error (of my own) in the published article has been corrected in what follows.

'GRAMMAR SCHOOL EXPERIMENT'

'A FLEXIBLE CURRICULUM'

' A major problem entailed by the new conception of

secondary education is that of correctly classifying pupils according to their interests and abilities, and of providing appropriate curricula. This problem is not simply one of dividing out children at 11: into three or more streams and providing for them three or more types of secondary school.

The division of pupils into forms, whether by age or "all-round" ability, results, if the division be rigidly adhered to for all subjects, in the "learning" of "subjects" in which some of the children are not interested and the neglect of activities which, however educative, cannot be found a place in the form time-table. It also creates heterogeneous classes, to the especial detriment of the brighter pupils. This difficulty is acute in the grammar school, where School Certificate requirements and the specialist qualifications of staff tend to aggravate it.

Various expedients have been used to try to solve the problem. Avoidance of the heterogeneous class has been sought in the 'set system', while the desire for increased flexibility of curriculum has led, in some schools, to the introduction of a 'core-and-options' organisation. Both these schemes have great benefits to offer. The set system, however, as generally understood, with A, B and C classes for each set subject (in a three-form year), presents the staffing difficulty of requiring simultaneous

instruction to be given in the same subject for all the sets of any given year and also dictates that each set, however strong or weak, shall receive the same time-allocation for the subject in question. The core-and-options organisation presents the difficulty of deciding what shall be the core (the options will in most schools tend to elect themselves), of whether it shall be the same core for all pupils, and how the time shall be divided between core and options.

A new scheme of organisation recently introduced into a boys' grammar school, and chiefly affecting the last two years of a four-years School Certificate course, may be of interest to readers as an attempt to secure the advantages and avoid the disadvantages of both sets and options. In framing the scheme attention was paid to the facts that the homogeneous class is especially demanded for Foreign languages, mathematics and (to a lesser degree) science, while for the English subjects a measure of heterogeneity is welcomed by some teachers. Another guiding principle lay in the belief, borne out by experience, that distinctive interests and abilities tend to become more pronounced as time goes on. The basic aims of the new organisation may be summarized as follows:

1. To provide for progressive divergence of courses and to ensure that alternatives shall give not only

variety of subjects but also varied time-allocations for the same subjects;

- ' 2. To give reasonable freedom of choice to pupils over as wide a field of options as possible;
 - ' 3. To classify pupils for each subject or group of related subjects solely by reference to individual interest and ability in that subject or group, except where heterogeneity is desired;
 - ' 4. To reduce the sizes of classes for practical work, especially in the laboratories;
 - ' 5. As far as possible to maintain form organisation for the sake of (1) community spirit; (2) keeping room-changing to a minimum; and (3) saving staff-time.
- ' There are three forms of about 30 boys in each year and 35 periods in the week for all forms except one first year form which has 33.

The organisation of the four years up to school Certificate is as follows :-

- ' 1st Year. - Three parallel forms take a common course of Religious Instruction (1), P.T. (2), English (5), History (2), Geography (2), Art (2), Woodwork (2), French (5), Latin (5), Mathematics (5), General Science (3), Singing (1). (Numbers in brackets give the numbers of periods in the week devoted to

each subject. One first form loses one period of English and one of Latin, because of special requirements of accommodation).

2nd Year:- Boys are promoted from first year forms on abilities in Latin and French only, with emphasis on Latin. This makes the three forms automatically foreign languages sets. Other subjects vary as shown below. All subjects are taken in forms except Mathematics, Chemistry and Physics, which appear in the curricula of the A and B forms and for which common sets 1 and 2 are provided. The C form follows a common course: there are no sets. In the analysis which follows || indicates groups of synchronised periods.

- | | | |
|-----|---|---|
| A : | Religious Instruction (1), P.T.(1),
English (4), History (2), Geography
(2),
French (5), Latin(5), Greek (3). | Sets 1 and 2:
Mathematics (5),
Chemistry (4),
Physics (3). |
| B: | As above, omitting Greek and
giving Religious Instruction (2),
and Art or Woodwork (alternatives)
(2). | |
| C : | Religious Instruction (2), P.T.(2), English (5), History (3),
Geography (3), French (5), Art (2), Woodwork (2),
Mathematics (6), General Science (5). | |

3rd Year :- Promotion to the three forms is on ability in French only (unless all-round ability is too low to warrant promotion at all), with the proviso that all A boys do Latin. For B (second set in French), Latin is optional. C do not take Latin. There are two Latin sets, X and Y. English, History, French, Religious Instruction and some P.T. are taken in Forms. For all other subjects all the pupils of the year are pooled and divided into sets following the alternative courses indicated below.

A	R.I.(2), Eng.(5), Hist.(3), French (5) P.T.(1)	Set X: Latin (4) Set Y: Latin (4)
B	R.I.(2), Eng.(5), Hist.(3), French (5), P.T.(1)	B. non-lat: P.T.(1), Eng.(1), Hist.(1), Fr. (1)
C	R.I.(2), P.T.(2), Eng.(6), Hist.(4) French (6)	

(continued) :-

A	Set X : Lat.(1) | P.T.(1)	Set 1: Greek(5), Gen. sc.(5)	Set 1: Geog.(3)
B	Set Y: P.T.(1) | Lat.(1)	Set 2: Maths (5), Chem.(4), Phys.(4)	
B non-Lat.	Art (2)	Set 3: Maths (5), Gen. sc.(3), Geog.(3), Art (2).	
C	OR Woodwork (2)	Set 4: Arith.(3), Gen. sc.(4), Geog.(4), Lat (2).	

