

SOCIAL CLASS, PEDAGOGIC PRACTICE
AND ACHIEVEMENT IN SCIENCE:

A STUDY OF SECONDARY SCHOOLS IN PORTUGAL

VOLUME ONE

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ABSTRACT

The thesis is concerned to investigate differential patterns of achievement in the sciences in middle and upper sections of eight Portuguese secondary schools selected according to location (city, country) and social class composition of pupils. The total sample of pupils is 1300. Achievement is measured by the scores obtained over a period of one year in science tests created and given by the eleven teachers of the classes of the pupils. These tests are obliged by the Government to measure achievement in two ways. Firstly by questions testing the pupil's understanding of basic definitions and factual knowledge (*A* competencies) and secondly by questions testing pupil's powers to apply and generalise scientific knowledge to a range of problems (*U* competencies). The thesis presents an analysis of the teacher's competence in distinguishing between these two types of competencies and an analysis of the pedagogic classroom competence of the teachers in transmitting the required skills. The results show that the effectiveness of the pedagogic practice of the teachers is related to the social class background of the pupils. Analysis of the pupils' scores (*A* and *U*) reveals a strong relation with social class and within social class to the gender of the pupil. These relations are especially strong in the case of *U* competencies. A more delicate analysis was undertaken to examine the inter-relations between teacher's pedagogic practice, location of school, social composition of school's pupils and gender in order to isolate the conditions under which the school exerts a stronger influence upon achievement in science than the influence of the pupil's family background.

A model derived from Bernstein's theory of cultural reproduction is used to interpret the results and to explore the possibilities for increasing the effectiveness of pedagogic practice.

This thesis is dedicated to
disadvantaged children who were
the sole reason for the research.

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INTRODUCTION

The thesis consists of two volumes, the first reports the empirical study and the second presents the appendices. The first volume contains an introduction to our study in which we briefly describe the context of science education in Portugal, its assumptions and limitations, together with the theoretical orientation which guided our research and the initial pilot study. Preceding the empirical study which is divided into two parts, there is one chapter concerned essentially with the sampling procedures, indices and their constraints. Part I of the empirical study focusses upon the teachers. In order to characterize the pedagogic practice of the teachers it was necessary to carry out a detailed analysis of the differential patterns of the development of pupils' achievements in acquiring two different types of competencies. This analysis, although essential, is, unfortunately, necessarily repetitive. We might suggest that the reader, if he/she wished, could read this chapter (chapter three) when its findings are used in later analyses. Part II of the study presents the analyses and findings which refer to the pupils. Two analyses are carried out; one at the level of the whole sample and the second at the level of the specific teaching context in each school. We discuss our findings in the order in which they were generated by the focus of our analyses. Our presentations, in general, begin with an initial, usually broad, hypothesis which during the course of its exploration leads to more delicate and specific analyses. In the conclusion we summarise the main findings and offer our interpretation together with a brief discussion of what we take to be the major policy implications.

The second volume contains the biographies of teachers and description of schools, questionnaires, test questions, statistical tabulations, base data, and diagrams of the Portuguese educational system and its curriculum organization. We would like to explain why the second volume contains such detailed description of the data, sample and

procedures of analysis. We believe that the research presented in this thesis is probably the largest, most detailed study of science education (biological sciences) carried out in secondary schools in Portugal. We considered that we should describe our data in some detail in order that it may provide a reference for further research, a basis for comparison and contribute to any archive of research in this area. Further we consider that the main text would be better understood if we provided the sources on which our quantitative and qualitative analyses are based. With this in mind we have included a translation of selected questions which appeared in the tests given to the pupils.

CHAPTER ONE

THE CONTEXT OF RESEARCH

1. INTRODUCTION

The central argument of this thesis is that the new paradigm for science education emphasised the understanding and application of general scientific principles through the use of pedagogic theories emphasising "learning by discovery" and "learning the structure of the subject". Such new curricula and pedagogic theories, stressing the active involvement of the child in his/her acquisition, were expected to increase the understanding of all children at a *higher* level of scientific literacy. We have reasons to believe that the benefits of the new paradigms, at least in Portugal, are not equally distributed to all children. Indeed we might wish to say that the gap between different groups of children could well have increased. More specifically, we consider that *social class, acting directly upon the family and indirectly upon the school, acts selectively upon the process of transmission and acquisition both in the official pedagogic context of the school and the local pedagogic context of the family.* We shall in this initial chapter explore the grounds for this hypothesis. Firstly we shall give a brief description of changes in science education in Portugal and how they were influenced by changes in the U.S.A. Secondly, we shall examine the major pedagogic theories of transmission/acquisition and some of their re-contextualisation. Thirdly, we shall discuss the role of the sociological context upon differential acquisition. Our hypotheses will be based upon this discussion and upon an initial pilot study both of which are the basis of the major study to follow.

2. CHANGES IN PORTUGUESE SCIENCE EDUCATION

In the past fifteen years there have been far reaching changes in education in Portugal: comprehensivization of preparatory and secondary schools, increased numbers of pupils attending school, new curricula, new methods of teaching and assessing and training of teachers. Profound

changes in science education have occurred. Changes in science education have broadly followed similar movements in other countries and were greatly influenced by changes in the U.S.A. In Portugal it is the biological sciences which have been the most affected by modern science teaching. The reasons and causes are complex and it is not the aim of this thesis to analyse this selective effect in detail of changes in science education. We will, however, to contextualize our research, give a short review of changes in science education, firstly from an international perspective and secondly, from the perspective of education in Portugal.

A good summary of changes in science education and their causes is provided by the following quotation from Mayer:¹

"The curriculum development movement initiated in 1957 with support from the National Science Foundation was a result of dissatisfaction on the part of both the scientific and educational communities with the quality of science education at the secondary school level. Science was not, as taught, a list of names to be memorized nor a group of fixed answers to questions dealing with minutia. Further, the content of science did not reflect the current state of the discipline but lagged almost fifty years behind the time."

"In general, the curriculum movement concentrated on the development of materials for students on what science is, the major concepts on which it depends, and the presentation of contemporary content in the most effective matrix. For biology this meant an emphasis on science as a process - as a way of knowing about one's world. It meant introducing general themes and theories that underlie the entire discipline, and it meant a de-emphasis on systematics and morphology and the rote dissect, look, draw, label memorize laboratory activity. It meant the introduction of genetics, behaviour, cellular physiology,

microbiology, evolution, ecology and major content blocks present by other than lectures. The emphasis on scientific investigation was reflected in the inquiry orientation of the materials and classroom presentation was organized around discussions, laboratories, and a wide variety of supplementary, student-centered activities rather than chalk and blackboard lectures".

In fact, biology and related fields were those which were most affected by the new curriculum movement. Firstly there had been major advances in the development of these scientific fields and secondly there was the successful work of the B.S.C.S. - Biological Science Curriculum Studies.² The U.S.A.'s B.S.C.S. was undoubtedly one of the curriculum developments which had massive impact on world science education. As Mayer³ puts it: "The B.S.C.S. occupies a unique position in the educational world, we believe, because it has endeavoured to incorporate modern content in a delivery system involving the most advanced pedagogy". To assess the extent of the influence of B.S.C.S. it should be said that adaptations of B.S.C.S. materials are being used in the schools of over sixty countries around the world and that the adapted materials have been printed in twenty languages, in addition to English-language adaptations.⁴ Referring to that influence Mayer⁵ says: "No other educational program developed in this country has such wide acceptance internationally as the B.S.C.S. materials and perhaps that is because they are in each instance adapted locally to the particular flora, fauna, educational system and biological problems of the region concerned".

From these quotations it is clear that the new movement in science curricula, especially in the biological sciences, carried the potential to make science in schools more meaningful and relevant and to develop important competencies. It also *raised the level of conceptual demand and of the competencies to be developed*. We would suggest that these effects should occur in all countries/

schools/classes/subjects where the new science education was implemented. It was certainly the case in Portugal.

Two major initiatives are responsible for the introduction of the new movement in science education in Portugal which occurred in the late sixties and early seventies. The first was the 'pilot-classes'⁶ which aimed at changing contents and methods in the last two years of the secondary school. The team in charge of introducing these innovations consisted of university teachers and secondary school teachers. The experiment had the support of the OEDC. An interesting (and apparently contradictory) feature of this development was that although use was made of curricula⁷ (contents and methods) imported from the U.S.A. and to a smaller extent from the U.K., advice was received from French expertise. However, the textbooks were written by the Portuguese team.⁸ The number of classes (originally only two in Lisbon) was slowly extended to other schools in the country. The experiment lasted for five years. In 1975 it was stopped because of pressure by groups of teachers who claimed the experiment was elitist in character. Nevertheless the impact had already brought about change at national level in methods of teaching but especially in contents of science. The pilot-classes only functioned for the Natural Sciences (Biology and Geology). Physics and Chemistry university teachers and secondary school teachers did not take part in these innovations which originally were intended to include all experimental sciences.

The other major influence on science education was the in-service teacher training developed by the Gulbenkian Foundation⁹ which started in 1971 and was parallel for a period of time with the pilot-classes. The aim of this in-service training was to introduce new contents and *especially* new methods. The courses for teachers were organized by a team of science researchers (Gulbenkian Foundation) and secondary school teachers. The B.S.C.S. was the initial source of materials, but the main concern

was the change of methods of science teaching and this explains the focus on teacher training. It also explains why, contrary to many other countries which made translations and adaptations of textbooks and teaching materials, the Gulbenkian Foundation decided for the translation and adaptation of the book¹⁰ containing the basic philosophy of the B.S.C.S. Although the B.S.C.S. was the major influence, the in-service training developed progressively materials of its own and in fact re-contextualized and integrated modern pedagogic methods and contents and produced an original scheme.

We are not going to enter into details about the nature of these courses. However, it seems important to say that undoubtedly they constituted the most comprehensive in-service teacher training which has ever been carried out in Portugal and that its characteristics made it a unique development either by national or international standards.¹¹ After the 1974 Revolution the courses were expanded and so a much larger number of teachers were able to attend. However, these courses were discontinued in 1978 when those responsible in the Gulbenkian Foundation determined that "the experience had proved its merits and should be taken up by the Ministry of Education". This never happened. Nevertheless the impact had made its mark. *The new paradigms of science education had definitely made their way into the Portuguese science classroom.* From the curriculum development, contents, methods and pupils' assessment to pre-service teacher training all showed the influence of the international 'new science education'.¹² It is important to note that here again, as with the pilot-classes, it was the biological sciences which were the focus of the changes. As before physics and chemistry researchers and teachers on the whole were unresponsive to the new curricula movement and did not develop major innovations in teacher training of their subjects.

The causes of this unresponsiveness of physics and chemistry education as compared with the biological sciences are complex and we cannot go into them here. From our point of view what is important to underline is that within the sciences the biological sciences are those which have undergone a comparatively much greater development. In physics and chemistry there has been no radical change in contents and methods, although some teachers have used original versions or translations of U.S.A. and U.K. curricula¹³ as references and a few interesting experiments have occurred¹⁴ but with little impact on the process of teaching. Only very recently have some textbooks showed signs of the 'new science education'.¹⁵ If studies of the effects of the new curricula were to be carried out, then such studies would have to be made in the field of the biological sciences because it was essentially in these sciences that change took place at the level of the classroom.

We shall now briefly examine some overviews of the new science curricula. Voss¹⁶ in examining the research in science education in 1981 concludes: "The studies indicate that science education is at the crisis stage. Many people are involved in meta-analysis attempting to determine those teaching practices that lead to effective learning and positive attitude development. The science education community is examining itself! It is to be hoped that new goals, direction, and support will become available".¹⁷ And Yager¹⁸ in an appraisal of the current status of science education in the U.S.A. gives some clues of the present 'crisis stage': "It is surprising in retrospect that *so few questions had been raised* during the twenty year period concerning the goals, the effectiveness of curriculum development and teacher education activities, the factors which led to the national programs in science education and the changes in such conditions. Suddenly it became painfully obvious that data were needed...".¹⁹ And Shayer adds: "The sixties have left us with many untested myths

about the aims of science education. We are uncertain whether to teach for the 'facts', the content of the subject, the conceptual structure of the subject, or the process of science which can be taught *through* scientific investigations. And it is uncertain whether science *does* develop thinking or, if it does, *which* of the three aims would best assist that process".²⁰ The U.K./U.S.A. science education seminar in 1982²¹ showed clearly that the enthusiasm of the sixties and even of the seventies has disappeared and has left a general discontent with many questions to be answered and solutions to be found. Portugal is no exception to these doubts. This sets the context in which our research began.

Essentially the new paradigms have their origin in psychology more specifically in theories of child development (Piaget, Bruner) especially concerned with cognitive development and in theories of the ordering and teaching of subjects in school (Gagné). Both of these groups of theories abstract the child from his/her institutional and cultural context and the school/teacher from the social context regulating the processes of transmission and acquisition. Our view is that the failure of the new paradigm to recognise the sociological context of learning in school may well have affected the success of this paradigm in improving the achievements of large numbers of pupils in school, more specifically of children of working-class backgrounds in Portugal.

We shall now examine the psychological theories which underpinned the new science curricula and created its pedagogic practice. This will be followed by a discussion of aspects of Bernstein's theory which we consider has a bearing upon the sociological context of teaching and acquisition. We will derive our initial theoretical perspective from this approach and an initial test of the derived hypotheses will be reported in the concluding section of this chapter.

3. THE NEW CURRICULA AND THEORIES OF ACQUISITION AND TRANSMISSION

We are going to confine ourselves here to what we take to be the basic theories underpinning the new science education. We shall place our emphasis on those theories which stress the importance of the pupil as active in his/her acquisition.

3.1 CONTRIBUTION OF PIAGET

One of the major, if not the major influence upon science teaching (and upon teaching in general at the primary level) is without doubt the work of Piaget. We shall now give a brief account of his work and the influence of Piaget's thought in science education.

3.1.1. Stages of Cognitive Development

Mental capacity increases progressively since the child is born to adolescence. In devising science curricula the sequence of conceptual development in children needs to be known. Since the early twenties Piaget investigated many aspects of the development of children's thought. The work he did, or inspired, constitutes a very large proportion of all that has ever been done in this field. Piaget demonstrated how a child's thinking progresses through three stages:

Stage 1 - Stage of Intuitive Thinking

Stage 2 - Stage of Concrete Operations

Stage 3 - Stage of Formal Operations

He also considered sub-stages: 2A and 2B within stage 2 and 3A and 3B within stage 3.

The U.K.'s science curriculum 'Schools Council 5/13'²² is one example of a curriculum devised on the basis of Piaget's stages of development. The way Piaget's thought is presented in this curriculum is both simple and

attractive (Figure 1.1).

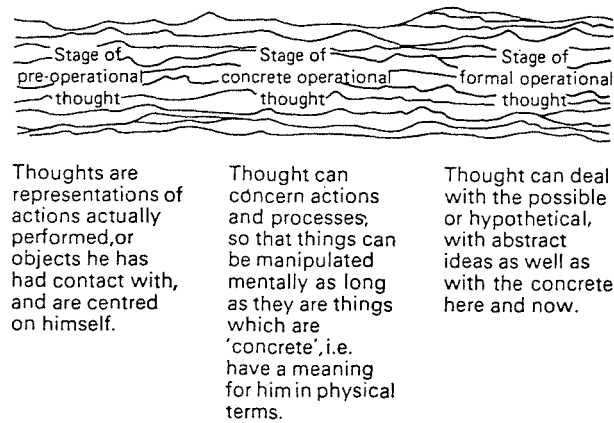


Figure 1.1. - *Piaget's stages of cognitive development*

"Each wavy line might be thought of as indicating the development of a concept or the growth of an idea or the progress towards some skill or ability. There would be a very great many such lines, or strands of development; we show only a few here so that their form might indicate some of the characteristics we believe children's mental development has:

- (a) The strands do not run in parallel straight lines; their waviness is meant to indicate that development does not always take place in what we think of as a forward direction.
- (b) Two or more strands may meet, where separate ideas become amalgamated into a more general idea.
- (c) One strand may divide into two or more, when ideas become more specific."²³

The details of these strands of development obviously vary from one individual to another, but Piaget's work has shown that it is possible to discern a pattern in them which is similar for different individuals - all children pass through these three stages, in this order but at a

rate which varies from child to child. The development is, of course, a continuous process with labels attached at certain points merely to make reference more easy. We will now look at each one of the three stages in a more detailed way.

In the first stage the child's mental work consists mainly of establishing relationships between experience and action; his concern is with manipulating the world through action. It corresponds roughly to the period from the first development of language to the fifth or sixth year of age, and therefore, as far as schooling is concerned, this stage is characteristic principally of the kindergarten. What is principally lacking at this stage of development is what the Geneva school has called the concept of reversibility. Because of this fundamental lack the child cannot understand some fundamental ideas that lie at the basis of mathematics and physics - the mathematical idea that one conserves quantity even when one partitions a set of things into sub-groups, or the physical idea that one conserves mass and weight even though one transforms the shape of an object.

The second stage is operational in contrast with the first which is merely active. The child develops an internalized structure with which to operate. Concrete operations are guided by the logic of classes and the logic of relations but these only allow the structuring of immediately present reality. The child is not yet readily able to deal with possibilities not directly before him/her or not already experienced.

Somewhere between ten and fourteen years of age the child passes into a third stage, the stage of 'formal operations'. The new achievement at this stage is to be able to translate concrete experience into some form of symbolic, or formal, representation, and then to carry out an operation on this representation itself. It is easier to understand the characteristics of this stage through an

example of a test question:

Susana is taller than Sofia
 Susana is smaller than Rita
 Who is the tallest of the three?

It is not until both comparisons have been translated in the mind or on paper into verbal reasoning, that one establishes a relation between both relations and solves the problem. So a crude measure of the difference between the concrete and the formal operations stages is that, while in the former relationships can be seen (e.g. this is bigger than that, etc.) in the latter relationships between relationships can be established, and this must involve some form of symbolic representation.