Set 1 Geog raphy is taken outside normal class time to allow

any boys in Set 2 who wish to do Geography to attend.

'4th Year. Organisation is on the same lines, with the same division into forms and sets, with the same subjects, as in the 3rd Year. Boys promoted into a 4th Year form will probably remain in the corresponding groups to those occupied in their 3rd Year, though this is not necessary.

'When it is added that additional voluntary classes are provided in Art, Woodwork and Music, it will be seen that an extremely wide range of courses is available. This middle school organisation leads to similar variety in the Sixth Forms where any of the academic studies previously mentioned may be continued to H.C. standard.

'The present writer would be glad to receive details of any other scheme of school organisation which is framed to deal with the same problems. Address, 193, Leeds Road, Newton Hill, Wakefield.'

In response to the invitation with which the article ends a few letters were received from interested readers, with some further inquiries, but no details of any comparable scheme were sent.

APPENDIX B: THE LINEAR PROGRAMMING METHOD.

A description is given below of the actual methods of formulating and working a scheme such as that described in Appendix A.

Some of the points to be mentioned are, no doubt, a common feature of all tasks of time-table construction. It may be of interest, and may avoid misunderstandings, however, to set down all the main points which it has been found necessary to bear in mind. Those points will be dealt with in the following order:

- (1) preliminary data, (2), decisions, (3) the actual time-table,
- (4) the allocation of pupils to forms and sets.

(1) Preliminary data.

The following information is required before any scheme can be formulated.

- (a) The number of pupils in each year. Their present arrangement in forms, sets, etc., and the course being followed. The minimum number of classes required under the new scheme.
- (b) The total staff-time available. Working to 30 periods per week for each full-time teacher, if the number of such teachers (or their equivalent) is S , the maximum weekly number of class-periods

for the whole school as 300. If the number of periods in the week is 35, the maximum average number of classes in operation is $\frac{300}{35} = \frac{60}{7}$. Conversely, the minimum number of staff required for an average of 3 classes working at any one time is $\frac{70}{5}$.

The maximum number of classes in operation at any time is, of course, 3.

(a) The subjects which each master can teach, is able and willing to teach, and to what level.

(d) The total number of rooms available, with special reference to laboratories, domestic science rooms (in girls' or mixed schools), gymnasiums, etc..

(e) The existence of any special equipment such as film projectors, wireless relay points and loud-speakers.

(2) Decisions.

As a matter of policy, certain decisions must be made about the use to which man-power, accommodation and equipment are to be put. The first three decisions listed below are mutually dependent: (a) and (b) are pre-requisites of (c) while (d) represents a logically necessary step following (c). (e) is required before the time-table is made.

- (a) What subjects to teach at what stages.
- (b) What appropriate allotment of time is required for each subject at each stage. (If this point is to be discussed by a committee, a good chairman is essential).
- (c) A plan (Plan A) must be drawn up, showing
- (i) what arrangement of classes, i.e. forms, sets, etc., are to operate in each year;
 - (ii) what subjects, with their numbers of periods, are to be taken by each class (to be checked against preliminary data);
 - (iii) which blocks of periods are to be synchronized (noting that in any block the number of periods must be the same for each class and that the periods covered by the different blocks must fit into a school week). (Plan A is illustrated in Chapter 7, Tables 33 to 38, and in Appendix A).
- (d) Another plan (Plan B) must be made, showing an analysis of each teacher's time, with the subjects taught and the number of periods given to each class. Where the same pupils are in both forms and sets, both forms and sets must be shown separately in the plan. Plan B is checked by reference to Plan A.

FORM

	1.	2	3	4	5	6	7
6 Sec. (3)							
" " (2)							
" " (1)							
5 Upper A							
" " B							
" " C							

Plan D can be made in the same way, with columns for days and periods, and one row for each teacher, or columns can stand for teachers and rows for times (if desired, one row for each day and a column row for each period).

In each space in one plan there corresponds a space in the other. Corresponding spaces are filled up at the same time (except for rooms, which are inserted later, unless they are special rooms such as laboratories). In each space in Plan C are entered a subject and teacher. In the corresponding space in Plan D are entered a class and subject. When both plans have received these entries in all their spaces, rooms are allotted, their numbers being inserted in corresponding spaces. Consideration is necessary to Plans C and B to secure agreement.

The insertions in Plans C and D are made in the following order:

- (i) lessons requiring special times (e.g. broadcast lessons);

- (ii) the narrowest blocks of synchronised periods in Plan A;
- (iii) lessons requiring special rooms;
- (iv) the remaining blocks of synchronised periods, starting with the narrowest.

All the time that insertions are being made regard must be had to the appropriate spacing of lessons in the subject for the same class and to the convenient spacing of the individual teachers' periods. It is a comfort to realise that the better the spacing at the beginning, the easier the spacing at the end, as appropriate spaces for future entries tend to be left blank.

Plans C and D, when completed, constitute, in their different forms, the time-table of the whole school. It is an easy matter to transcribe the time-tables of individual teachers and of forms and sets.

(4) The allocation of pupils to forms and sets.

The general principles have been discussed in Chapter 7. The following is the method of putting them into practice which is actually in use.

The Headmaster places each new boy in an appropriate form. If this form is affected by the multiple classification scheme, the master in charge of the class is consulted and a course decided on for the boy which

seems best to correspond to his previous work, to his interests and to his projected career (if any).

During the summer term a provisional list is compiled by one master giving new forms and sets for all boys x including those about to enter one of the Sixth Forms. This list is made out, in the first place, by reference to each boy's previous work, his degree of success in each subject as shown by terminal reports and examinations, and his special interests, so far as known.

The provisional list is then checked and, if necessary, altered, in two ways. Firstly, it is passed round the staff and thoroughly discussed, both informally and in specially convened meetings of groups. Secondly, after agreed changes have been made, each pupil is told to what classes and courses he has been provisionally assigned (by reading portions of the list to forms). It is made clear that changes can be made in response to special requirements of projected careers, strong preferences or parents' wishes. After all such requests have been considered and, so far as practicable, accommodated, the provisional list is handed to the Headmaster for his final decisions and approval.

x Excluding, in the school using the scheme, boys in the Junior Department, i.e. under 11.

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TABLE 39: Curriculum, Time-Analysis.

	Rel. Inst.	Phys. Ed.	Eng.	Hist.	Geog.	French.	Latin.	German.	Maths.	Physics.	Chemistry.	Bio-logy.	Art.	Music.	Handicrafts.	Library.	Total
1st Year.	6	11	15	6	6	15	5	-	15	3	3	3	6	5	6		105
2nd "	4	12	17	6	6	15	10	-	15	3	3	3	6	3	2		105
3rd "	4	7	13	6	6	15	10	-	15	7	7	2	6	3	4		105
4th "	6	8	12	6	6	12	8	4	18	9	9	4	6	2	6	2	118
5th "	5	7	13	9	9	8	8	4	18	9	9	4	4	3	6	2	118
6th "	4	2	12	10	10	8	8	8	8	8	8	10	2	2	2		102
7th "	4	2	12	10	10	8	8	8	8	8	8	10	2	2	2		102
Total	33	49	94	53	53	81	57	24	97	47	47	36	32	20	28	4	<u>755</u>

N.B. 2 periods of 'languages' for 2nd Year Form C are counted as English in the analysis.

4 periods of "General Science" any class are counted as 1 Physics, 1 Chemistry and 2 Biology.

Number of pupils assumed = 500. Number of teachers required = 25. Pupils-to-teacher ratio = 20:1.

TABLE 19: Means (M), Deviations (d) and Average Absolute Deviations (Av. |d|), Schools A to Q (Group 2).

Schools	English Language.		English Literature.		History.		French.		Latin.		Maths.		General Science.		Av. |d|.	
	M	d	M	d	M	d	M	d	M	d	M	d	M	d		
A	23	17.0	+3.0	13.4	+0.6	12.7	-1.6	19.9	+4.3	14.5	+3.7	19.7	+5.3	13.5	-1.1	2.4
B	17	12.4	-1.6	12.5	-0.3	12.4	-1.9	13.2	-2.4	8.3	-2.5	14.4	0	14.0	-0.6	1.3
C	25	13.8	-0.2	14.5	+1.7	16.6	+2.3	13.4	-2.2	6.4	-4.4	11.8	-2.6	17.1	+2.5	2.3
D	4	14.5	+0.5	14.8	+2.0	15.3	+1.0	16.8	+1.2	9.3	-1.5	13.5	-0.9	16.3	+1.7	1.2
E	14	11.6	-2.4	11.4	-1.4	10.6	-3.7	15.1	-0.5	7.0	-3.8	12.9	-1.5	15.4	+0.8	2.0
F	14	14.6	+0.6	14.2	+1.4	12.7	-1.6	17.4	+1.8	12.9	+2.1	18.6	+4.2	18.0	+3.4	2.2
G	7	16.9	+2.9	13.7	+0.9	15.0	+0.7	14.7	-0.9	15.4	+4.6	15.9	+1.5	17.1	+2.5	2.0
H	4	15.8	+1.8	12.3	-0.5	18.5	+4.2	15.8	+0.2	13.8	+3.0	15.3	+0.9	16.3	+1.7	1.8
I	11	13.4	-0.6	14.1	+1.3	18.9	+4.6	14.9	-0.7	10.1	-0.7	13.4	-1.0	13.4	-1.2	1.4
J	3	14.7	+0.7	12.0	-0.8	15.0	+0.7	14.0	-1.6	8.3	-2.5	13.3	-1.1	11.7	-2.9	1.5
K	7	16.3	+2.3	14.0	+1.2	19.0	+4.7	20.4	+4.8	15.0	+4.2	18.3	+3.9	16.1	+1.5	3.2
L	26	12.5	-1.5	11.8	-1.0	12.2	-2.1	15.7	+0.1	12.6	+1.8	11.2	-3.2	14.8	+0.2	1.4
M	7	12.4	-1.6	7.7	-5.1	12.6	-1.7	11.7	-3.9	6.1	-4.7	14.3	-0.1	12.4	-2.2	2.8
N	29	14.3	+0.3	12.4	-0.4	15.8	+1.5	14.3	-1.3	11.0	+0.2	13.5	-0.9	11.5	-3.1	1.1
O	4	11.5	-2.5	11.3	-1.5	14.8	+0.5	15.5	-0.1	11.8	+1.0	12.3	-2.1	12.8	-1.8	1.4
P	1	11.0	-3.0	18.0	+5.2	17.0	+2.7	20.0	+4.4	17.0	+6.2	18.0	+3.6	21.0	+6.4	4.5
Q	2	18.5	+4.5	13.5	+0.7	16.0	+1.7	20.5	+4.9	19.0	+8.2	18.0	+3.6	14.0	-0.6	3.5
Total 198																
Subject-mean for																
whole Distribution.		14.0		12.8		14.3		15.6		10.8		14.4		14.6		