3.1.2. Influence of Piaget's Thought in Science Curricula

We can see then how ideas and competencies of children change enormously between the ages of 4 and 15, when they are typically at school. If this line of thought is accepted, a number of consequences will follow with respect to science education:²⁴

- (a) Teachers will have great limitations in transmitting concepts to a child at the first stage, even in a highly intuitive manner.
- (b) 'Learning by discovery' at stage 2 will be very limited as children at this stage: will only be able to make hypotheses in very simple situations; find difficulty in separating the effects of two or more variables; be satisfied when they have solved a particular problem and are unlikely to try to abstract from it a principle which might apply in other situations, or to explain it in terms of a generalisation; be able to reason logically but very dependent upon information from their senses, and they are unlikely to reason about a situation they have not had direct experience of.

- (c) 'Learning by discovery' and the understanding of science in terms of principles will be only possible in the last two years of compulsory schooling (14-15) when children have reached the stage of formal operations. The preparatory school in Portugal when children are 10-12 years corresponds broadly to stage 2, although a few children will have already reached stage 3 in the last of these two years. The first year of secondary school (7th year of schooling), when children are 13 still will correspond for most of them to stage 2. Teachers teaching these children must be aware that the children still need much work based on concrete material to consolidate concrete operations.

The devising of a science course should be such that its stages follow the same order of increasing logical complexity as is present in the pupils' own development. The age range over which the course is taught should match the age range over which these stages develop. The main direct consequence of Piaget's work in devising science courses is that *some knowledge and some ways of acquiring that knowledge cannot be taught to children until the appropriate age is reached.*

These ideas have already had direct influence upon the structure of some science curricula. In the U.K., for example, the 'Schools Council 5/13' is, as we have said before, essentially structured around Piaget's stages of development. Also the revision of the last editions of the Nuffield science courses was essentially based on the grounds of research into the conceptual demands of those curricula and their mismatch with the cognitive development of the children, based on Piaget's stages of development. This research has been mainly carried out by Shayer.²⁵

Shayer starts from Piaget's and Inhelder's ideas about the sequence of conceptual development in children²⁶ and tries to find out the statistical distribution of the stages, i.e. the proportions of children reaching a particular level at different ages. He shows²⁷ that in the *general population* only 20 per cent of children will have reached stage 3A (i.e. early formal operations), and less than 10 per cent stage 3B, at the age of 14; at the same age 100 per cent will have reached stage 2A (early concrete operational) and 80 per cent stage 2B. In a mixed ability class in a non-selective school, as it is, in general, the case in Portugal, we should therefore expect numbers of that sort in the 8th year classes. Further he shows²⁸ that, also in the general population, the percentage of children able to perform formal operations will increase at the ages of 15 and 16. About 30 per cent of the children reach stage 3A and about 10 per cent 3B. We should therefore expect numbers of that sort in the 9th and 10th years, in Portugal.

Although these findings are questionable in terms of the assumptions underlying the research and their applicability to other countries,²⁹ they should not be ignored. They suggest that much of what is being taught in our 8th, 9th and 10th years of schooling cannot be learned by the majority of our pupils. One can therefore find here *one cause for the failure children have experienced*. In fact Shayer has also made an analysis of each sub-topic of the Nuffield O-level science courses³⁰ to show that most of them require pupils to be at stage 3A considered the "minimum necessary for any interest (to make any sense of what he is doing)". If, however, the "minimum necessary for appreciating the structure of the course" i.e. to "comprehend the course in a well-integrated way" is considered, still many topics require pupils to be at stage 3B. These courses are intended for pupils between 13-16 years of age. Establishing a relationship between this and the findings above, it is clear that only 10-30 per cent of the pupils will be able to make any sense of the text they have to

learn. It is true that Nuffield O-level science courses are intended for the top 20 per cent of the pupils and not for mixed ability classes. For such children Shayer shows³¹ that the stages of development occur earlier than for a general population; e.g. in selective schools about 70 per cent of children reach stage 3A at the age of 15 and 90 per cent in super-selective schools. Even then, however many children will not be able to understand the course.

Thus Shayer concludes that a *mismatch between curriculum demand and cognitive development is a major cause of failure in the science classroom*. As a solution he recommends changes in science curricula: "(...) until definite evidence is obtained of the possibility of cognitive acceleration and the limits of its scope, the most substantial possibility of improving the experience of science teaching for most pupils lies in the cognitive level matching policy".³²

3.2. CONTRIBUTION OF BRUNER

One of the major influences upon science teaching, as it has been conceived in the last two decades, is without doubt the work of Bruner. We shall now give a brief account of his thought relating it to the work of the Geneva school we have analysed.

3.2.1. 'Learning by Inquiry' and 'Learning the Structure of the Subject'

In September 1959, there gathered at Woods Hole on Cape Cod (Mass. U.S.A.) some thirty-five scientists, scholars and educators to discuss how education in science might be improved in primary and secondary schools followed by a book by Bruner, *The Process of Education*.³³ Many see that conference and that book as the driving force (along with the pressure on the U.S.A. by the Soviet Union launching of Sputnik) for the changes which occurred in science education not only in the U.S.A. but directly or indirectly (via

textbooks and teacher's guides provenient from the U.S.A.) in other countries. Whether or not the book was a driving force, it contained the basic ideas which, synthesised and conceptualised by Bruner have undoubtedly influenced science education as it is at present in many countries. In this respect Portugal is no exception.

'Learning by inquiry' and 'learning the structure of the subject' have since then constituted fundamental paradigms in which most science curricula are predicated. In explaining the advantages of them Bruner says:

"There are at least four general claims that can be made for teaching the fundamental structure of a subject, claims in need of a detailed study. The first is that understanding fundamentals makes a subject more comprehensible (...). The second point relates to human memory. Perhaps the most basic thing that can be said about human memory, after a century of intensive research, is that unless detail is placed into a structured pattern, it is rapidly forgotten (...). Third, an understanding of fundamental principles and ideas (...). appears to be the main road to adequate 'transfer of training' (...). The fourth claim for emphasis on structure and principles in teaching is that by constantly re-examining material taught in elementary and secondary schools for its fundamental character, one is able to narrow the gap between 'advanced' knowledge and 'elementary' knowledge".³⁴

Before going any further, particular attention should be drawn to Bruner's statement "claims in need of detailed study". In fact, before such a study was carried out the approach was implemented.

Nevertheless, Bruner holds the view that the pupil should be trained to grasp the underlying structure or significance of the complex knowledge. To him "grasping the structure of a subject is understanding it in a way that permits many other things to be related to it meaningfully".³⁵ The optimum conditions for learning are seen

to be in revealing the structure of science to pupils and moving in an upward spiral, returning several times to each principle progressively redefining and reforming and eventually producing a well-woven fabric of knowledge. This is what Bruner calls the *spiral curriculum*. However, as he also pointed out, "much too little is known about how to teach fundamental structure effectively or how to provide learning conditions that foster it".³⁶

3.2.2. To Facilitate Movement through the Various Stages of Intellectual Development

We will now relate Bruner's and the Geneva school's ideas. In presenting the thought of Inhelder, Bruner shows that children can be moved faster through those stages of development if an appropriate *way* of teaching is used:-

"A teaching method that takes into account the natural thought processes will allow the child to discover such principles of invariance by giving him an opportunity to progress beyond his own primitive mode of thinking *through confrontation by concrete data* - as when he notes that liquid that looks greater in volume in a tall, thin receptacle is in fact the same as that quantity in a flat, low vessel. *Concrete activity that becomes increasingly formal* is what leads the child to the kind of mental mobility that approaches the naturally reversible operations of mathematics and logic".³⁷ "(...) it is possible to draw up methods of teaching the basic ideas in science and mathematics to children considerably younger than the traditional age. It is at this *earlier age that systematic instruction can lay a groundwork* in the fundamentals that can be used later and with great profit at the secondary level".³⁸

Bruner starts with the hypothesis that any subject can be taught to any child at any stage of development. As he says "no evidence exists to contradict it; considerable evidence is being amassed that supports it".³⁹

According to him the task of teaching a subject to a child at any particular age is one of representing the structure of that subject in terms of the child's way of viewing things. When the child is still in the stage of concrete operations he/she

is capable of grasping intuitively and concretely a great many of the basic ideas of sciences, mathematics. But he can do so only in terms of concrete operations. Thus, as Inhelder points out⁴⁰ basic notions in the field of sciences are accessible to children of seven to ten years of age, provided that they are divorced from their mathematical expression and studied through materials that the child can handle himself. "Later at the appropriate stage of development and *given a certain amount of practice in concrete operations*, the time would be ripe for introducing them to the necessary formalism".⁴¹ However if the child has not had that early foundation he/she will not be able to understand the concepts and to use them in an effective way. What seems important, therefore, is that the child be helped to pass progressively from concrete thinking to the utilization of more conceptually adequate modes of thought.

To sum up Bruner does not believe, and nor does the Geneva school, that children are unable to learn important concepts until they reach the age of formal thinking. Rather he believes that such ideas can and *should* be grasped earlier on at an *intuitive level*, totally divorced from their mathematical expression. The ability to translate concepts in a symbolic form is a sign of the stage of formal thinking when a child is able to construct abstract ideas and transmit them in a symbolic way; at the stage of concrete thinking he/she is able to understand those ideas in an intuitive manner.

As can be seen throughout the whole book,⁴² and as we have seen before, he also advocates that *meaningful learning must be achieved through teaching the structure of the subject*. At first sight this seems contradictory to the idea

of learning at an intuitive level. However, if one remembers the 'spiral curriculum' as Bruner sees it, one can understand that "moving in an upward spiral, returning several times to each principle, progressively redefining and reforming..." may mean pupils starting to learn at an intuitive level and only performing concrete operations, and moving progressively to higher and higher levels of abstraction. Further, learning by discovery advocated by Bruner seems contradictory to learning at an intuitive level. That learning is obviously limited in *level*, when the child is at the stage of concrete operations, because most of the steps involved require a high level of abstraction. Limited, however, does not mean that learning by discovery cannot be effected. Further, as Bruner points out, the important thing is to represent the structure of the subject in terms of the child's way of viewing things. This does not imply that teaching should be limited to that 'exact' measure thought as appropriate for a certain stage: "experience has shown that it is worth the effort to provide the growing child with problems that tempt him into next stages of development".⁴³

Bruner places great emphasis on teaching methods, on the *way* children are taught. Appropriate teaching methods (and of course appropriate curricula) would allow children not only to move faster but also to reach a full understanding of concepts later on.

From what was said above it is clear that Bruner's thoughts do not contradict the Geneva school findings. However, he does not use them in the 'passive' and limited way some curriculum developers and educationists have done. He considers the stages of development established by Piaget but does not come to the conclusion that one has to wait for certain ages to teach certain knowledge and develop certain competencies, but to show *how* that same knowledge and those same competencies should be taught at those different stages. Here, of course, lies the difficult part of the task for, as he says, "there is a surprising lack of research on how one most wisely devises adequate learning episodes for

children of different ages and in different subject matters".⁴⁴ This was written more than twenty years ago. Regrettably not too much has been done so far. Research like that of Shayer could be very useful provided it did not create a basis, as it seems to have done, for a narrow view of science courses planning and evaluation. Seen in the light of Bruner's thought, Shayer's findings would gain another dimension and would allow us to take a somehow more optimistic view of teaching at the last years of comprehensive schooling in Portugal (8th and 9th years). For if Shayer tells us that 70-90 per cent of the general population will not be able to understand those concepts and conceptual schemes which give to all an integrated view of the subject and of the world in which we live, Bruner tells us that those pupils (even if those percentages are taken as fact) *will be able to understand such ideas, provided they are divorced from their mathematical expression and provided they are learned at an intuitive level.*

Based on these considerations it could now be suggested that the devising of science courses should be such that, although tempting children to move to further stages of development and although allowing those children who are able to, to grasp scientific concepts in the highest possible abstract way, could at the same time enable all children to understand scientific concepts in an intuitive way. This seems already a step further because we have been faced so far with two extremes: a few children who can understand science courses in the abstract they now demand and a large group of scientific illiterates who appear not to understand it at all. If science education enabled all children to grasp fundamental ideas in an intuitive way, there would be some hope of having a scientifically educated population.

3.3 SOME POSSIBLE CAUSES OF FAILURE

The work of the educationists cited above, useful as it is, when taken together, for the planning of science education,

leaves, however, fundamental gaps in the reasoning. One of them is related to causes of failure.

Why are some children able to achieve the level of formal operations much earlier than others? *Why* is it that some children (according to Shayer) never attain that level during the period of compulsory schooling? *Why* do some children fail and other succeed so well? *Why* a gap between two groups of children?

With the Geneva school and Bruner it is understood that "given a certain amount of practice in concrete operations" children can be introduced to formalism. This can lead to the thought that children who, at the ages of fourteen or fifteen, are not yet able to grasp scientific concepts at the necessary degree of abstraction might be those who have not had that practice in concrete operations. To make the reasoning clearer let us analyse this suggestion made by Inhelder and presented by Bruner:

"One wonders in the light of all this whether it might not be interesting to devote the first two years of school to a series of exercises in manipulating, classifying, and ordering objects in ways that highlight basic operations of logical addition, multiplication, inclusion, serial ordering and the like (...). The effect of such an approach would be, we think, to put more continuity into science and mathematics and also to give the child a much better and firmer comprehension of the concepts which, unless he has this early foundation, he will mough later without being able to use them in any effective way".⁴⁵ According to Bruner: "there is evidence to indicate that such rigorous and relevant early training [in the basic logical operations that underlie instruction in mathematics and science] has the effect of making later learning easier".⁴⁶

Although the authors do not make it sufficiently explicit, these kind of remarks point to a possible cause for differential achievement between two groups of children identified as successes and failures in the school, i.e.

they point to a cause other than genetically inherited factors. *Children who have experienced a certain kind of practice in concrete operations will perform better in science subjects later on.* If we look at the general school population, such children would be identified as those who: (a) have attended two years in a pre-school establishment (something that in Portugal exists essentially in the private school sector and therefore is essentially available to middle and upper middle-class children) between the ages of four and six; (b) and/or have attended a good primary school where practice in concrete operations is likely to be obtained; (c) and/or have come from homes where that practice is also likely to be obtained through mother-child intercourse, games available, etc. Bruner seems to give some importance to the 'environment'. However, he places the emphasis on the school environment rather than on the family environment: "but the intellectual development of the child is no clockwork sequence of events: it also responds to influences from the environment, notably the school environment".⁴⁷

Further Bloom, widely known for his 'Taxonomy of educational objectives' places a great emphasis on the influence of the school environment.⁴⁸ He presents the thesis that "variations in learning and the level of learning of students are determined by the students' learning history and the quality of instruction they receive".⁴⁹ The variables which have to be taken into account are three: cognitive entry behaviours, affective entry behaviours (that taken together constitute the students' learning history) and quality of instruction. The estimated effect of these on the variation in school achievement is: 25% for the quality of instruction; 25% for affective entry behaviours; 50% for cognitive entry behaviours; 90% for all three combined.

Though one could be led to understand that some of these variables are related to 'something exterior' to the school, Bloom appears to imply that all of them have to do with learning at school, at its various stages. He goes

as far as saying that if one could control all these variables one would have 90% of achievement in school learning. However, he concedes that since it is difficult and often impossible for *each teacher* and even for *each school* to exert a direct influence on the children's history - which means to influence the two variables, cognitive entry behaviours and affective entry characteristics - in the last instance "who can learn in the school is determined to a large extent by the conditions in the school; the quality of instruction is a major determiner of who will learn well - *the few or the many*".⁵⁰ In one way or another it is clear that, for him, school environment is the crucial determinant of children's achievement.

It is important to stress here that, as many other educationists, he *places the focus of failure at school in a deficit school rather than in a deficit child*. He takes the view that what one child can learn any other child can, all being a question of time in good school conditions, after the child enters the school. Therefore, it seems, individual characteristics, family environment, are of little importance except, may be, for those few 10% who, he concedes, cannot reach the normal degree of achievement. The tendency, shared by many educationists, to think that the school can *alone* be made accountable for the achievement of a small proportion of children seems to be shared by Bloom.

This tendency explains the development of the movement of the mastery learning spread in the U.S.A. and in some other countries in the last few years. For Gagné,⁵¹ as for Mager⁵² (and Bloom) a child would learn provided the teaching is divided in adequate learning episodes, a system of feedback to the teacher and pupils is set, the learning pace is appropriate and so forth, *irrespective of the level of abstraction required*. This assumption has led in extreme cases to the reduction of all learning to a mastery level, something which is only possible for objectives of a very low level of abstraction. In other cases it has led to a profound rejection by teachers and educationists of the objectives

approach. We consider each of these two extreme positions unproductive.⁵³ In fact, Gagné's theory of instruction and *its recontextualising* at the various levels has had some influence in the science classroom and curriculum development in the U.S.A. and directly or indirectly in other countries.

The assumption that "any child can learn what another child can" is socially appealing and therefore the type of teaching proposed is easily accepted without necessarily noting the possible low level learning that may be achieved. Of course what one child learns should be learned by another child but such learning should include knowledge and competencies of a high level of abstraction potentially available at school.

At this point we are left with the same questions about failure in the science classroom. The work of Ausubel and Novak⁵⁴ does not lead us much further in that respect. Disagreeing with Bruner they advocate that learning by discovery should give place in most cases to reception learning and concept formation should be replaced by concept assimilation in science education. They oppose meaningful learning to rote learning to say that either reception learning or discovery learning can be meaningful or rote learning.⁵⁵ Although they see many advantages as Bruner sees in discovery learning,⁵⁶ they say:

"The crucial points at issue, however, are not whether learning by discovery enhances learning, retention, and transferability, but whether: (1) it does *sufficiently*, for learners who are capable of learning concepts and principles meaningfully without it, to warrant the vastly increased expenditure of time it requires; and (2) in view of this time-cost consideration, the discovery method is a feasible technique for transmitting the substantive content of an intellectual or scientific discipline to cognitively mature students who have already mastered its rudiments and basic vocabulary".⁵⁷

This quotation is but one example of Ausubel's and Novak's statements which make clear that:

- (a) meaningful reception learning is only possible when the subject has already been introduced and when children have already achieved the stage of formal thought; this related to Piaget's, Shayer's work shows that this sort of teaching can have a limited use at the ages when *all* children are typically at school and even beyond them;
- (b) their main concern are privileged children rather than *all* children.