Fig. 1: Loadings on Axes I, II, and Rotation to Axes I', II',

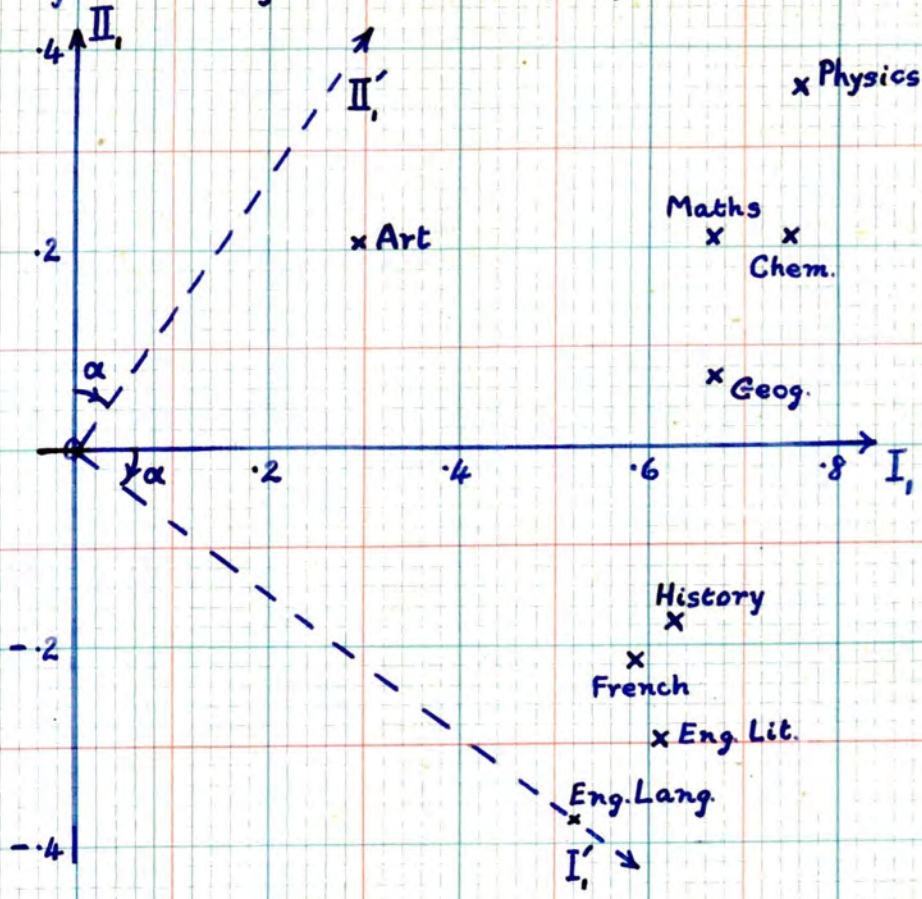


Fig. 2: Loadings on Axes I, III,

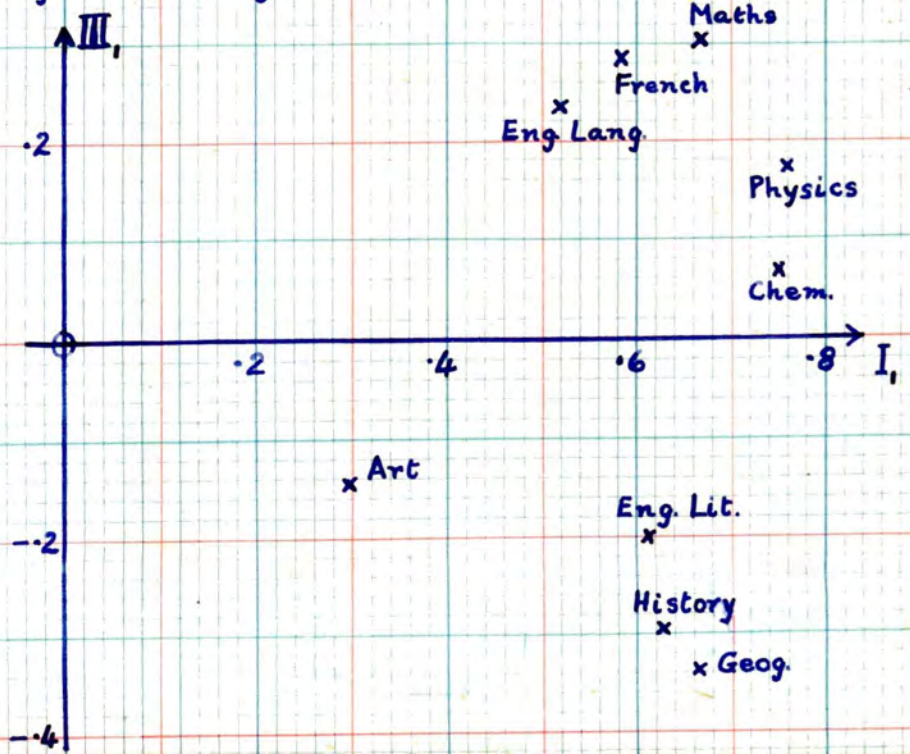


Fig. 3: Loadings on Axes II, , III, .

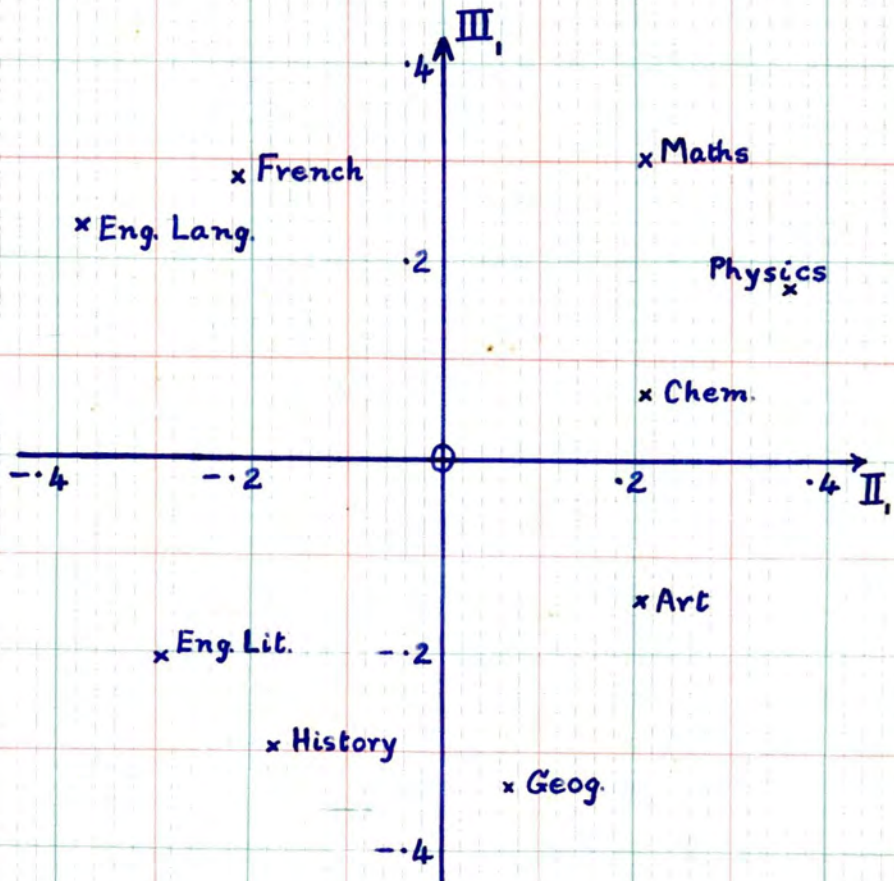


Fig. 4: Loadings on Axes $I', III,$ and Rotation to Axes $I'', III',$

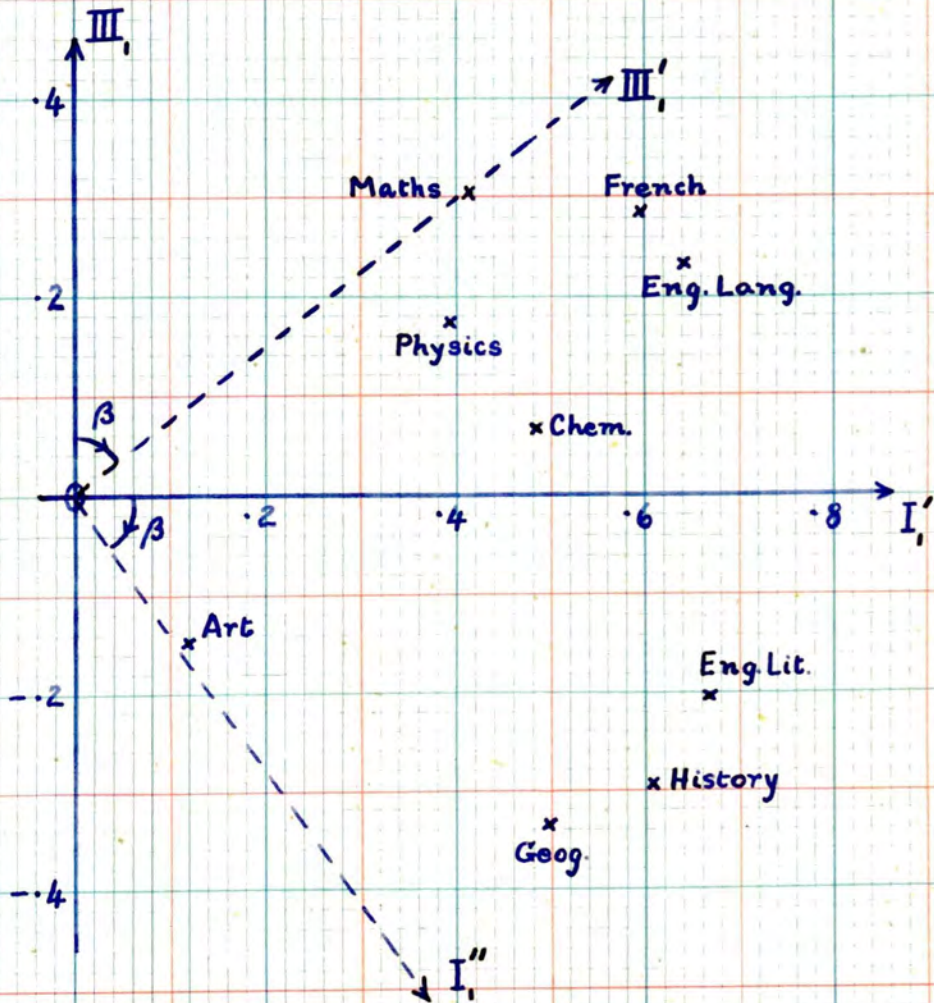