There is a promising area of research which has been developing in the last few years (in fact after we started this study) and which is based on Kelly's personal construct theory.⁵⁸ It is also based on Piaget's work. Essentially, this research admits that children hold their own views of science and that before being taught about science at school they have already developed conceptual frameworks to make sense of their own experiences and which they satisfactorily use in their everyday lives. In these circumstances the role of science education at school would not be one of 'destroying' children's concepts but of finding out about them and challenging them: "... to bridge the gap between 'formal science' and the personal constructions of the learner...".⁵⁹ As Driver⁶⁰ says, when entering school "pupils' thinking may need to undergo a paradigm shift in learning science". And this takes time she adds.

Driver, Gilbert, Pope, Osborne, Viennot⁶¹ are some of the people who have recently been working in establishing 'pupils' alternative frameworks', 'alternative conceptions', 'the personal construction of knowledge', 'knowledge as a generative process'. A polarizing of views is already evident between this line of research and that of Shayer to which we have referred. Gilbert⁶² sets the major parts of disagreement: (a) the Piagetians see learning as essentially independent of content and context whilst the personal constructivists see it as content and context-

dependent; (b) some Piagetians adhere to the concept of 'stages of development', with its overtones of predestination; learning is seen as universal, and developing directionally with maturity; personal constructivists see learning as a localised phenomenon, developing without a pre-ordained directionality and largely independent of age; (c) 'conceptual development', for a Piagetian, means 'progress through Piaget's stages', whilst for a personal constructivist, it means 'developing one's conception of a phenomenon'. And he adds that the resolution of these contradictions should lie in the applicability of the approaches to the design and conduct of school science for the average citizen.

The line followed by Solomon⁶³ is interesting. She takes the view that "socially acquired meanings are not consistent and logical"⁶⁴ and therefore it would be a mistake to consider the pupils' contributions as 'alternative frameworks' or as personally constructed explanations.

As far as the relationship between sociological factors and achievement in the sciences is concerned very little research has been carried out. It is the case that some sociologists of education (Young *et al*)⁶⁵ have challenged the assumptions of the knowledge which is made available in school and have emphasised its social rather than objective basis. These authors from a phenomenological position asserted the underlying similarity between everyday knowledge and scientific knowledge. However, no empirical research into science classrooms have been carried out by this group. The study carried out by James and Pafford⁶⁶ which looked for a relationship between academic achievement in science and father's occupation, because of its elementary character, does not allow for any definite conclusions. The UNESCO study⁶⁷ points to differential achievement between girls and boys; however, the use of standardised tests, we suggest, sets a limitation on the conclusions. Most of the studies on the relationship between sociological factors and achievement in the sciences have concentrated on

gender. Thus, for example, the interesting 'Girls into science and technology' project which is now being carried out by Kelly⁶⁸ looks for causes and solutions to the apparent differential achievement between boys and girls in England. We should also draw attention to the ethnographic research of Walkerdine⁶⁹ who shows the differential positioning of boys and girls in science teaching in both primary and secondary school classes.

4. THEORETICAL ORIENTATION OF THE RESEARCH

In the work we have briefly reviewed it appears that whilst the new paradigms *by implication* appear to note the possibilities of differential achievement arising out of methods of teaching or the emphasis of the curricula in the early years, their basis in psychology (whether defenders or opposers of the paradigms) has prevented any systematic examination of the social context of transmission and acquisition both in the family and school.

We shall use Bernstein's theory of the process of cultural reproduction through education because it offers the possibility of showing the inter-relations between family, school and work in class societies. From our point of view we see this thesis as offering an initial starting point for the analysis of the inter-relationships between family and school as these are shaped by class relations acting directly on the family and indirectly upon the school. Today the family and the school have been opposed to each other as sources of the under-achievement of pupils; either under-achievement (and presumably achievement) is the responsibility of the school or failure lies in the preparation for and in support of the practices of the school. Bernstein rejects this polarising of responsibility and has developed a conceptual language and programme of empirical research designed to show the inter-relationships.

It is not our intention to review the theory which has evolved over the past twenty years, nor to engage in the controversy surrounding it but to select those features of the thesis which served as the starting point for our research hypotheses. Recent overviews of the thesis with special reference to the classroom and the school may be found in Pedro and Diaz studies.⁷⁰

Central to the thesis is the concept of code which is used as a generative concept purporting to show the relationships between surface level features of communication and their underlying ordering principles. Code is defined as a regulative principle tacitly acquired which selects, integrates and contextualises relevant meanings. Crucial to the definition is the integration of three analytically distinct levels: meanings (relevant referential relations) realisation media (devices of communication) and interactional practices. The definition also implies relations of dominance. Relevant meanings implies irrelevant meanings and so relations of legitimacy and illegitimacy and this holds also for appropriate realisations generated by appropriate contexts. Codes, from this point of view entail power relations which rank communication principles in a hierarchy of relevance and legitimacy.

Bernstein makes it quite clear that code presupposes linguistic, cognitive and cultural competences. He distinguishes between competencies shared and universally available *and* the specialised performances to which they give rise. In order to define specific codes it is necessary to make a distinction between what Bernstein has called orientations to relevant meanings *and* the rules of their realisation.

Orientations

A distinction is made between *restricted orientations* and *elaborated orientations*. Restricted orientations refer to meanings which have a direct relation to a specific and local material base. These meanings are imbedded in local contexts and practices and may be considered relatively context dependent and particular in their focus. Elaborated orientations refer to meanings which have an indirect relation to a specific material base and as a consequence these meanings are relatively context independent and general in their focus and are much less imbedded in a local context and practice. Bernstein argues that these orientations had their origin in agencies of symbolic control in 'simple societies' (religious and kinship systems) but their location and distribution in modern societies is specialised to different positions within the hierarchy of work relations. He argues that the principles of the social division of labour and its social relations of work has distributed two forms of solidarity in the Durkheimian sense; mechanical solidarity in the case of the dominated work functions and organic solidarity in the case of the dominant functions of management and technology. That is, restricted orientations are considered to arise out of forms of mechanical solidarity and elaborated orientations out of forms of organic solidarity; both a consequence of either a simple division of labour (restricted) or a complex division of labour (elaborated) in which different individuals are placed through the regulation of class relations in modern societies. Bernstein recognises that location does not necessarily determine orientation and he points to the role of trade unions, political parties and resistance groups.⁷¹ He regards education as the crucial institution which has made elaborated orientations generally available *if not generally* acquired in modern societies.

Specialised performances

These, according to Bernstein, depend upon the controls on the realisation of these orientations. He argues whether

a code (orientation *plus* realisation rules), for example the pedagogic code of the school, is acquired by the few or the many is essentially a question of the realisation rules instituted by the school whereby its elaborated orientation is given a specific form or practice. Bernstein has developed the concepts of classification and framing to show the principles underlying different realisation rules. Briefly whether a pedagogic code is acquired by the many or the few depends, from this point of view, upon the relative strengths of the classificatory and framing principles regulating the relations of transmission and acquisition both in the home and the school *and* their inter-relations.⁷²

From the point of view of our research it is useful to illustrate these concepts with reference to an experiment designed by Bernstein and Adlam and analysed and published by Holland.⁷³ A set of pictures of food items (bread, eggs, vegetables, soup, meats, fish, etc.) were presented to a sample of middle-class and lower working-class seven year olds, and the children were invited to make groupings of the pictures according to the pictures which 'went together' and then to give the reasons for their groupings. It was found that middle-class children gave reasons based upon a principle indicating a relatively context independent orientation, general rather than particular in focus and indirectly rather than directly related to a specific material base ("These have all got butter in them", "these come from a farm/sea"), whereas the lower working-class children gave reasons based upon a principle of grouping which was relatively context dependent, particular rather than general in focus and imbedded in a local context and practice ("S'what we have for breakfast/dinner/what I don't like"). However, when the children were asked to make a second grouping of the pictures and asked to give the reasons for their grouping, the middle-class children switched their principles of grouping and gave reasons similar to the lower working-class children, whereas the latter did not change their principle and its focus upon the local context and practice. Bernstein suggests that the reasons offered by

the middle-class children were well known to the lower working-class children but that both groups of children operated with different recognition and realisation rules. Essentially the middle-class children operated with a principle of strong classification between the experimental context and other contexts (peer group, informal family contexts) and as such they were able to recognise the specialised features of the experimental context (adult instructional, evaluative) and so produce an elaborated orientation which they considered to be appropriate. These children, Bernstein further proposes held a strong framing principle which regulated their selection of the realisation rule producing their communication. Although the instruction to them was apparently one of weak framing, "I wonder why you put them together like that", implying no reason was especially privileged, the children produced for themselves a strong framing principle which in turn was responsible for a very specialised communication rule for the construction of their text (give general, exhaustive, principle, no narrative or listing). The point here is that the middle-class children *initially* offered an elaborated coding of their text and only secondly offered a restricted coding. This example enables us to point to the different levels of the analysis of code, orientation, realisation, specialised performances. The latter is regulated by recognition and realisation rules which enable a context to be distinguished from other contexts and a particular text to be prepared and offered. We can note that classification determines recognition rules, and framing realisation rules. From this point of view middle-class children and lower working-class children were operating with different classification and framing procedures and so producing a different coding of the context, and these coding orientations had their source in different forms of family socialisation with respect to the school. However, *the orientation of the middle-class child also tells us what that child considers to be the dominant orientation of the school, that is, elaborated.* Conceivably it is possible to consider a pedagogic context where initially the lower working-class child's orientations would be regarded as

dominant and privileged in which case a normative context more dependent on everyday realisation would be privileged.

In our research we shall be concerned essentially with secondary school pupils who already in Bernstein's sense will have the recognition rule enabling them to distinguish and recognise the distinctive marking which specialises the school context from other contexts and such pupils are also likely to have the recognition rules by which the various subjects of the curriculum are distinguished. In other words all pupils irrespective of social class background will share similar strong classificatory principles and be socialised into the power relations these presupposes. However, according to Bernstein they will be differentially orientated to, and so differentially receptive to the framing of the relations of transmission/acquisition. These framing relations regulate the pedagogic realisation rules of classroom practice through the control over the selection, sequencing, pacing and criterial rules of the transmission. Bernstein would argue that middle-class children relative to lower working-class children are more likely to achieve under the present framing of teacher/pupil relations, because they are more prepared for, supported and motivated towards the rules of the transmission by virtue of their family background, and that *the present school framing carries assumptions both in its ordering principles and in its relevance* which place the working-class pupil, especially the lower working-class pupil, at a considerable disadvantage. In other words there is a different relation between *and within the official pedagogic practice of the school and its assumptions, and the local pedagogic practice of the family and its assumptions, depending broadly upon the social class background of the family.*

Of particular pertinence for our research is a crucial criticism of Bernstein's thesis which questions that the school demands an elaborated code. This criticism was initially put forward by Rosen⁷⁴ and recently by Cooper⁷⁵ in the context of the science classroom. Cooper upon the basis of some observations of mathematics and science lessons asserts that "...the observed mathematics and science curriculum appeared to be predicated in Bernstein's terms on a restricted rather than an elaborated code".⁷⁶ Cooper ignores Bernstein's remarks on the relation of the language use of the teacher to the meanings and to the principle to be acquired.⁷⁷ An analysis of Cooper's study reveals that his conclusion is only possible because his definition of code does not correspond with that used by Bernstein. Bernstein makes it quite clear⁷⁸ that the linguistic realisations of codes depend upon the context. That the crucial feature of codes is the *orientation to meanings* elaborated and restricted and that the linguistic realisation of these orientations is a function of the context. He himself gives as an example that a short simple although explicit phrase, sentence may well mark an elaborated coding as in the condensed summary of a *précis*.⁷⁹ In the same way the features of the grammar and lexis will vary greatly in a Science and English lesson but this would indicate different contextual realisations of elaborated orientations. In the same way features of the language of the teacher will vary with the strength of framing of the pedagogic practice and particularly with the age of the pupil. However, the underlying principles which the teacher is attempting to transmit in Cooper's science and mathematics lessons were elaborated as a glance at any school textbook/workbook would show.

Indeed it might be argued that modern science education demands an understanding of a higher level of abstraction than perhaps older traditional approaches which may have focussed more upon the remembering of procedural rules, definitions, experiments rather than upon the understanding of principles and their application to new situations.

There are some apparent parallels between Bernstein and Piaget in that both are concerned with context dependent/independent principles and processes. However, these parallels are superficial and perhaps even misleading to draw. For Bernstein, Piagetian sequences would be regarded as constituting at a given level, cognitive competencies apparently shared and universal, independent of a particular culture, which would set limits to the operations available for assimilation and accommodation. However performances of children sharing a given level would vary according to their code modality and orientation. Whereas Piaget considers that a child at a stage of concrete operations cannot have the operations necessary to produce formal thought, Bernstein would be concerned more with differences in potential orientations and the classification and framing procedures of the pedagogic practice. He would argue that both processes can and should go on at the same time, concrete experience can be translatable appropriately into more general rules without devaluing concrete experience or displacing the concrete by the general. Thus when Piaget says that the concept of reversibility cannot be understood by a five year old, perhaps that should not be understood as that child being unable to think in terms of rules and principles (context independent) but rather that the child is unable to perform that *particular* operation leading to that *particular* abstraction.

Of course much like Bruner and Piaget, Bernstein would say that any child would gain if the learning of general principles would be grounded in concrete experiences and therefore in a context dependent situation. If this is valid for adults how much more so for children. Bernstein would want to add in *whose* concrete experiences is the child's/pupil's experience grounded and in *what way* is the child/pupil introduced and expected to acquire general principles.

We shall come back to Bernstein's theory in the final chapter of this thesis. We shall use the theory to derive

the general hypotheses guiding our research.

5. ANALYSIS OF A MODERN SCIENCE COURSE

On the basis of our reading of Bernstein we decided to embark upon a small *pilot* study to examine differential achievement in science in a secondary school class where a special course based upon the new paradigm was designed and taught.

In the academic year of 1976-77 a course on Environmental Science⁸⁰ to be followed by pupils of the 9th year of schooling was developed in Portugal. The unique experimental character of the course (both in contents and processes) demanded that each one of its authors taught a class of the sixty classes of pupils involved in the experiment, receiving feedback which was immediately taken into account in the final version of materials used by teachers and pupils. As one of the authors we obtained direct information of our class which constitutes data upon which the general hypotheses of the thesis are based.

5.1. BRIEF CHARACTERIZATION

An analysis of the course shows that some of the modern paradigms of science education are behind it: 'learning by inquiry' and 'learning the structure of the subject' are at the core of the course. Further the objectives of the course pre-supposed that the process of teaching-learning emerged from the balanced inter-action of three factors: competencies to be developed, contents to be learned, relevance of the social problems involved. Starting from social problems the pupils would, through an inquiry process, achieve knowledge; after acquiring this knowledge initial problems are then re-examined from the perspective of general principles. The devising and implementation of the course of Environmental Science was based upon the conviction that:

- (a) pupils should be equipped not only with a way of

- approaching environmental problems but also they were to be aware of their individual responsibility in the search and implementation of the most appropriate solutions;
- (b) a course on Environmental Science should be multi-disciplinary and global in character, avoiding encyclopedism and creating integration through systematic resource to the fundamental scientific concepts.

The course made use of broad unifying concepts integrating knowledge of such different fields as physics, ecology, chemistry, biology and geography. A systemic approach unified the processes of learning. The level of abstraction required was extremely high, especially if one considers the pupils' age level to which the course was directed. Direct observation of the materials used by teachers and pupils confirms this conclusion.⁸¹ Tests given to the pupils give an indirect measure of that level: over 70% of the questions are at the highest levels of comprehension or above (application, etc.) and over 30% are at the level of application or above; projects are all at the level of application or the highest levels.⁸²

The course was devised for pupils of 15+ of age. According to Piaget we might have expected that the majority of the pupils would have already attained the stage of formal operations and therefore would be able to learn concepts and principles at a high level of abstraction. The figures in the table of Figure 1.2 (paragraph 5.2) show that only 38.5% of the children had a fair level of understanding. We have taken 12 as the minimum acceptable pass mark because 10 is only a marginal pass and other factors would have to be taken into account if the pupil was to be permitted a pass mark.

The percentage of 38.5% although low could be considered quite high if we take into account Shayer's studies referred to previously, since only 10-30% of the pupils should have attained the stage of formal thought. However

if we consider that a major underlying idea of this course was to provide knowledge and competencies useful to every citizen, it is clear that our achievement fell far below this ideal. In terms of pupils' success, the important point is that this Environmental Science course contained crucial integrating supra-concepts whose understanding required high levels of abstraction. If those concepts were not grasped the course could not be understood. It is true that teaching strategies had been carefully selected and employed a wide range of variety and appropriateness,⁸³ but they were clearly not successful for the majority of pupils.

5.2 A SUMMARY SOCIOLOGICAL ANALYSIS

The low achievement of many children and the high achievement of some led us to suspect that such differential achievement could be related to social class. We then carried out an elementary sociological analysis on the basis of the data available.

The table in Figure 1.2 shows the number of pupils, according to social class, who achieved each one of the pass marks. The characterization of the children's social class is a very crude one which made use of the limited available information:

- (a) *Lower working-class* - occupation essentially manual, unskilled; very low educational qualification (primary school)
- (b) '*Lower middle-class*' - manual skilled/lower clerical occupation; medium educational qualification (some secondary education). This is a mixed group.
- (c) *Middle class* - professional occupation; high educational qualification (university degree or equivalent).