Fig. 5: Loadings on Axes I_1'' , II_1' .

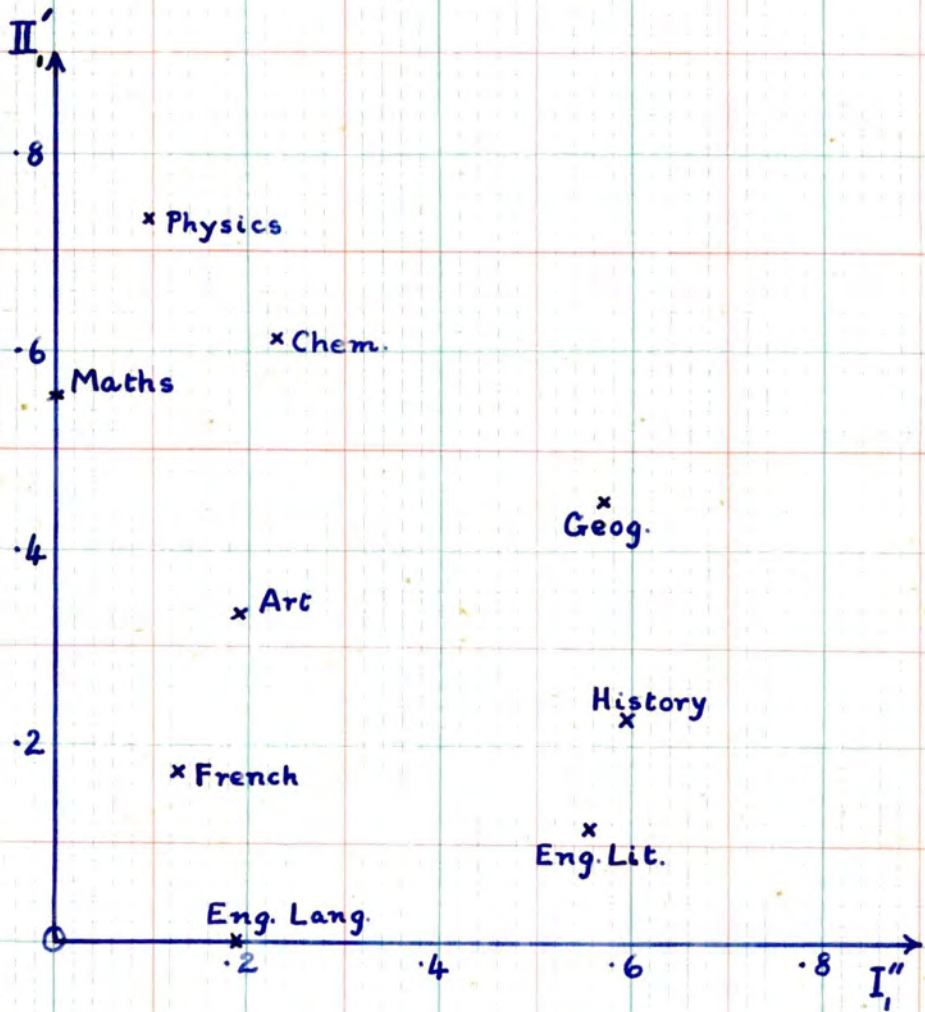


Fig. 6: Loadings on Axes III'_1, II'_1 .

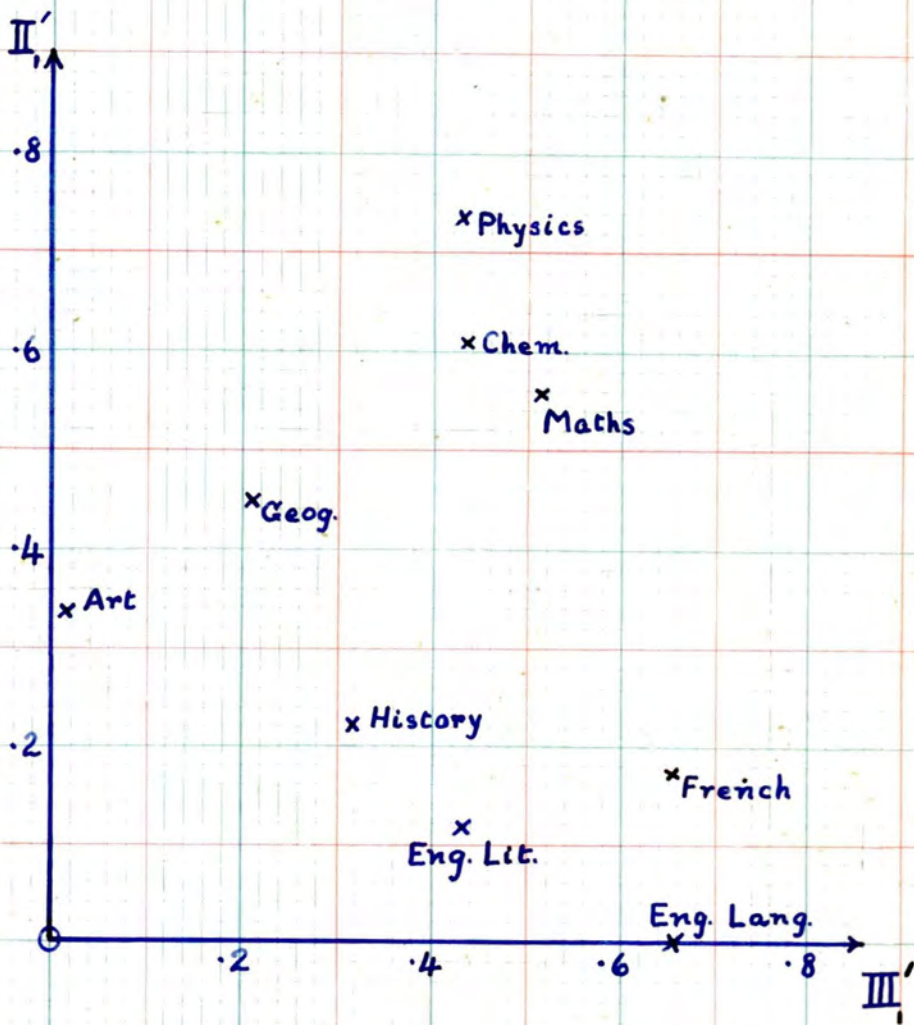


Fig. 7: Loadings on Axes I_2, II_2 and Rotation to Axes I'_2, II'_2 .