In the table only the occupation and educational qualification of the father was included.

| FINAL MARKS PUPILS' SOCIAL CLASS | FINAL MARKS | | | | | | | Total |
|--|-------------|----|----|----|----|----|----|-------|
| | 8* | 10 | 12 | 14 | 15 | 17 | 20 | |
| <i>Working class</i> | 2 | 2 | 0 | 0 | 1 | 0 | 0 | 5 |
| <i>'Lower middle-class'</i> | 6 | 3 | 1 | 0 | 0 | 1 | 0 | 11 |
| <i>Middle class</i> | 1 | 2 | 2 | 1 | 1 | 1 | 2 | 10 |
| <i>TOTAL</i> | 9 | 7 | 3 | 1 | 2 | 2 | 2 | 26 |

* Marks below 8 are included in this category

Figure 1.2 - *Distribution of pupils of different social classes throughout the marks scale: pilot study*

The analysis of the table shows that 19% of the failures and 70% of the successes are middle-class children. This by itself does not say much because that class is not equally represented when compared to the other two. However, as can be seen 70% of the middle-class children passed and 30% failed whereas 19% of the other two classes passed and 81% failed. This analysis shows something that has been pointed out by sociologists and that is now a widely known fact: children from lower social classes tend to be failures at school.⁸⁴

Let us now take the analysis a step further by looking at achievement in different types of competencies.⁸⁵ The table in Figure 1.3 shows the number of pupils, according to social class, who achieved different levels in different competencies. The table refers only to cognitive competencies, and marks of tests (3rd term), final examination and projects are considered. A percentage of $\geq 50\%$ is here considered as a sign of achievement. The previous score (Figure 1.2) was based upon test marks but also on more subjective assessments of conduct, interest and general understanding. This score

is wholly based upon marks given to written work.

| COMPETENCIES PUPIL'S SOCIAL CLASS | <i>Low Knowledge and lower level of comprehension</i> | | <i>Total</i> | <i>High Higher levels of comprehension application, etc</i> | | <i>Total</i> |
|---|---|--------------|--------------|---|--------------|--------------|
| | <i>< 50%</i> | <i>≥ 50%</i> | | <i>< 50%</i> | <i>≥ 50%</i> | |
| <i>Working-class</i> | 2 | 3 | 5 | 4 | 1 | 5 |
| <i>'Lower middle- class'</i> | 7 | 4 | 11 | 9 | 2 | 11 |
| <i>Middle-class</i> | 3 | 7 | 10 | 3 | 7 | 10 |
| <i>TOTAL</i> | 12 | 14 | 26 | 16 | 10 | 26 |

Figure 1.3 - *Distribution of pupils of different social classes by achievement in two types of competencies: pilot study*

The analysis of the figures in the table show that:

(a) *Middle-class children*

70% achieved $\geq 50\%$ in the low level competencies

70% achieved $\geq 50\%$ in the high level competencies

(b) *Working & 'Lower middle-class' children*

44% achieved $\geq 50\%$ in the low level competencies

19% achieved $\geq 50\%$ in the high level competencies

It seems therefore that children from higher social classes do not have special difficulties in learning that part of the text which demands a high level of abstraction: percentages of children who performed well in both types of competencies are equal and quite high. Achievement in the lower classes is low in both competencies but *especially* in the high level ones. It seems therefore that children of such social classes have special difficulties in learning that part of the text which requires a high level of abstraction with respect to the pedagogic practice used.

6. HYPOTHESES

It would be dangerous to generalise from this pilot study although it does point to (at least in Portugal) differential class related achievement especially of what we have called the higher competencies; that is the competencies which require a high level of abstraction. It is all the more of interest that the course was designed according to the principles of the 'new paradigm' in science education and the pupils in the pilot study were taught by an experienced, well trained teacher in this paradigm. We may, of course be also measuring the different facility of pupils of different social class backgrounds to adapt to a revised curriculum. However, what this one year course succeeded in doing was to produce a polarisation of achievement especially of the higher competencies. It is possible that in Portugal, under present conditions of training of teachers, curricula, class backgrounds of pupils and social composition of schools, a relatively sharper division between the children who succeed and those who fail will be created. It is possible that this new improved form of science education will, under the present pedagogic regime in Portugal (where there is a compulsory common curriculum for all secondary school pupils) increase the gap between different social groups of pupils.

On the basis of our orientating theory and the very limited results of our pilot study we shall design a large scale study concerned to explore the following hypotheses:

- (1) New science curricula are based on broad concepts and principles entailing the understanding and application of highly abstract knowledge for which many children, especially lower working-class children have not been adequately prepared either by their family or by the school. Under these conditions the higher the level of abstraction of a common course the greater will be the difference in achievement according to the social class background of the pupil where lower working-class pupils are more likely to fail and upper middle-

class pupils very much more likely to succeed.

- (2) If competences required by science curricula are divided into two groups those requiring knowledge of elementary procedural rules and definitions and those requiring application of principles to new situations, the social class differential achievement will be greater in the latter than in the former competences. The highest achievement will be shown by the upper middle-class pupils and the lowest achievement by the lower working-class children.

Whilst our orientating theory indicates the selective role of the pedagogic practice of the school upon achievement of pupils we do not consider that at this preliminary stage we can offer a *specific hypothesis* which sharply delineates the crucial features of such a selective pedagogic practice. However, our analysis will be concerned to investigate such a practice.

7. NOTES AND REFERENCES

1. W. Mayer, 1977.
2. See some characteristics of this curriculum in, for example, B.S.C.S. 1970, B.S.C.S. 1968, B.S.C.S. Newsletters referenced in Mayer 1974, 1977.
3. W. Mayer 1974, p. 4.
4. R. Tolman 1977, p. 13.
5. *Ibid* 3, p. 3.
6. See, for example, S. Marques *et al* 1972.
7. Especially the U.S.A.'s B.S.C.S. and the U.K.'s Nuffield course.
8. C. Assunção 1970, G. Sacrarrão 1971.
9. See major features of the Gulbenkian in-service teacher training in A. Domingos 1979. See materials used in the courses in, for example, G.T.E.B. 1977, A. Domingos *et al* 1981, A. Domingos *et al* 1983.

10. B.S.C.S., Biology Teacher's Handbook.
11. *Ibid* 9.
12. See recent textbooks, for example, H. Barradas 1981, M. Botelho 1979, L. Galhardo 1982, A. Domingos 1983. In the beginning of the curriculum movement original foreign textbooks and translations were used as references: for example B.S.C.S. 1973, E.S.C.P. 1972, F.U.N.B.E.C. 1967 a, b, I.S.C.S. 1970.
13. For example, the U.K.'s Nuffield Courses (1966), the U.S.A.'s Project Physics (Holton 1981) and I.S.C.S. (1970). For translations see *Projecto Fisica* (O. Valente 1979-82), *Quimica-Uma Ciência Experimental* (G. Pimentel, 1976).
14. For example, the experience (1976-79) for the 8th and 9th grades on 'The energy - its forms and characteristics' carried out by the Ministry of Education in collaboration with the university (O. Valente in the department of education at the Lisbon Faculty of Sciences), and based on the U.S.A.'s I.S.C.S. - Intermediate Science Curriculum Study.
15. See, for example, T. Almeida 1982, A. Faria 1983, C. Gonçalves 1983.
16. B. Voss 1983.
17. *Ibid* 16, p. 293.
18. R. Yager 1982.
19. *Ibid* 18, p. 7, our emphasis. See in R. Stake 1978 the description of one of the three studies which the USA's National Science Foundation promoted in 1976, to assemble information on science education.
20. M. Shayer 1982, p. 42.
21. J. Head 1982.
22. See Schools Council, 1982, where the philosophy of this science curriculum is expressed.
23. *Ibid* 22, pp. 9-10.
24. *Ibid* 22 (adaptation).
25. M. Shayer, 1981.
26. J. Piaget and B. Inhelder, 1959.
27. *Ibid* 25, p. 9.
28. *Ibid* 25, p. 9.

29. M. Sequeira (1981) carried out a study in Portugal; it is less detailed than the English study and therefore comparisons are difficult to establish.
30. *Ibid* 25, pp. 11-13.
31. *Ibid* 25, p. 10.
32. *Ibid* 25, p. 136.
33. J. Bruner, 1960.
34. *Ibid* 33, pp. 25-6. See in E. Keislar 1966 critical analyses about discovery methods in education. See also D. Ausubel 1978.
35. *Ibid* 33, p. 7.
36. *Ibid* 33, p. 12.
37. *Ibid* 33, p. 42; our emphasis.
38. *Ibid* 33, pp. 44-5; our emphasis.
39. *Ibid* 33, p. 33.
40. *Ibid* 33, p. 43.
41. *Ibid* 33, p. 38; our emphasis.
42. *Ibid* 33, e.g. p. 7.
43. *Ibid* 33, p. 39.
44. *Ibid* 33, p. 49.
45. *Ibid* 33, p. 46.
46. *Ibid* 33, p. 47.
47. *Ibid* 33, p. 39.
48. B. Bloom, 1976.
49. *Ibid* 48, e.g. pp. 11 and 169.
50. *Ibid* 48, p. 138.
51. R. Gagné, 1975, 1977.
52. R. Mager, 1975.
53. See further elaboration in Chapter three on Patterns of achievement in different types of competencies.
54. Ausubel *et al*, 1978.
55. *Ibid* 54, e.g. p. 25.
56. *Ibid* 54, e.g. p. 529.
57. *Ibid* 54, p. 529.
58. G. Kelly 1955.
59. M. Pope 1982, p. 9.
60. R. Driver 1981, p. 100.
61. Driver 1978, 1981, 1983; Gilbert 1982, 1983; Pope 1982, 1983; Osborne 1983; Viennot 1983. See also

- N. Vasconcelos who is carrying out a study on intuitive concepts, in Portugal. See also J. Novak 1983 for the approach to understand concepts through 'concept mapping'.
62. J. Gilbert 1982, p. 28.
 63. See, for example, J. Solomon 1983.
 64. *Ibid* 63, p. 227.
 65. See, for example, M. Young 1971.
 66. A. James, 1973.
 67. L. Comber, 1973.
 68. See, for example, A. Kelly 1982. See also A. Kelly 1981, where the issue of gender and achievement in the sciences is discussed.
 69. See, for example, R. Walden and V. Walkerdine, 1982.
 70. M. Diaz 1981, E. Pedro 1983.
 71. B. Bernstein 1982.
 72. B. Bernstein 1977.
 73. J. Holland 1980.
 74. H. Rosen 1974.
 75. B. Cooper 1976.
 76. *Ibid* 75, p. 42.
 77. See Introduction D. Adlam 1977.
 78. See Introduction B. Bernstein 1971 and B. Bernstein 1973(b).
 79. See Introduction, B. Bernstein 1971.
 80. A. Domingos *et al* 1983.
 81. *Ibid* 80; teacher's edition which contains most of the materials used.
 82. Taking the Bloom's Taxonomy of Educational Objectives as reference.
 83. *Ibid* 80.
 84. See, for example, D. Lavin 1967. For studies in Portugal see, for example, A. Benavente 1981, S. Grácio 1977, L. Leal 1981, S. Miranda 1978, M. Saraiva 1982.
 85. *Ibid* 81.

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CHAPTER TWO

INTRODUCTION TO THE EMPIRICAL STUDY

1. INTRODUCTION

Here we shall outline the procedures we followed in testing our hypotheses and how we created the sample of teachers, classes, schools and the information which was to provide the base data on the family background of the pupils.

We have hypothesized that the introduction of modern science teaching has sharpened the difference between two groups of children; this differential achievement would be a consequence of the high level of abstraction required by modern science courses. We hypothesized that if we divided competencies in two groups, those requiring a low level of abstraction and those requiring a high level of abstraction greater differential achievement would occur in the latter; working-class children would produce the lowest performance and upper middle-class would produce the highest. Our research focusses upon the relationship between social class and differential achievement in different types of competencies. We broadened the study to include the role of the pedagogic practice of the school.

In essence our research is composed of three inter-related investigations which we considered were essential if we were to obtain a sensitive understanding of the differential achievement in science in secondary schools. Whilst a survey of the relation between pupils' results on tests (either constructed by the researcher or teachers) in different schools, in different areas would reveal variations in tests scores which we could examine with respect to, on the one hand, the family background and gender of the pupil, and on the other to the characteristics of the teachers, we would not be in a position to understand the processes *within* the pedagogic practice which were (or could be) related to variations in pupils' achievement. Further if we were to understand the latter, that is the pedagogic practice of the teacher, how could we devise a method which would be both compatible with the time required to gather a large sample (necessary to take

into account the influence of a number of variables) *and* the time requirements of a study of classroom inter-action; both to be carried out by one researcher. This dilemma is not unusual in educational research into achievement.

We considered that as little data existed in Portugal about differential achievement in science it was important to use a survey technique in order to obtain some understanding of the overall pattern in a sample as large as we could manage. However, we were also concerned to gain some understanding of the influence of the teachers' pedagogic practice and to this end we designed two further studies. One was concerned to examine the principles teachers used in marking the tests they gave to their pupils. We hoped that this study would give us some possibility of inferring the degree of conceptual demand made by a teacher from the extent to which a given teacher, relative to other teachers, was either a strict or benevolent marker. A second study of the teachers was concerned not so much with the degree of conceptual demand as indicated by teachers marking practice but with examining the focus of their teaching. Teachers in Portugal are expected to teach and design test questions with respect to their pupils' acquisition of two different types of competencies; the first type includes lower level competencies necessary for the understanding of higher knowledge and the second type are competencies which enable pupils to understand higher level knowledge and to apply it to new situations and problems (see later discussion). The fact that teachers are compelled by the Ministry of Education to distinguish between such competencies and examine them separately in the tests they constructed each term offered a unique opportunity to examine the extent to which teachers shared similar principles in distinguishing between such competencies *and* the opportunity to study the differential focus on these competencies as revealed by a study of the questions teachers set their pupils in tests. From this study we hoped to gain some understanding of the focus of the teachers'

pedagogic practice with respect to the relative emphasis upon competencies requiring a low or a high level of abstraction as revealed by the type of questions set by the teacher. Thus we hoped that our studies of the marking and evaluation principles used by teachers would give us a measure of the effectiveness of each teacher's pedagogic practice as revealed by (a) the focus of the teacher's pedagogic practice and (b) the degree of conceptual demand.

However, we must point out that once we had decided to use the teachers' own test questions as our measure of pupil achievement of both competencies (see later discussion) we necessarily had to plan a study of the principles of the teachers' marking practice and the principles they used to discriminate between the types of competencies. This study of the reliability and validity of the teachers' principles of marking and discrimination enabled us to develop our study of the focus and degree of demand of the teachers' pedagogic practice. In this way our major study of social class differences in achievement could be made more sensitive by our understanding of the teachers' classroom practice as revealed by the principles used to construct tests of pupils' performance and to mark pupils' answers to tests.

Within our limits we wanted the characterization of the teacher's pedagogic practice to be as complete as possible and we thought that it would be important to have a measure of the effectiveness of the teacher in assisting her pupils to reach a given level of achievement. With this purpose we incorporated into our major study a special study of the evolution of learning of the two types of competencies to which we have referred. If we could establish differential patterns of acquisition for these two different types of competencies then we would have criteria to evaluate each teacher's pedagogic practice. Furthermore, given the fact that this special study required a change in the teacher's pedagogic practice we had the opportunity

of analysing the effects of such a change upon differential achievement of specific groups of children (class, gender).

Thus although our research is of the survey type we have built into it a series of investigations which we hope will reveal the role of the teacher's pedagogic practice as a mediating process in the production of patterns of differential pupil achievement. Our research was therefore devised to include a study of:

- (a) Relationships between family background and achievement in two types of competencies of secondary school pupils in science.
- (b) Characterization of teacher's pedagogic practice.
- (c) Patterns of achievement in different types of competencies.

Each of these studies required particular methods of research and particular treatment and analysis of the data. These methods are described and discussed in detail in the relevant sections of the thesis. For these reasons we shall not in this chapter enter into a discussion of our specific procedures.

Finally we think it is important to clarify one more point about the focus of our research. The whole study is *exclusively* based on the cognitive domain and this should be interpreted as a constraint on the empirical research rather than a diminishing of the importance of other domains upon differential patterns of achievement.

2. THE SELECTION OF SCIENCE SUBJECTS AND THE PROCEDURES FOR THEIR ANALYSIS

2.1. THE CHOICE OF SCIENCE SUBJECTS

We chose particular fields within science education which are biology and related fields like ecology, environmental science, human physiology. The major factors which influenced our choice were:

- (a) Within science education these are the fields which have experienced greater changes (at the level of the secondary school) both in their scientific content and in the teaching methodology.
- (b) The kind of data needed for our study required particular competencies from the teachers and it is among biology teachers that these competencies are more likely to be found.¹
- (c) The researcher has more complete knowledge of the syllabuses and objectives of these scientific fields.

The choice of the above subjects is clearly a constraint on the research but we would like to point out that this constraint is not any greater than if we had focussed only on physics and/or chemistry. We will argue that the idea that biology is an easier area of science is an out-of-date prejudice which unfortunately is still held especially among teachers of physics and chemistry. Modern biology if adequately taught entails a very high level of conceptual demand comparable to the other two traditional sciences, i.e. physics and chemistry. The work carried out by Shayer and others² on the mismatch of the levels of cognitive demand of science courses and the levels of cognitive development of pupils shows that for instance cognitive demand in the Nuffield O-level biology course is not below

the demands of the chemistry and physics courses.³ Further when analysing the major differences between the sciences (physics, chemistry, biology) Shayer says: "For different reasons, both physics and biology are accessible, in some aspects, at lower levels of conceptual demand than chemistry. [...] Yet *both*⁴ physics and biology are more demanding when it comes to grasping the great integrating ideas [...]. The complexity of thought required for competence [in physics and biology] is qualitatively different - *though equivalent*⁵ - between the two sciences".⁶

The analysis of a sample of tests⁷ constructed by the teachers show that many *U* questions demand a very high level of abstraction,⁸ a level of abstraction which places them among highest categories of Bloom's Taxonomy of Educational Objectives. The teaching of the biological sciences in Portugal have experienced enormous changes in the last fifteen years, comparatively greater than in physics and chemistry; the competencies required in all these three fields we would argue are now equivalent. This explains the well known fact that in Portugal pupils' final marks in subjects like ecology, biology, environmental science and human physiology are similar and sometimes indeed are lower than marks in physics and chemistry.⁹ Furthermore, we should remember that the scientific content and competencies involved in subjects like human physiology, ecology, environmental science, biology are basically grounded in concepts of chemistry and physics which are integrated and brought to higher levels of abstraction in the understanding of environmental problems, health problems.¹⁰

2.2. ACHIEVEMENT ASSESSED BY TEACHER'S TESTS

We did not use standardised tests to be answered by all the pupils of the sample because our ultimate interest *was not* to monitor standards (although our study also gave

us that information) but to assess what the pupils have learned *from what they had been taught*. For this reason we used the tests which were devised by the teachers themselves. The validity of a test devised by the teacher has good chances of being higher than the validity of a test devised by the researcher. Our *intention was to find out why pupils failed with respect to the scientific content and competencies developed in the classroom rather than to verify whether or not a given set of contents and competencies had been developed in the classroom*. If we had devised our own tests these tests would not have corresponded to the actual teaching which had taken place in each teacher's classes. As a consequence when pupils succeeded or failed that success or failure would not necessarily tell us about success or failure in contents and competencies developed in the classroom.

As we were going to use the teachers' own tests it was essential that teachers knew how to construct a valid test so that it was an accurate reflection of what had been taught. In our meetings with the teachers we discussed with them the procedures for constructing such valid tests or better, perhaps, how to reduce invalidity. Those teachers who were unaware of these guiding principles were given special attention and reading materials. Further we were also bound to examine the degree of agreement among teachers in their marking practices and in their powers of discriminating between the scientific competencies crucial to achievement.

2.3. SEPARATION OF COMPETENCIES IN TWO GROUPS AND TEACHERS' POWER OF DISCRIMINATION

Our hypotheses stated that differential achievement between pupils of different social groups should be higher in competencies requiring a high level of abstraction. In such circumstances it was crucial for the empirical research

to divide competencies developed in the classroom in two groups, the first group with those competencies requiring a low level of abstraction and the second with those requiring a high level of abstraction. It was also crucial to define *very precisely* what was meant by each one of these two groups of competencies.

The first group called *Acquisition of Knowledge* includes all knowledge whose learning requires a very low level of abstraction on the part of the learner. In practical terms, and as far as science education is concerned, the first group of competencies includes factual knowledge and the understanding of primary concepts at the lowest level defined, for instance, by the ability to define a concept in one's own words. With respect to the scientific process, this group of competencies includes observation, recording and interpretation of data at the lowest levels. In terms of Bloom's Taxonomy of Educational Objectives, the competencies of this first group are included in the first category of the cognitive domain, i.e. 'Knowledge'. They are also included in the lowest sub-category (translation) of its second category 'Comprehension'. The competencies we defined as A competencies can be considered as a pre-requisite to further learning.

The second group of competencies called *Use of Knowledge in New Situations* includes all knowledge whose learning requires a high level of abstraction. In practical terms, this second group includes the understanding of concepts at a higher level defined, for instance, by the ability to make predictions on the basis of a concept. It also includes the application of concepts to new situations, and with respect to the scientific process it includes nearly all the abilities this process requires from the more complex level of interpreting data to the ability to state problems and hypotheses. In terms of Bloom's Taxonomy of Educational Objectives the competencies of this second group are included in the two highest sub-categories (interpretation,

extrapolation) of its second category 'Comprehension' and also in the categories 'Application', 'Analysis', 'Synthesis', 'Evaluation'. The reader can see examples of questions testing the first and second groups of competencies in Appendix IV where we show the classification given by a teacher (X_7) who shares the same criterion as the researcher. Further questions can be seen in Appendix V, devised by teacher X_7 and by teacher X_3 .

From now on the first type of competency will be indicated as *A* competencies and the second as *U* competencies. We should point out again that *by definition* *A* competencies are those which require a low level of abstraction on the part of the pupil and *U* competencies are those which require a high level of abstraction.

To make a distinction between these two types of competencies is, in practical terms, not always easy. We therefore had to follow a set of procedures to assure that all our teachers would hold the same criterion:

- (a) We discussed with the teachers the criterion we needed for this study and we provided them with written material and bibliographic references on the subject. Our discussions included classifying through practical examples.
- (b) We assessed the degree of agreement between teachers in distinguishing *A* and *U* competencies twice in the year.
- (c) We kept in constant contact with the teachers and they were asked to keep also in contact with each other; in this way the planning of their tests was discussed whenever that contact was possible.

We must point out that although the teachers were being asked to make a distinction between *A* and *U* competencies

according to a boundary or line *set by the researcher*, all teachers are expected by the Ministry of Education to record pupils' marks for these two types of competencies once in each of the three terms of the year. Further all the teachers were acquainted with the issues involved in making these distinctions as a consequence of the training courses they had attended. Our task then was not one of introducing teachers to the distinction between *A* and *U* competencies for they already were expected to make such a distinction but to understand and be able to operate the *researcher's criterion* for making the distinction. The distinction made by the Ministry of Education included among *A* competencies some *U* competencies of a lower order. We wished to make the distinction sharper and so we excluded from *A* competencies these lower level *U* competencies which now belonged to our *U* category. For this reason it was crucial for all teachers to be able to operate our criterion (see later discussion about teachers meetings). We should add that to draw a firm line between two types of competencies in practice is not always easy in every case; some degree of error was therefore to be expected.

3. THE SAMPLE - CHOICE AND DISTRIBUTION

By virtue of the researcher's position as a trainer of science teachers the researcher had access to a large number of teachers varying in their experience, in-service training, publications and who taught in different types of schools in different geographical areas. On the basis of attributes of teachers' competence, type of school, geographical area, a sample was created which would allow us the possibility of comparing the influence of school location (big cities/country), school type, competence of teacher, upon differential pupil achievement. It is also the case that geographical area and type of school reflects the social class composition of pupils.

We followed the following basic criteria for the selection of the sample:

- (a) we wanted a greater percentage of pupils from the middle than the upper section of the school.
- (b) We wanted a balanced distribution of pupils from two main areas; large cities and towns in the country
- (c) we wanted a balanced distribution of pupils from three types of schools: (1) comprehensive schools former 'liceus'; (2) comprehensive schools former technical schools; (3) newly built comprehensive schools.¹¹
- (d) we wanted a balanced distribution of teachers with different degrees of practice and competence within the new paradigm.¹²

Despite our preferred criteria a major constraint on our actual sample arose out of the availability, willingness and co-operativeness of teachers and also out of the minimum level of pedagogic training and competence we required of the teachers. The teachers as we shall see had to collect data, follow instructions, attend meetings, acquire particular criteria, mark and evaluate each other's questions. These constraints necessarily made the sample of teachers perhaps more selective in some respects than we would have wished. From one point of view our sample of teachers assists our research aims. All the teachers necessarily are motivated and interested within different ranges of competence and as a consequence the achievement of the pupils cannot be attributed to inadequate, ineffective, unmotivated teachers. Indeed whatever results we obtain will be probably different from those of a randomly selected group. As a disadvantage we had to work with the classes allocated to the selected teachers in our selected schools. As a consequence the number of classes our

teachers teach varies with a range of different factors such as the number of years the teacher has already worked, the other functions the teacher carries out in the school.

The pupils are separated in two groups. The first group includes 7th, 8th and 9th years of schooling and is conventionally called here the middle school and the second group includes 10th and 11th years and here is called the upper school. It is important for the purpose of this study to separate these two groups of pupils. The upper school consists of pupils all of whom have elected to stay on at school. The middle school which contains the majority of pupils attending secondary school consists of pupils who are still within compulsory education and those who have elected to remain at school for the period of the middle school.

The table in Figure 2.1 shows the distribution of pupils in the sample. In this table we can see the number of classes within each year and each subject and taught by each teacher, in relation to school location. The sample is constituted by 8 schools, 11 teachers and 1,410 pupils.

By the end of the year the sample was slightly modified because the number of pupils had decreased. Throughout the year pupils dropped out of the classes either giving up their studies for a job¹³ or by failing the year because of a high number absences. This often precedes early leaving of school. Further some of the upper school pupils dropped out and took the exam as external pupils.¹⁴ Pupils who gave up are shown in the table of Figure 2.2 distributed by teachers and sections of the school. In each case the number of pupils who dropped out and the respective percentage in relation to initial enrolments are shown.

To these pupils we have to add (a) two pupils who eventually were rejected because it turned out to be too difficult to clarify satisfactorily their family characteristics and (b) a few pupils who moved to the night school

| SCHOOL LOCATION | YEARS AND SUBJECTS | 7th YEAR (Age 13) | 8th YEAR (Age 14) | 9th YEAR (Age 15) | SUB-TOTAL | 10th YEAR (Age 16) | | 11th YEAR (Age 17) | SUB-TOTAL | TOTAL |
|-----------------|--------------------|---|---|----------------------------|-----------|--------------------|------------------|--------------------|-----------|-------|
| | | BIOLOGY | ECOLOGY | HUMAN BIOLOGY | | BIOLOGY | ENVIRON. SCIENCE | | | |
| URBAN | | 1 (X_3) 3 (X_4) 4 (X_7) | 1 (X_1) 4 (X_6) 3 (X_7) | 4 (X_2) 3 (X_5) | | 1 (X_1) | | 5 (X_3) | | |
| SUB-TOTAL | | 8 | 8 | 7 | 23 | 1 | | 5 | 6 | 29 |
| COUNTRY | | 1 (Z_1) 7 (Z_3) | 6 (Z_1) | 1 (Z_1) 5 (Z_4) | | 2 (Z_2) | 2 (Z_2) | | | |
| SUB-TOTAL | | 8 | 6 | 6 | 20 | 2 | 2 | | 4 | 24 |
| TOTAL | | 16 | 14 | 13 | 43 | 3 | 2 | 5 | 10 | 53 |

- (1) The teacher is indicated in brackets
(2) *Urban* refers here to a large city, in this case Lisbon and Porto
Country refers to towns in the country

Figure 2.1 - Distribution of the sample: Number of classes within each year and each subject and referred to teachers, in relation to school areas

shift or to other schools during the course of the year.

| TEACHERS SECTIONS OF SCHOOL | X_1 | | X_2 | | X_3 | | X_4 | | X_5 | | X_6 | | X_7 | | Z_1 | | Z_2 | | Z_3 | | Z_4 | | TOTAL | |
|-----------------------------------|-------|---|-------|---|-------|---|-------|---|-------|---|-------|---|-------|---|-------|---|-------|----|-------|---|-------|---|-------|----|
| | N | % | N | % | N | % | N | % | N | % | N | % | N | % | N | % | N | % | N | % | N | % | N | % |
| <i>Middle</i> (7th, 8th, 9th) | 1 | 3 | 5 | 4 | 0 | 0 | 1 | 1 | 1 | 2 | 0 | 0 | 15 | 8 | 12 | 7 | - | - | 15 | 9 | 8 | 6 | 58 | 5 |
| <i>Upper</i> (10th, 11th) | 3 | 9 | - | - | 12 | 9 | - | - | - | - | - | - | - | - | - | - | 14 | 11 | - | - | - | - | 29 | 10 |
| TOTAL | 4 | 6 | 5 | 4 | 12 | 7 | 1 | 1 | 1 | 2 | 0 | 0 | 15 | 8 | 12 | 7 | 14 | 11 | 15 | 9 | 8 | 6 | 87 | 6 |

Figure 2.2 - Drop-outs with reference to initial enrolments

Our sample is based upon those pupils who were still at school at the end of the year. There are 1,320 pupils, 1,059 in the middle school and 261 in the upper school. The tables in Figures 2.3 and 2.4 show the distribution of the final sample according to all variables considered. The tables VIII.3 and VIII.4 of Appendix VIII also show the distribution of the sample according to all variables for each teacher in the middle and the upper school. These tables are referred to in the chapter 'Quantitative analysis of sociological variables and achievement' because they are summary statistics which correspond to the first quantitative treatment of the base data.

We can make some comments on the pupils who left school.

- (a) In the middle school the highest percentages are found in the schools outside Lisbon all of them working-class schools¹⁵ irrespective of teacher and facilities in the school.

| | *3RD ACQ | 3RD USE | 3RD GLO | AGE | GENDER | SIBLINGS | SIB.POS. | PRIM.SCH | REPEAT. | LIVING | F.' AGE | F.' QUAL | F.'DCC. | M.'AGE | M.'QUALI | M.'DCC. | SCH.AREA | TEACHER | SCH.TYPE | F.SCHOOL | M.SCHOOL |
|------------|----------|---------|---------|-------|--------|----------|----------|----------|---------|--------|---------|----------|---------|--------|----------|---------|----------|---------|----------|----------|----------|
| 1 | 33 | 102 | 33 | 0 | 522 | 146 | 501 | 725 | 794 | 1021 | 213 | 64 | 0 | 426 | 127 | 578 | 619 | 174 | 474 | 296 | 240 |
| I COL | 3.12 | 9.63 | 3.12 | 0.00 | 49.29 | 13.79 | 47.35 | 73.53 | 74.98 | 96.50 | 20.34 | 6.09 | 0.00 | 40.34 | 11.99 | 54.58 | 58.45 | 16.43 | 44.76 | 64.77 | 75.47 |
| 2 | 205 | 499 | 335 | 24 | 537 | 485 | 176 | 261 | 265 | 1 | 646 | 530 | 128 | 519 | 614 | 46 | 440 | 113 | 216 | 161 | 78 |
| I COL | 19.36 | 47.12 | 31.63 | 2.28 | 50.71 | 45.80 | 16.64 | 26.47 | 25.02 | .09 | 61.70 | 50.43 | 12.18 | 49.15 | 57.98 | 4.34 | 41.55 | 10.67 | 20.40 | 35.23 | 24.53 |
| 3 | 463 | 382 | 551 | 210 | 0 | 243 | 381 | 0 | 0 | 36 | 180 | 112 | 129 | 111 | 73 | 83 | 0 | 117 | 369 | 0 | 0 |
| I COL | 43.72 | 36.07 | 52.03 | 19.98 | 0.00 | 22.95 | 36.01 | 0.00 | 0.00 | 3.40 | 17.96 | 10.66 | 12.27 | 10.51 | 6.89 | 7.84 | 0.00 | 11.05 | 34.84 | 0.00 | 0.00 |
| 4 | 358 | 76 | 140 | 302 | 0 | 99 | 0 | 0 | 0 | 0 | 0 | 91 | 0 | 0 | 74 | 48 | 0 | 153 | 0 | 0 | 0 |
| I COL | 33.81 | 7.18 | 13.22 | 28.73 | 0.00 | 9.35 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 8.66 | 0.00 | 0.00 | 6.99 | 4.53 | 0.00 | 14.45 | 0.00 | 0.00 | 0.00 |
| 5 | 0 | 0 | 0 | 224 | 0 | 38 | 0 | 0 | 0 | 0 | 0 | 73 | 191 | 0 | 89 | 23 | 0 | 84 | 0 | 0 | 0 |
| I COL | 0.00 | 0.00 | 0.00 | 21.31 | 0.00 | 3.59 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 6.95 | 18.17 | 0.00 | 8.40 | 2.17 | 0.00 | 7.93 | 0.00 | 0.00 | 0.00 |
| 6 | 0 | 0 | 0 | 111 | 0 | 27 | 0 | 0 | 0 | 0 | 0 | 55 | 122 | 0 | 22 | 80 | 0 | 29 | 0 | 0 | 0 |
| I COL | 0.00 | 0.00 | 0.00 | 10.56 | 0.00 | 2.55 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 5.23 | 11.61 | 0.00 | 2.00 | 7.55 | 0.00 | 2.74 | 0.00 | 0.00 | 0.00 |
| 7 | 0 | 0 | 0 | 87 | 0 | 14 | 0 | 0 | 0 | 0 | 0 | 126 | 174 | 0 | 60 | 70 | 0 | 63 | 0 | 0 | 0 |
| I COL | 0.00 | 0.00 | 0.00 | 8.28 | 0.00 | 1.32 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 11.99 | 16.56 | 0.00 | 5.67 | 6.61 | 0.00 | 5.95 | 0.00 | 0.00 | 0.00 |
| 8 | 0 | 0 | 0 | 62 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 90 | 0 | 0 | 37 | 0 | 0 | 0 | 0 | 0 |
| I COL | 0.00 | 0.00 | 0.00 | 5.90 | 0.00 | .38 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 8.56 | 0.00 | 0.00 | 3.49 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 9 | 0 | 0 | 0 | 18 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 24 | 0 | 113 | 0 | 0 | 0 |
| I COL | 0.00 | 0.00 | 0.00 | 1.71 | 0.00 | .09 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.27 | 0.00 | 10.67 | 0.00 | 0.00 | 0.00 |
| 10 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 84 | 0 | 0 | 17 | 0 | 26 | 0 | 0 | 0 |
| I COL | 0.00 | 0.00 | 0.00 | .95 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 7.99 | 0.00 | 0.00 | 1.61 | 0.00 | 2.46 | 0.00 | 0.00 | 0.00 |
| 11 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 0 | 0 | 32 | 0 | 187 | 0 | 0 | 0 |
| I COL | 0.00 | 0.00 | 0.00 | .19 | 0.00 | .09 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.14 | 0.00 | 0.00 | 3.02 | 0.00 | 17.66 | 0.00 | 0.00 | 0.00 |
| 12 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 121 | 0 | 0 | 21 | 0 | 0 | 0 | 0 | 0 |
| I COL | 0.00 | 0.00 | 0.00 | .10 | 0.00 | .09 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 11.51 | 0.00 | 0.00 | 1.98 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| TOTAL COL: | 1059 | 1059 | 1059 | 1051 | 1059 | 1059 | 1058 | 986 | 1059 | 1058 | 1047 | 1051 | 1051 | 1056 | 1059 | 1059 | 1059 | 1059 | 1059 | 457 | 318 |
| MISSING : | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 73 | 0 | 1 | 12 | 0 | 8 | 3 | 0 | 0 | 0 | 0 | 0 | 602 | 741 |
| MEAN : | 3.00 | 2.41 | 2.75 | 4.83 | 1.51 | 2.60 | 1.89 | 1.26 | 1.25 | 1.07 | 1.98 | 3.24 | 6.37 | 1.70 | 2.71 | 3.29 | 1.42 | 5.41 | 1.90 | 1.35 | 1.25 |