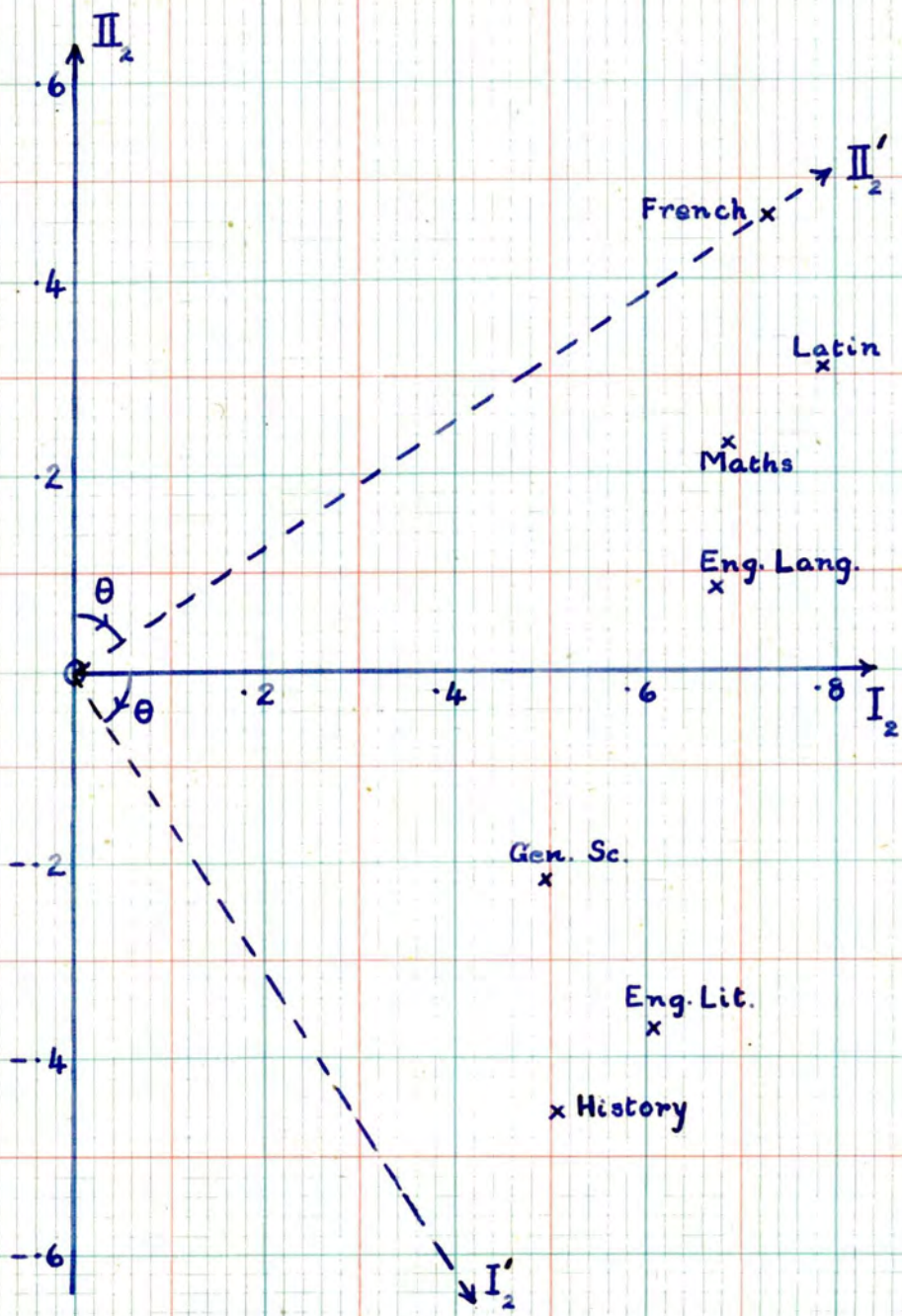


TABLE 18: Means (M), Deviations (d) and Average Absolute Deviations (Av. |d|), Schools 1 to 16 (Group 1.)

No.	N	English Language.		English Literature.		History.		Geography.		French.		Maths.		Physics.		Chemistry.		Art.		Av. |d|.
		M	d	M	d	M	d	M	d	M	d	M	d	M	d	M	d	M	d	
1	25	12.7	-0.1	12.0	-0.3	12.1	+0.2	13.0	-1.1	10.8	-0.5	15.1	+0.7	11.6	-0.6	12.0	-0.9	12.9	+0.2	0.6
2	4	13.8	+1.0	13.6	+1.3	11.3	-0.6	13.3	-0.8	10.3	-1.0	17.6	+3.2	16.0	+3.8	16.0	+3.1	12.9	+0.2	0.6
3	9	12.9	+0.1	11.1	-1.2	9.3	-2.6	10.8	-3.3	15.2	+3.9	12.6	-1.8	12.6	+0.4	11.0	-1.9	12.3	-0.4	1.7
4	48	13.6	+0.8	12.7	+0.4	12.9	+1.0	15.7	+1.6	12.6	+1.3	17.9	+3.5	13.1	+0.9	13.9	+1.0	11.9	-0.7	1.8
5	1	15.0	+2.2	17.0	+4.7	17.0	+5.1	22.0	+7.9	10.0	-1.3	8.0	-6.4	13.0	+0.8	14.0	+1.1	5.0	-7.7	4.1
6	9	14.2	+1.4	13.2	+0.9	13.4	+1.5	13.4	-0.7	13.0	+1.7	14.4	0	13.6	+1.4	14.0	+1.1	12.4	-0.3	0.9
7	4	15.3	+2.5	15.3	+3.0	15.8	+3.9	17.3	+3.2	10.8	-0.5	15.8	+1.4	16.0	+3.8	15.0	+2.1	17.3	+4.6	2.8
8	4	15.0	+2.2	16.3	+4.0	16.5	+4.6	17.0	+2.9	8.3	-3.0	11.5	-2.9	13.0	+0.8	13.0	+0.1	13.0	+0.3	2.4
9	21	11.3	-1.5	8.8	-3.5	7.9	-4.0	12.2	-1.9	5.5	-5.8	7.7	-6.7	7.1	-5.1	9.0	-3.9	11.4	-1.3	3.7
10	8	12.8	0	14.9	+2.6	14.8	+2.9	14.5	+0.4	15.5	+4.2	18.8	+4.4	16.1	+3.9	17.0	+4.1	16.4	+3.7	2.9
11	33	11.3	-1.5	13.5	+1.2	12.2	+0.3	15.5	+1.4	10.3	-1.0	14.2	-0.2	13.2	+1.0	14.5	+1.6	13.4	+0.7	1.0
12	13	12.0	-0.8	10.6	-1.7	9.5	-2.4	12.0	-2.1	11.4	+0.1	12.8	-1.6	10.3	-1.9	9.3	-3.6	14.3	+1.6	1.8
13	9	14.2	+1.4	11.6	-0.7	18.0	+6.1	15.4	+1.3	15.2	+3.9	14.1	-0.3	13.4	+1.2	14.6	+1.7	19.0	+6.3	2.5
14	1	15.0	+2.2	14.0	+1.7	15.0	+3.1	15.0	+0.9	16.0	+4.7	16.0	+1.6	21.0	+8.8	8.0	-4.9	19.0	+6.3	3.8
15	5	13.0	+0.2	15.0	+2.7	12.0	+0.1	15.8	+1.7	10.4	-0.9	17.2	+2.8	15.8	+3.6	16.0	+3.1	14.6	+1.9	1.9
16	14	12.9	+0.1	11.4	-0.9	9.4	-2.5	11.9	-2.2	12.6	+1.3	11.2	-3.2	8.9	-3.3	11.7	-1.2	11.2	-1.5	1.8
Total 208																				
Subject-Mean																				
for Whole		} 12.8		} 12.3		} 11.9		} 14.1		} 11.3		} 14.4		} 12.2		} 12.9		} 12.7		
Distribution.																				