Figure 2.3. - Distribution of the final sample: Middle school

| | 3RD ARU | 3RD USE | 3RD GLO | AGE | SEI | SIBLINGS | SIB.POS. | PRIM.SCH | REPEAT. | ILIVING | IF. | AGE | IF. | OCUP | IM. | AGE | IM. | QUALI | IM. | OCUP | ISCH.AREA | TEACHER | ISCH.TYPE | IF.SCHOOL | IM.SCHOOL | |
|------------|---------|---------|---------|-------|-------|----------|----------|----------|---------|---------|-------|-------|-------|-------|-------|-------|-------|-------|--------|------|-----------|---------|-----------|-----------|-----------|-----|
| 1 | 9 | 39 | 13 | 0 | 188 | 54 | 142 | 112 | 239 | 249 | 27 | 13 | 0 | 74 | 21 | 102 | 151 | 0 | 0 | 0 | 0 | 0 | 0 | 99 | 94 | |
| Z COL | 3.45 | 14.94 | 4.88 | 0.00 | 41.38 | 28.69 | 54.41 | 48.87 | 91.57 | 95.48 | 18.63 | 5.86 | 0.00 | 28.88 | 8.88 | 39.23 | 57.85 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 65.13 | 74.38 | |
| 2 | 59 | 124 | 165 | 0 | 153 | 44 | 121 | 22 | 0 | 164 | 92 | 16 | 151 | 118 | 12 | 110 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 53 | 31 | |
| Z COL | 22.61 | 47.51 | 48.23 | 0.00 | 58.62 | 44.06 | 16.88 | 51.93 | 8.43 | 0.00 | 64.57 | 35.88 | 6.25 | 58.53 | 45.38 | 4.62 | 42.15 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 34.87 | 25.62 | |
| 3 | 142 | 89 | 122 | 0 | 0 | 46 | 75 | 0 | 0 | 12 | 63 | 38 | 29 | 33 | 25 | 26 | 0 | 0 | 261 | 0 | 0 | 0 | 261 | 0 | 0 | |
| Z COL | 58.41 | 34.10 | 46.74 | 0.00 | 0.00 | 17.62 | 28.74 | 0.00 | 0.00 | 4.68 | 24.88 | 11.67 | 11.33 | 12.79 | 9.62 | 18.88 | 0.00 | 0.00 | 189.88 | 0.00 | 0.00 | 0.00 | 189.88 | 0.00 | 0.00 | |
| 4 | 51 | 9 | 21 | 0 | 0 | 22 | 0 | 0 | 0 | 0 | 0 | 33 | 0 | 0 | 33 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Z COL | 19.54 | 3.45 | 8.85 | 0.00 | 0.00 | 8.43 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 12.84 | 0.00 | 0.00 | 12.69 | 2.69 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| 5 | 0 | 0 | 0 | 11 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 17 | 28 | 0 | 27 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Z COL | 0.00 | 0.00 | 0.00 | 4.25 | 0.00 | 3.83 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 6.61 | 7.81 | 0.00 | 18.38 | 2.69 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| 6 | 0 | 0 | 0 | 74 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 19 | 27 | 0 | 6 | 27 | 0 | 0 | 27 | 0 | 0 | 0 | 27 | 0 | 0 | |
| Z COL | 0.00 | 0.00 | 0.00 | 28.37 | 0.00 | 3.45 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 7.39 | 18.55 | 0.00 | 2.31 | 18.38 | 0.00 | 0.00 | 18.34 | 0.00 | 0.00 | 18.34 | 0.00 | 0.00 | 0.00 | |
| 7 | 0 | 0 | 0 | 97 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 53 | 44 | 0 | 38 | 28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Z COL | 0.00 | 0.00 | 0.00 | 37.45 | 0.00 | 1.53 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 28.62 | 17.19 | 0.00 | 11.54 | 7.69 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| 8 | 0 | 0 | 0 | 58 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 32 | 0 | 0 | 16 | 0 | 0 | 118 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Z COL | 0.00 | 0.00 | 0.00 | 19.31 | 0.00 | .38 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 12.58 | 0.00 | 0.00 | 6.15 | 0.00 | 0.00 | 42.15 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| 9 | 0 | 0 | 0 | 23 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Z COL | 0.00 | 0.00 | 0.00 | 8.88 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.46 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| 10 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 36 | 0 | 0 | 8 | 0 | 0 | 124 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Z COL | 0.00 | 0.00 | 0.00 | 1.54 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 14.86 | 0.00 | 0.00 | 3.88 | 0.00 | 0.00 | 47.51 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 19 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Z COL | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.73 | 0.00 | 0.00 | 6.88 | 7.31 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 45 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Z COL | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 17.58 | 0.00 | 0.00 | 2.69 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| TOTAL COL: | 261 | 261 | 261 | 261 | 261 | 261 | 261 | 233 | 261 | 261 | 254 | 257 | 256 | 258 | 268 | 261 | 261 | 261 | 261 | 261 | 261 | 261 | 261 | 261 | 152 | 121 |
| MISSING : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 28 | 0 | 0 | 7 | 4 | 5 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 109 | 148 |
| MEAN : | 2.98 | 2.26 | 2.58 | 7.85 | 1.59 | 2.49 | 1.74 | 1.55 | 1.88 | 1.89 | 2.14 | 3.85 | 7.51 | 1.84 | 3.25 | 4.43 | 1.42 | 8.74 | 3.88 | 1.35 | 1.35 | 1.35 | 1.35 | 1.35 | 1.26 | |

Figure 2.4. - Distribution of the final sample: Upper school

- (b) Further in the middle school *nearly all drop-outs are working-class children.*
- (c) In the upper school working-class children gave up studies for a job whereas middle-class children dropped out to take their exam as *external pupils.*

4. THE ROLE OF THE TEACHERS IN THE CREATION OF THE PUPILS' DATA

We made arrangements for science teachers in our sample teaching in Portuguese secondary schools to work in close connection with us during the academic year of 1980-1981, so that the data we needed could be obtained. The nature of the data required a very close contact with these teachers which included individual meetings, group meetings, visits to the schools, discussions, constant exchange of written material. We shall present a summary description of these contacts organised according to the tasks the teachers had to carry out.

4.1. INFORMATION ON FAMILY BACKGROUND

We sent to teachers a first questionnaire¹⁶ which was filled-in by the teachers themselves asking for information they usually possess about their pupils. This questionnaire was returned to the researcher as many times as necessary to clarify the accuracy of the information about the pupils.

Although some teachers were at first reluctant to give a questionnaire to the pupils they came to understand later in the year that the kind of information we required for our study was only incompletely given in the questionnaire they filled in. A second questionnaire,¹⁷ this time for the pupils, was therefore given to the teachers. We

gave the teachers oral and written information on how the questionnaires should be filled in so that the teachers could help their pupils to complete it correctly.

The questionnaires were returned to us as many times as required. We checked the information and sent the questionnaires back signalling where information was incomplete. The teachers tried to clarify the points with the pupils who in many cases consulted their parents at home. Finally, when the teachers felt they had obtained as accurate information as possible but where we had reasons to believe the information was inadequate, we entered in direct contact with parents either by telephone or by going in person to the homes. This was done whenever we thought the information was incomplete *or* whenever there were doubts about the information given. We made over three hundred contacts with parents. This work was essential (although incredibly time-consuming) because we believed that the *value of the study relied heavily on the accuracy of the information gathered on the family background of the pupils.* It was not a light undertaking. It involved about fourteen hundred initial questionnaires to the teachers and the same number later to the pupils checked several times and supplemented by direct contacts with the families.

4.2. PUPILS' TEST SCORES

We asked the teachers to record the marks of the pupils' tests in the appropriate table.¹⁸ They were also asked to record the score level (global and for each type of competency) they gave to the pupil at the end of each term.¹⁹ We agreed initially with the teachers that 60% of each test should be allocated to *A* competencies and 40% to *U* competencies. This was changed in the second term when we agreed on 50% *A* and 50% *U*. We all considered that 60% of the test for *A* competencies was a very high proportion given that our criterion had placed in this group of competencies only

very low level competencies. This change could have had consequences when comparing global marks for the three terms but that analysis was not carried out as it was thought superfluous.

The pupils' marks in the different tests recorded by teachers in each pupil's table with respect to achievement in three dimensions (*A*, *U*, global) in the three terms, were then totalled by the researcher. The marks were then entered into the computer and all reduced to a 0-100 scale which was subsequently changed according to the analyses we carried out.

4.3. PRINCIPLES OF THE DISTINCTION BETWEEN *A* AND *U* COMPETENCIES AND OF THE MARKING OF PUPILS' ANSWERS

The teachers were informed of the importance of making a clear distinction between the two types of competencies. They were explained the hypotheses which were to be tested and the crucial importance of the assessment of pupils' achievement in *A* and in *U* competencies. We explained to the teachers that we intended to carry out two major evaluations of them and comparisons between them; the first in their powers of distinguishing between *A* and *U* competencies and the second in their degree of agreement in the marking of pupils' answers.

Two meetings were held with the teachers for these purposes, the first lasted two days at the end of the second term and the second lasted three days at the end of the year. For these meetings the teachers teaching in the country had to come to Lisbon where the meetings were held. The details of the procedures they had to follow in preparation for these meetings and, in the meetings themselves, are explained in Chapter four. Let us only point out here that the teachers gave up their free time to attend these meetings (holidays, Sundays) and exposed their teaching

principles during whole-day sessions. Apart from the payment of their travelling expenses the only payment they received was the expressed gratitude of the researcher.

If we now add to this work, the work the teachers carried out as preparation for the meetings, answering questionnaires, following the researcher's instructions, we can see that such a burden of work requires more than the mere thanks we gave them. Teachers X_3 and X_7 were especially overburdened (see 4.4.). It is true that many of these teachers had worked with the researcher either in previous research, teacher training and curriculum development or in attending in-service teachers' courses carried out by a team which included the researcher.²⁰ The teachers were committed to similar aims to those of the researcher. This, however, in no way diminishes their merit in carrying out a task far and beyond the requirements of their normal teaching.

4.4. SPECIAL TEACHING PROGRAMME

We indicated in the introduction to this chapter that we were going to include in our research a study of the teaching of selected objectives. This study would allow us to examine the evolution of achievement in two types of competencies (A and U) and therefore to have a reference to compare each teacher's pedagogic practice. Further the results of the study of selected objectives would enable us to carry out an analysis of the effects of a special teaching programme upon pupils' differential achievement.

Two teachers were involved in this study, X_3 and X_7 . A full account of this programme is given in Chapter three and its effects are analysed in Chapters six and seven. These two teachers were chosen because of the high level of their pedagogic competence already known to the researcher, and their previous training and research experience which

included previous collaborative work with the researcher. As this was an explorative study we wished to reduce the number of variables which have been introduced if we had chosen two teachers randomly. At least with these teachers we were sure of their competence, motivation and experience which were *indispensable* to this kind of study.

We discussed with these two teachers how the study should be carried out, that is what teaching objectives in *A* and *U* competencies should be selected for the special teaching programme, the strategies of the teaching programme, its insertion in the daily practice and the test questions to be designed to check acquisition of the objectives. We have to state how much we are in the debt of the teachers for their competence, willingness and interest in carrying out this programme which added to the daily burden of their teaching.

5. THE SCALING OF SOCIAL CLASS INDICES

We shall present the various scales we constructed for the processing of our data and for the establishing of categories of analysis. We shall give in great detail the procedures and assumptions of our index of social class because of the crucial role we expect social stratification to play in accounting for differential pupil achievement in science in secondary schools. The other scales with the exception of the scale for ranking teachers in order of imputed competence, are conventional. These scales and the conventions we used are needed for reference and we will give them in an appendix to the chapter.

5.1. INTRODUCTION

We can distinguish between the use of social class as an analytic concept in theories where the concept has an explanatory power in the understanding of processes of social change, conflict and contradiction and social class as a *nominal*, descriptive concept where it is used to create a somewhat arbitrary distinction between social groups hierarchically arranged on the basis of occupation or education or both. There is some association between the empirical specification of such hierarchically arranged groups and the expected relations entailed in the analytic concept of social class and class relations. For example most nominal social class scales are based upon a crucial distinction between manual and non-manual occupational functions although the crossover point and especially its sociological meaning has become very ambiguous. Further it is likely to be the case that an unequal distribution of power over physical and symbolic markets, prestige and opportunity is broadly associated with positions in the hierarchy of social classes empirically specified by the nominal concept. On the other hand there is always difficulty when we use the analytic concept of social class and class relations to specify empirically the precise boundaries between class groups, class factions and their internal and external relations. It is not our intention to enter into this discussion here but simply to show how we are going to use 'social class' as a crucial regulator of differential patterns of pupil achievement in secondary schools.

There are many difficulties in the construction of a nominal social class scale.^{21,22,23} In general empirical sociological research uses or modifies an existing social class scale which has been constructed on the basis of a rational methodology. However, it is also the case that researchers tend to construct scales according to the specific requirements of their research on the basis of occupational function and/or educational level. In our

case we had a double problem. Whilst some social class scales do exist in Portugal their construction does not necessarily create an explicit hierarchy of occupations in terms of power, prestige and opportunity.

Further the scales are not constructed to create discrete groups necessarily relevant to the understanding of differential patterns of the school achievement of pupils. We were also faced with the problem that the U.K. social class scales based upon a rational methodology referred to an occupational and prestige structure different from that of Portugal which in many respects can be regarded as a developing society. To complicate matters still further after 1974 (the Revolution) there was some re-defining of the prestige/power relations between social groups.

We thus had to face the following problems:

- (a) U.K. scales of social class could not simply be transferred to Portugal.
- (b) Portuguese scales either of social class or occupational function were not adequate to the research.
- (c) We wished to introduce into a scale the possibility of distinguishing discrete occupational functions within a given level which we believed were associated with differential patterns of pupil achievement.

The scale we have produced is therefore a compromise between U.K., Portuguese scales *and* the particular requirements of our research. The scale is a twelve point scale, which can be collapsed into a nine point scale so that we are also able to test the influence of discrete occupational functions within a given level upon patterns of pupil achievement. In a sense the scale represents an hypothesis

of the likely relations between nominal social class position as given by the scale and differential patterns of pupil achievement.

5.2. FATHER'S AND MOTHER'S OCCUPATIONS

To work out a scale of parents' occupations proved to be a very difficult task. There were two main sources of difficulties in setting up an appropriate scale: (a) the huge variety of different occupations; (b) the ill-definition of most of those occupations in the questionnaires' answers.

We carried out three different kinds of complementary procedures:

- (a) We consulted relevant literature on the social grading of occupations both in the United Kingdom and in Portugal²⁴ and sought advice from and had broad discussions with Professor B. Bernstein and also with Professor Sedas Nunes.
- (b) We talked to pupils and to parents whenever a better description of parents' occupations was needed.
- (c) We made a preliminary survey of all occupations referred to in the questionnaires.

Procedures (b) and (c) were of course highly time consuming but they were indispensable; procedure (b) increased the degree of accuracy and decreased the degree of subjectivity and error the grading of occupations entails, and procedure (c) gave a greater insight into the numbers in each occupation and therefore helped in the establishment of the final categories. Procedure (a) gave the direction and critical view of recognized authorities.

Finally nine categories were established, after taking into account the literature, advice, our own judgement, and the constraint of real numbers in each occupational group. The occupational scale we obtained seems to have as balanced a distribution as could be expected (see Figures 2.3 and 2.4). It should be noticed that the *basic criterion* for its establishment was the *socio-economic condition of the parents*; although in most cases the cultural aspect as indexed by educational level cannot be easily separated, this class feature was considered as a separate variable (paragraph 5.3.).

We should point out that we in fact made a number of scales before finally settling on the one we actually used.

We tried to ensure an hierarchical basis to the scale. There was, however, a group, that of housewives, for which no place could be found in such a hierarchy. Housewives represent a very heterogeneous category, although a very important one, for about 50% of the sample fall in it. We placed them as the first category but this obviously does not mean that they are at the bottom of the scale. Further there can be little difference in terms of socio-economic status for instance between those placed in groups 2 and 3. These facts *should be kept in mind whenever the interpretation of data is made.*

Other placement criteria were used because of the many constraints. Thus:

(a) occupational groups which were difficult to distinguish from each other, *given the available information*, were placed in the same category in order to diminish the probability of error (e.g. those who possessed a small enterprise and those who were self-employed);

(b) whenever a father or mother had more than one occupation he/she was classified in the highest category

among those occupations he/she followed;

(c) the capability of organizing an independent occupational life received high weight when deciding between near categories (e.g. a proprietor of a small shop ranks higher than an hired electrician);

(d) Armed and Police forces had to be split across the whole scale for their numbers were not high enough to keep them as separate groups as primarily intended;

(e) rural workers could not be kept as a separate category, as we firstly intended, because of their small number.

Finally, because an analysis of some special sub-groups within categories was thought to be important, each one of such a category was split in two to permit the separation of the sub-groups where needed. This is the case with categories 4, 9 and 11 which are respectively part of categories 3, 8 and 10 (see whole scale and re-classified scale below).

Our final scale is:

1. Housewives
2. (a) Unskilled manual workers²⁵
(General labourers; factory labourers; skilled manual worker's assistants.
Examples: masons, industrial cleaners, sawyers, stevedores, switchmen and other railway workers; rural workers)
- (b) Self-employed workers in Agriculture and street vendors.

3. Service workers: lower and intermediate grades without supervisory functions²⁶
(examples: shop assistants - lower grade; lorry, taxi, bus and coach drivers; engine drivers; caretakers; guards and attendants; telephone operators; messengers; postal workers; meter and receiver men; waiters; barmen and bar women; counter hands; office cleaners; butchers; store-keepers; packers; cooks, etc.).

4. Service workers: lower and intermediate grades without supervisory functions (cont.)
(examples: Domestic helpers and maids; female building keepers; messengers in schools; hair-dressers, etc.)

5. (a) Skilled and Qualified Manual Workers with and without supervisory function in Manufacturing, Commerce, Service and Agriculture
(examples: Maintenance and other fitters (e.g. electricians, plumbers, etc.); millwrights; assemblers; tool-makers; machine-setters; sheet metal workers; machine-tool operators; chemical process workers; food and other process workers (e.g. bakers, dressmakers and tailors); printers and compositors; carpenters and joiners; painters and decorators; bricklayers; operators of cranes and earthmoving equipment; plant and engine operators; gardeners, etc.).

(b) Unskilled Supervisory workers
(examples: masons, etc.)

(c) Controllers and Inspectors: lowest grades

- (d) Armed and Police forces: lowest ranks
(examples: soldiers; sailors; guards;
constables)
- 6.
- (a) Nonmanual employees in Administration and
Commerce
(examples: clerical workers in offices,
banks, insurance companies, etc.;
commercial travellers; vendors; supervisors
of sales personnel)
 - (b) Nurses without supervisory functions
 - (c) Technicians: lower grade
(examples: laboratory technicians; electrical
and electronic technicians; post office
technicians, etc.)
 - (d) Armed and Police forces: low ranks
(examples: sergeants, etc.)
- 7.
- (a) Small proprietors
(examples: working owners of small shops and
service agencies; small builders, etc.)
 - (b) Managers in small enterprises
(examples: Managers in commerce, engineering,
general manufacturing and construction,
personnel managers)
 - (c) Supervisors of manual employees: higher
grade
(examples: foremen in engineering, construction,
etc.)
 - (d) Self-employed workers in Manufacturing,
Commerce
(examples: see 5(a), (b))

8. (a) Supervisors of non-manual employees in Administration and Commerce
(examples: supervisors of clerical staff, also secretaries - higher grade)
 - (b) Lower Management
(examples: chiefs of section of public enterprises; managers of sections of medium private enterprises; commercial inspectors)
 - (c) Nurses with supervisory function
 - (d) Technicians: intermediate grade
(examples: laboratory technicians; computer technicians; computer programmers; draughtsmen and women; dietists; sales technicians; graphic arts people; etc.)
 - (e) Armed and Police forces: intermediate-lower ranks (non-existent in the sample, except for a police chief who was included here)
9. Continuation of group 8.
- (f) Primary and kindergarten teachers
10. (a) Self-employed and salaried professionals: lower grade
(examples: civil service executive officers; public inspectors; social welfare workers; artists and journalists - lower grade; personnel with a high degree not included in group 12; commercial navy officers; air controllers, etc.)
- (b) Medium proprietors
(examples: working owners of medium shops and service agencies; medium builders; working

owners of medium agricultural enterprises, etc.)

- (c) Managers of medium enterprises
(examples: managers in medium commercial enterprises and public utilities; industrial managers in medium enterprises; engineering, general manufacturing and construction; personnel managers in all medium establishments; also managers of sections of large enterprises and chiefs of division of public enterprises)
- (d) Technicians: higher grade
(examples: Technician-engineer; technician-economist; marketing technician; system analyst, etc.)
- (e) Armed and Police Forces: intermediate-higher ranks
(examples: lieutenant-colonels and majors; lieutenant-captains)

11. Salaried Professionals: lower grade (cont.)
Preparatory and Secondary school teachers

- 12. (a) Self-employed and Salaried Professionals: higher grade
(examples: doctors; lawyers; engineers; economists architects; university teachers; researchers; diplomats; psychologists; geologists; pharmacists; airline pilots; artists and journalists - higher grade; TV producers, etc.)
- (b) Large Proprietors
(examples: working owners of large shops and service agencies; large builders; working owners of large agricultural enterprises, etc.)

- (c) Administrators and officials: higher grade
(examples: managers in large commercial enterprises and public utilities; senior civil servants; company directors, etc.)
- (d) Industrial Managers: large enterprises
(examples: managers in engineering, general manufacturing and construction; personnel managers in all large establishments)
- (e) Armed and Police forces: highest ranks
(examples: Generals, brigadiers and colonels; admirals, vice-admirals; commodores)

Following a primary treatment of the data the above 1-12 scale was reduced to a 1-9 scale, in which:

| | |
|-----------|-------------|
| 1 - 1 | 6 - 7 |
| 2 - 2 | 7 - 8 & 9 |
| 3 - 3 & 4 | 8 - 10 & 11 |
| 4 - 5 | 9 - 12 |
| 5 - 6 | |

We made this change when we saw that a 1-12 scale was too extended a scale which created small numbers in some cells. However our chief reason for the reduction of the scale was in order to maintain the initial basic categories which, as we have previously explained, consisted of nine. These nine categories create a hierarchical occupational scale with the exception as we previously explained of category 1. This scale was used for the eventual stepwise regression analysis where we required a more adequate hierarchical scale important for this type of analysis. The twelve category scale appears in the tables of summary statistics in Appendix VIII and was used in the cross-tabulation of variables.

N.B. Whenever parents have been substituted by surrogates, those people are considered as parents for the purpose of this study. 'Lives' means that the pupil has always lived at least up to five years of age with own parents, except if from that age onwards father or mother was substituted by a surrogate. We also considered as 'living with parents' those pupils who are only away from home during school term time.

5.3. FATHER'S AND MOTHER'S EDUCATIONAL QUALIFICATIONS

Number of years of schooling was the main criterion for the scale of educational qualifications. For the same number of years, 'Liceu' and Technical School were always kept apart in different groups. Medium-level courses (nursing, secretarial, kindergarten teaching, etc.) were grouped according to the grades of schooling which had been done before, and joined to 'Liceu' and 'Technical School' groups according to the school attended; two exceptions were made for groups 4-5 and 6-7, in which cases medium-level courses were always joined to the technical school groups (5 or 7) for they are actually a vocational choice corresponding to the technical route.

- 1 - Cannot read or write
- 2 - Did not go to Primary School, but can read and write
- 3 - Completed Primary School (3rd or 4th grades)
- 4 - Attended some years of a Secondary School (5th-9th grades) in a 'Liceu' or in a Comprehensive Secondary School
- 5 - Attended some years of a Secondary School (5th-9th grades) in a Technical School or completed a Medium-level course after primary school
- 6 - Took the 9th grade exams in a 'Liceu'
- 7 - Took the 9th grade exams in a Technical School or completed a Medium-level course after 6th grade.

- 8 - Took the 11th grade exams (completed secondary school) in a 'Liceu' or completed a Medium-level course (2 years) after 'Liceu' 9th grade.
- 9 - Took the 11th grade exams (completed secondary school) in a Technical School or completed a Medium-level course (2 years) after Technical School 9th grade.
- 10 - Completed a Medium-level course(or did some years at a University) after 'Liceu' 11th grade, or after 'Liceu' 9th grade whenever that course represents over two years of studies
- 11 - Completed a Medium-level course(or did some years at a University) after Technical School 11th grade, or after Technical School 9th grade whenever that course represents over two years of studies
- 12 - Obtained a University degree after 'Liceu'
- 13 - Obtained a University degree after Technical School

Following a primary treatment of the data the above 1-13 scale was changed to a 1-7 scale, in which:

- | | |
|-----------|-------------|
| 1 - 1 & 2 | 5 - 8 & 9 |
| 2 - 3 | 6 - 10 & 11 |
| 3 - 4 & 5 | 7 - 12 & 13 |
| 4 - 6 & 7 | |

The reduced scale was constructed because of the small number in some cells of the expanded scale. The decision was taken to:

(a) join 1 and 2 because the distinction had a limited meaning as those parents who can read and write but never went to primary school are likely to fall in one of the following situations: either they possessed poor reading and writing competency, or they did not possess such competencies. Further pupils may have been ashamed to admit

such failures of their parents. In any case they are a small number.

(b) Put together all those who have the same years of schooling no matter which type of school ('Liceu' or Technical School) they attended.

This did not lead to less information because at the same time a new separate variable was introduced to indicate the type of school mother or father attended:

1 - Attended a 'Liceu'

2 - Attended a Technical School

N.B. See note for 5.2.: it also applies here

6. GENERAL CHARACTERISTICS OF THE SAMPLE

We shall give here a description of the general characteristics of our sample as these are revealed by the distributions according to type of primary school attended by the pupils, gender and pupil location in the middle/upper school, years repeated during school life and the number of pupils per type of teacher, school area and school type. This will be followed by examining the distributions created by fathers' and mothers' educational and occupational levels, and the age, sibling and sibling position of the pupil in the family, together with the distribution of pupils with respect to families of only one or both parents. We shall discuss these distributions with respect to the whole sample (Figures 2.3 and 2.4). If the reader is interested in examining the distribution of these characteristics for each sub-sample of each teacher he/she should refer to Appendix VIII.

6.1. TYPE OF PRIMARY SCHOOL

The relative percentage of pupils who attended primary school in the state and in the private sector is very different in the middle and in the upper school. In the former three fourths of the pupils attended a state school and in the latter about half of the pupils attended a state school and the other half a private school. The social class selection which has already taken place at the middle school level is very clear in the passage from the middle to the upper school.

6.2. GENDER AND MIDDLE AND UPPER SCHOOL

The number of boys and girls are equal in the middle school whereas girls outnumber boys in the upper school. This should not lead us to conclude that a higher number of girls attend the upper school. In fact, according to the present secondary school curriculum, pupils choose different areas of study at that period of their school career; our sample falls in only *one* of these areas (area A²⁷) and does not represent the distribution of boys and girls in the whole of the upper school. It still is a matter of interest that area A is chosen predominantly by girls in the upper school.

6.3. YEARS REPEATED DURING SCHOOL LIFE

Less pupils repeat a year in the upper than in the middle school. One fourth of the pupils are repeating a year in the middle school and only 8% of the pupils in the upper school. This points to the strong process of selection that has already taken place rather than to the easier syllabuses in the upper school. In fact, the level of conceptual demand relative to the respective ages of the pupils is in general higher in the upper than in the middle school.

6.4. NUMBER OF PUPILS PER TYPE OF TEACHER

We originally divided our teachers on a scale of pedagogic adequacy from one to five on the basis of their teaching *curriculum vitae* (training, years of experience, courses attended, research, publications).²⁸ On this grouping of teachers there was not much difference between teachers with respect to the number of pupils each taught. However very early in our analysis²⁹ it became clear to us that there was too great a range of variation between teachers to allow only a five-fold division. We had to treat each teacher/classes as a discrete sub-sample and this introduced considerable variation between teachers with respect to the number of pupils taught. It also led to the appearance of two small sub-samples in the middle school and one in the upper school which we were unable to use if a particular variable was divided into a number of sub-categories, e.g. parents educational/occupational level.

6.5. SCHOOL LOCATION, SCHOOL TYPE AND PUPILS

There is in our sample a higher percentage of pupils from large cities than from towns in the country, in both the middle and the upper school. When we selected the sample we tried to balance school classes between our two areas. However, the size of the classes in the country turned out to be in general smaller and this partly accounts for the imbalance. In the middle school there are more (~ 30% more) pupils in schools which were former technical schools than from those which were former 'liceus'. This we knew from the beginning and this imbalance was due to the constraints imposed on the choice of teachers *and* the classes they taught to which we have already referred. The number of pupils in new secondary schools is smaller as it should be because there are fewer schools of this type than former 'liceus' and technical schools. These imbalances within the sample should not have much consequence because our sample is very large. In the upper school our sample

has only pupils of former 'liceus' because the subjects which were the object of our study are currently mainly taught in this type of school.

After the first treatment of the data it was found that in the case of the middle school our sample had more schools (and more teacher sub-samples) with a predominantly working-class population than with a social mixed population. In the upper school there is an opposite distribution. This was not expected as at least schools Z_B and Z_C , the first a former 'liceu' and the second the only secondary school in the town, should have had a social mixed population. This indicates the low social class composition of the towns in the country as compared with the large cities.

6.6. FATHER'S AND MOTHER'S EDUCATIONAL QUALIFICATION

Parents' educational qualifications are higher in the upper than in the middle school and mothers' educational qualifications are on average lower than fathers' both in the middle and the upper school. The comparison of the respective means shows clearly this distribution. The higher educational qualifications of both parents of the pupils in the upper school points to the higher social class selection which has taken place at this level. If we look at the distribution across the whole scale we can see that $\sim 60\%$ of fathers and $\sim 70\%$ of mothers in the middle school have either completed only primary education or are illiterate against $\sim 40\%$ of fathers and $\sim 50\%$ of mothers in the upper school. With respect to the highest category in the educational scale, we can see that only $\sim 10\%$ of fathers and $\sim 5\%$ of mothers in the middle school have a higher degree whereas in the upper school the percentages are respectively $\sim 20\%$ and $\sim 10\%$.

6.7. FATHER'S AND MOTHER'S OCCUPATIONS

We can find a similar trend in parents' occupations to that which we had found for parents' educational qualifications. The mean cannot be used as a measure of that trend because some of the twelve categories represented in the occupational scale are sub-categories of main categories. We must therefore compare categories for mothers and fathers *with each other* in both middle and upper school. Such a comparison shows that mothers' occupations are lower than fathers' particularly in the middle school and especially at the top of the occupational scale for both middle and upper school. There is a very large number of housewives and that number is higher in the middle than in the upper school (~ 55% and 40%). There are good reasons to believe that *some* of these mothers are not just housewives as reported because they most probably do some kind of paid work at home or have been employed on a non-regular basis. Also some of them may well have been housewives at the time of our study, but were previously employed. In general, however, we believe that most of them are certainly just housewives. Here again, as in the case of parents' educational qualifications, we can notice a stronger process of social class selection at the level of the upper school.

6.8. FATHER'S AND MOTHER'S AGE

About 60% of the parents of the pupils in the upper school and the same percentage of the fathers in the middle school have ages between 40 and 50 years. About 50% of the mothers are of that age in the middle school.

6.9. SIBLINGS

Nearly half of the pupils have only one sibling both in middle and upper school. A percentage of about 35% of

the pupils have either no siblings or two siblings. The percentage of children with more than two siblings is very small in both middle and upper school ($\sim 17\%$).

6.10. SIBLING POSITION

Nearly half of the pupils are either the only child or the oldest in both middle and upper school. There is a small percentage ($\sim 17\%$) of pupils who are in the middle position and the remainder of the pupils are the youngest in the family. It would seem that family size is small and secondary education acts selectively on the relation between sibling position and school retention. A finding noted in many other studies outside of Portugal.³⁰

6.11. LIVING WITH BOTH PARENTS OR WITH ONE

Most of the pupils of our sample live with both parents in both the middle and the upper school ($\sim 95\%$). The remainder of the pupils live with their mothers. It should not be expected, therefore, that this variable will have much influence on the achievement of the *whole* school population.

7. PROBLEMS OF THE SAMPLE

Our sample in no sense can be said to be representative of the distributions of characteristics which would be found in a nationally planned study. However, it can be considered a form of quota sample in which we have selected at the level of geographical location of the school, type of school, teacher attributes and subject focus. As far as the pupils are concerned the sample cannot be considered representative of class, education and other family attributes because it is drawn from secondary school pupils who have undergone strong selection particularly in the upper school.

We deliberately chose to sample a cross section of year grades of pupils rather than to concentrate on one year grade although this did introduce a number of problems. We have, of course, in our analysis separated the middle school from the upper school pupils and in the sub-samples we distinguish pupils in terms of their year grade with the minor exception of teachers X_7 and Z_1 . However we are left with a number of problems.

7.1. SELECTION OF TEACHERS

The number of pupils as we have seen varies with teachers but this problem was not of our making and was entirely a function of the distribution of school classes to teachers. Once we had decided to select teachers who represented a range of experience then we had to take the classes allocated to these teachers. Further not only does the total number of pupils vary with each teacher but also the grades taught vary with teachers. This means that within the middle or within the upper school in the case of the *total* sample but *not* for sub-samples we are sometimes comparing achievement in different subjects for different grades of pupils.

We were faced with difficult choices. If we controlled for year grade we would have required many more teachers, far more than a Ph.D. candidate could have been able to manage. On the other hand we could have made a random choice of teachers and controlled for an equal number of classes for each of them. However, it would have been most unlikely that this random sample of teachers would have yielded teachers with the competence required for our study and whose interests and motivations in the teaching of science would have ensured their unpaid attendance in their free time at two two/three days meetings where they would have been involved in long tedious sessions necessary for the setting and achieving of criteria basic to the carrying out of our research. Further we could question whether these teachers

would have played the crucial part vital to the collection of the family data from the pupils. The probability of drop-outs among the teachers would have been high and we would have been left with a sample of teachers, pupils and families whose selective basis would have been arbitrary.

We are in no way attempting to diminish the limitations of our sample only to show that for the aims of our study an alternative sample in principle more reliable and valid may well in practice have created a different set of intractable problems. The teachers who formed the basis of our sample are a particular group. They are all concerned with improving the science curriculum, methods of teaching and pupils' achievement. It is probably for this reason that they cooperated so willingly and gave up their free time so generously. This means that the results we shall report have been produced by a range of teachers who although, by design, vary in their experience as teachers, still shared an important level of commitment and a level of competence which we believe would distinguish them from a random selection of secondary school teachers in Portugal if not elsewhere.

7.2. VALIDITY OF INFORMATION DERIVED FROM THE QUESTIONNAIRE

As we have already mentioned in the chapter the teachers were initially reluctant to give the questionnaire to the pupils and so to begin with we had to rely on the information possessed by the teacher about the family background of the pupil. However the teachers did agree to give the questionnaire to the pupils and took steps to assist the pupil and the family to give the information required. It is the case that the researcher herself got in touch with over three hundred families where she suspected the information on the questionnaire was inadequate, incomplete or unreliable. For the other two thirds of the sample we rely on information given by the pupils with the assistance of teachers; a reliance not unique in this type of research.

Despite the limitations to which we have referred we do have a sample in which we have a range of areas, types of school, teachers, pupils, families, where we have some index of the pedagogic characteristics of each teacher with respect to the focus of their teaching, their marking practice and their ability to assist their pupils to reach a given level of performance, where we can examine the complex pattern of inter-relations between patterns of pupils achievements and sociological variables. The large size of our sample both of pupils and teachers enables us to not only describe patterns at the level of the whole sample but also to carry out more delicate and revealing analyses of sub-samples of teacher/classes.

8. NOTES AND REFERENCES

1. Biology teachers have attended well organised in-service teachers' courses (see note 4 of Appendix II) in larger numbers than other science teachers.
2. M. Shayer *et. al*, 1981.
3. *Ibid.* 11, for example, pp. 11-13.
4. Our emphasis.
5. Our emphasis.
6. *Ibid.* 11, pp. 85-86.
7. See Appendices IV and V.
8. This demand depends on the teacher's pedagogic practice as it also would depend if the subjects were physics and chemistry. See chapter four, where a comparison of teachers shows a range of conceptual demand.
9. Wherever biology and related fields have been taught in up-to-date contents and methods.
10. This would be thoroughly understood through the analysis of all contents and competencies required by these courses. Unfortunately because of space limitations we cannot present all the possible information here.

11. See schools characteristics in Appendix I.
12. See summary *curriculum vitae* of teachers in Appendix II.
13. Some of these pupils continue their studies in the evening shift, where they can follow courses similar to those they left.
14. In the upper school the examination for each subject is taken separately. Pupils can drop out any subject they wish within a given period before the year finishes, and take the exam as external pupils (i.e. pupils not registered to attend school classes). This procedure is often used by pupils who expect to fail as a result of the year's assessment of their marks.
15. See in summary statistics in Appendix VIII the social composition of each teacher's classes.
16. See Appendix III.
17. *Ibid.* 20.
18. *Ibid.* 20, table in questionnaire for teachers.
19. Given the complexity of the analysis we were unable to use the overall mark level given by each teacher to each pupil. This level is a summary of a number of different forms of assessment.
20. See note 4 of Appendix II.
21. See A. Nunes, 1969.
22. See E. Cruzeiro and M. Antunes, 1973.
23. See J. Goldthorpe, 1974.
24. See the first four bibliographic references, which were the main sources of our information in constructing the occupational scale.
25. Workers who perform undifferentiated and auxiliary tasks of a simple and ordinary character requiring the use of physical strength. This group also includes workers doing routine work with machines.
26. This group also includes some workers in commerce.
27. See diagram of the secondary school curriculum in Appendix XI.
28. See *curriculum vitae* of teachers in Appendix II.
29. See chapter four on Teacher's pedagogic practice.
30. See, for example, A. Reader, 1970.

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APPENDIX

VARIABLES: CONVENTIONS, CLASSIFICATION AND CODE NUMBERS

1. MAIN CONVENTIONS

Conventions, used during the collecting, treatment and interpretation of data to identify schools, teachers, tests and pupils and also the type of mark, are here indicated.

1.1. Schools

X - Large city

Z - Town in the country

X_A, X_B, X_C, X_D, X_E - schools in large cities

Z_A, Z_B, Z_C - schools in towns in the country

1.2. Sections of school

Two sections of the secondary school are considered and they are conventionally called middle and upper school:

Middle school - 7th, 8th, 9th years

Upper school - 10th, 11th years

1.3. Teachers

Also referred to as X or Z according to the area of school.

$X_1, X_2, X_3, X_4, X_5, X_6, X_7$ - teachers in large cities

Z_1, Z_2, Z_3, Z_4 - teachers in towns in the country

Teachers X_1 and X_2 - school X_A

Teachers X_3 and X_4 - school X_B

Teacher X_5 - school X_D

Teacher X_6 - school X_C

Teacher X_7 - school X_E

Teachers Z_1 and Z_4 - school Z_A

Teacher Z_2 - school Z_B

Teacher Z_3 - school Z_C

1.4. Tests

Example: X_1 9A2

where:

X_1 is the teacher

9 is the year

A is the class

2 is the number of the test following a sequential order in time throughout the whole academic year

1.5. Pupils

Example: X_7 8B18

where:

X_7 is the teacher

8 is the year

B is the class

18 is the number of the pupil

1.6. Type of mark

1st - 1st term

2nd - 2nd term

3rd - 3rd term

A - 'Acquisition and comprehension of knowledge' competencies

U - 'Use of knowledge to new situations' competencies

G - Global Achievement (a mean of A and U for that term).¹

2. CLASSIFICATION AND CODE NUMBERS OF VARIABLES

There are in this empirical study a number of independent variables which represent pupils', teachers' and schools' characteristics to be related with pupils' scores which are the dependent variables.

Dependent variables, i.e. pupils' scores, are A, U and G final marks for the three terms.

Independent variables are the sociological variables and we considered a number of them: (a) pupil's age, gender, type of primary school attended, repetitions at school, number of siblings, sibling position, living with mother and father or only with one of them; (b) father's age, academic qualification, occupation; (c) mother's age, academic qualification, occupation; (d) teacher's attributes; (e) school's area; (f) school's type.

It should be noted that relationships within both groups of variables (dependent and independent) are considered.

2.1. Pupils' Scores

First term - A, U, G

Second term - A, U, G

Third term - A, U, G

Scores which were obtained on a scale 0-100 were reduced to a 1-4 scale in which:

1 - $0 \leq x < 25$

2 - $25 \leq x < 50$

3 - $50 \leq x < 75$

4 - $75 \leq x \leq 100$

The initial scale read from 1-10. However the figures obtained created some cells with very low numbers. Further the probability of dependence was too low in a number of cases. Despite the loss of information it was decided to settle for the 1-4 scale.

2.2. Teachers

1 - Teachers Z_1 and Z_4

2 - Teachers X_4, X_5 and X_6

3 - Teachers X_1 and Z_3

4 - Teachers X_2 and Z_2

5 - Teachers X_3 and X_7

This scale was based on teachers' basic attributes, described in Appendix II, such as extra official qualifications, knowledge of the particular pedagogy required, etc. It was also based on my own judgement and such a scale is therefore likely to be a very subjective one. Despite the inadequacies of the scale it pointed to the importance of the teachers' scaling of scores and also to the difference between teachers in their scaling of *U* and *A* scores.

Following a primary treatment of the data the above 1-5 scale was expanded to a 1-11 scale in which:

- | | |
|-------------------|--------------------|
| 1 - Teacher Z_1 | 6 - Teacher X_1 |
| 2 - Teacher Z_4 | 7 - Teacher X_5 |
| 3 - Teacher X_6 | 8 - Teacher Z_2 |
| 4 - Teacher Z_3 | 9 - Teacher X_2 |
| 5 - Teacher X_4 | 10 - Teacher X_3 |
| | 11 - Teacher X_7 |

In this scale each teacher is considered as a separate category. This seemed the right procedure to be followed after a first treatment of data was carried out of both the relationship between sociological variables and achievement (see chapters 5, 6, 7) and the teacher's pedagogical practice (see Chapter 4).

2.3. School's Area

- 1 - Large city
- 2 - Town in the country

2.4. School's Type

- 1 - A former Technical School
- 2 - A secondary school opened after the comprehensive system was established
- 3 - A former 'Liceu'

N.B. Although a 'Liceu' was the most similar type of school to a grammar school, some of its features make it quite different from that kind of English school; for this reason the Portuguese word is always kept throughout the text.

After a primary treatment of the data, type 1 and 2 showed to have a predominantly working-class population and type 3 a social mixed population, in the middle school of our sample. Type 3, the only one existent in the upper school of our sample (the areas of study which were object of the study are only taught in types 2 and mainly 3), showed to have both social compositions. Therefore the sociological variable school's type can be understood in our case as:

Middle school: 1, 2 - *working class school*

(X_D, X_E, Z_A, Z_C)

3 - Mixed class school, referred in the text as *middle class school*

(X_A, X_B, X_C)

Upper school: 3 - *working class school* (Z_B)

middle class school (X_B)

2.5. Age

12 - Twelve years old

⋮

21 - Twenty one years old

It was re-classified in 2...13. Therefore AGE = X + 10

N.B. Age at the end of September of the academic year 1980-1981.

In the course of the treatment of the data this variable proved to be of little value and it was not considered in most analyses. In fact two groups were always considered, middle school which contain pupils of three

different years and upper school which contain pupils of two different years; thus, for example, a 15 year old pupil could be at the appropriate age if a member of a 9th grade class or at an inappropriate age if a member of a 7th grade class. The number of years repeated (paragraph 2.12) is, therefore, a more useful measure.

2.6. Gender

- 1 - Male
- 2 - Female

2.7. Number of Siblings

- 1 - Without siblings
 - 2 - One sibling
 - 3 - Two siblings
 - ⋮
 - 13 - Twelve siblings
- Therefore $N = X - 1$

2.8. Sibling Position

- 1 - The oldest or the only son
- 2 - One of the middle
- 3 - The youngest

N.B. When twins, they have the number their position gives to them; for example if they are the oldest ones they have both number 1.

2.9. Living with both parents or with one

- 1 - Lives with both parents
- 2 - Lives with father
- 3 - Lives with mother

N.B. Whenever parents have been substituted by surrogates, those people are considered as parents for the purpose of this study. 'Lives' means the pupil has always lived or lived at least up to five years of

age with own parents, except if from that age onwards father or mother was substituted by a surrogate. We also considered as living with parents those pupils who are only away from home during schooling term time.

2.10. Father's and Mother's age

- 1 - up to 40 years
- 2 - from 40 to 50 years
- 3 - More than 50 years

N.B. See note for 2.9: it also applies here.

2.11. Type of Primary School attended

- 1 - State school
- 2 - Private school

N.B. Number 2 was attributed whenever a private school was attended even when some years of primary education were done at a state school.

2.12. Years Repeated during school life

- 1 - Never repeated a year
- 2 - Repeated the year he/she is attending
- 3 - Repeated the year he/she is attending and some other years
- 4 - Repeated one year in the past
- 5 - Repeated two or more years in the past

N.B. 'Repeat a year' can mean once, twice, three times. Following a primary treatment of the data the above 1-5 scale was changed to a 1-2 scale, in which:

- 1 - 1, 4, 5
- 2 - 2, 3

The reduced scale was constructed to have a better hierarchy and therefore more meaningful values for correlations which in their turn will reflect in the stepwise

regression. Different numbers were used in other parts of the thesis.

¹See a filled-in example of teacher's questionnaire in Appendix III.

PART I

THE TEACHERS

CHAPTER THREE

PATTERNS OF ACHIEVEMENT IN DIFFERENT
TYPES OF COMPETENCIES

1. INTRODUCTION

The initial hypothesis of the thesis state that if competencies required by science curricula are separated in two groups, those which require a low level of abstraction (*A* competencies) and those which demand a high level of abstraction (*U* competencies) differential achievement between children will be greater in the latter. Since modern science courses are predicated on high levels of conceptual demand they then may give rise to higher differential achievement between groups of children.

It was therefore crucial to the further development of the research to conduct an empirical study of the process of learning of these two types of competencies. We shall attempt a fundamental analysis of the basis of *A* and *U* competencies and we shall investigate whether test questions of *A* and *U* competencies give rise to different learning curves and whether these learning curves have a different evolution.

We shall develop an initial model from which we shall derive our expectations of difference both in the patterns of scores of these competencies and in the evolution of acquisition of each specific competency. We will proceed by an initial exploration of our hypothesis and follow through subsequent analyses which arise out of our initial investigation. We will then consider whether a reformulation of our first model is required and this will lead to a general conclusion.

We have seriously considered whether this chapter should be placed as an appendix to the thesis rather than assuming the place of the first chapter to the empirical study. It is probably not the most exciting chapter to read as the procedure we have had to follow makes for much repetition. On the other hand this analysis is crucial if not fundamental to the major analyses of the thesis. It would be possible for a reader if he/she so wishes to pass over the chapter at this point and return to it when the findings are mentioned in specific chapters. We hope the reader will appreciate our

difficulty in this matter of presentation. We could facilitate the reading but only at the expense of reducing the explicitness of the basis of the analysis.

2. FIRST THEORETICAL MODEL

In the researcher's previous work, arising out of her teaching experience, a theory of expected differences in the evolution of the acquisition of specific competencies was put forward.^{1,2} However no systematic empirical test was made of this theory.

2.1. LEARNING AT THE 'MINIMUM ESSENTIALS LEVEL'

Learning goals that are considered minimum essentials, are typically goals that require a low level of abstraction and can be easily and rapidly attained by the majority of pupils. Since these goals serve as pre-requisites for further learning, they have to be attained by all pupils, if not at the same time, at least, at some point in a course of study. If *adequate* learning of the competencies at the 'minimum essentials level' has taken place and is examined by written questions designed to test acquisition then a graphic representation of an adequate sample of scores should give a *J* curve (Figure 3.1)

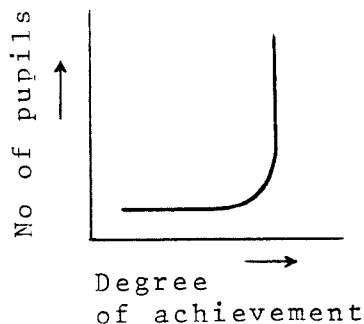


Figure 3.1. - *Final state of learning of a 'minimum level' objective*^{3,4}

The analysis of this figure shows that, even though a small number of pupils will not display 'mastery' or 'competence' in a given objective, the majority master that objective, and therefore should be able to go on to the next stage. The horizontal part of the curve which represents the small number of pupils who do not attain this objective may indicate that there are pupils with difficulties, who probably should receive special teaching of some kind, or that there may be some grounds for revising the teaching.⁵

It should be noted that a specific evolution⁶ characterises the learning of objectives at this 'minimum essentials' level. Thus, when teaching begins, it is expected that an *I* curve (graph A, Figure 3.2) illustrates best the pupils' position for these objectives; as the teaching-learning process progresses the position will be illustrated by a curve more or less similar to a Gaussian curve (graph B, Figure 3.2); and only by the end of the process will it be illustrated by a typical *J* curve (graph C, Figure 3.2).

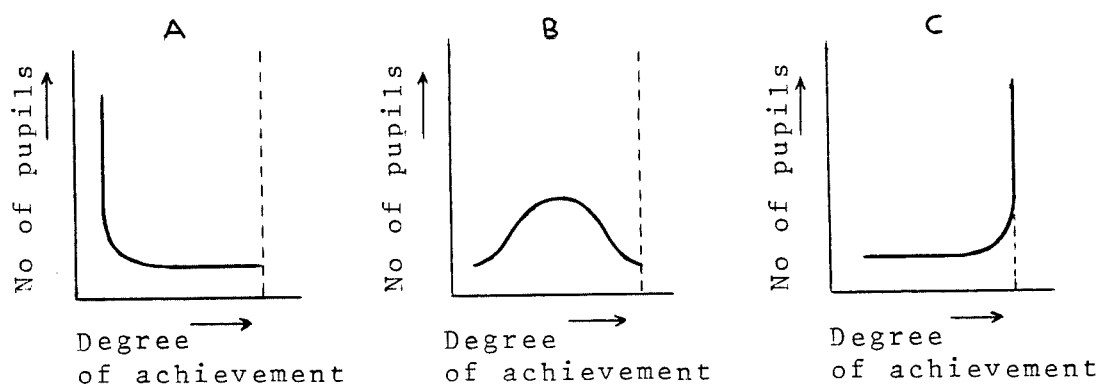


Figure 3.2 - Evolution of the degree of achievement attained by pupils during learning of a 'minimum level' objective^{7,8}

The first curve, *I* curve, shows that in the beginning of the teaching-learning process, the degree of achievement reached by the majority of pupils is necessarily very low; however a very small number of pupils may show a certain degree of achievement. In the following phase the majority

of students shows an average degree of achievement; some pupils still have difficulties, some others have already acquired mastery of the objective. Lastly the *J* curve makes it evident that the degree of achievement attained by almost all pupils corresponds to the highest pattern of achievement (previously defined by the teacher).

2.2. LEARNING AT THE 'DEVELOPMENTAL LEVEL'

Learning objectives that are considered developmental ones are typically goals requiring a high level of abstraction. "They represent goals toward which students may show different degrees of progress but which they never fully achieve. The ability to understand, to apply, to interpret and to think critically, for example, typically depend on an extended period of development. Their complete attainment is not expected in any given course. All we can expect is to define each objective in terms of those behavioural outcomes that are appropriate to the students' learning levels and that represent reasonable degrees of progress toward the goal."⁹

The final result in a class involved in learning at the developmental level, we predict, cannot be expressed by a *J* curve, but only by a curve of the Gaussian curve type (Figure 3.3). A curve of this type shows that for any given level the majority of pupils reveals an average degree of achievement, a smaller number attains a higher degree and, as in the minimum level, there is still a small number of pupils who attain a lower degree. Clearly the bell shaped curve will only arise when the scores are obtained from a random (i.e. not selected) group of pupils and when the questions allow for a wide range of marks.

The evolution of the degree of achievement is here different from the evolution in the case of objectives at the "minimum essentials level".¹² Since a pattern of achievement cannot be defined previously, what is expected from the children is that they show an evolution (through several

years of schooling) towards a progressive increase of their degree of achievement with respect to the same developmental level objective.

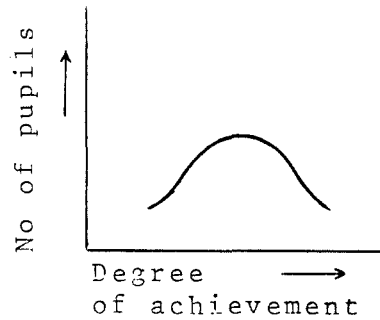


Figure 3.3 - *Final state of learning for a development objective*^{10, 11}

Each of the graphs in Figure 3.4 shows that in a given period of the learning process the children are in different positions. Further, the sequence of the three graphs, shows that children move gradually in the course of time. This movement is a reflection of the progressive improvement of all children with respect to a given general objective at the developmental level.

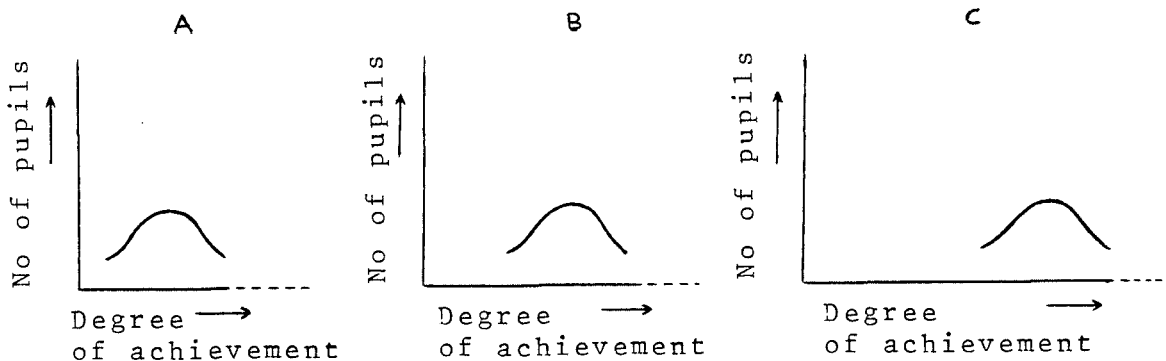

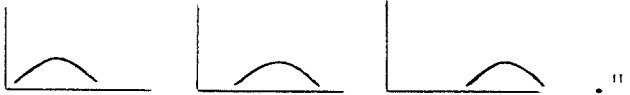


Figure 3.4. - *Evolution of the degree of achievement attained by pupils during learning of a development objective*^{13, 14}

3. INITIAL HYPOTHESIS

The evolution we have described was not based on data resulting from a study properly structured for that purpose. Here we shall take our predicted evolution of the two competencies as the starting hypothesis for our empirical investigation. We start from the hypothesis that the evolution of learning obeys different patterns according to whether we are dealing with competencies requiring a low level of abstraction - *A* competencies, or with competencies requiring a high level of abstraction - *U* competencies. The hypothesis is schematised in the following way:

"The evolution of competencies requiring a low level of abstraction takes place according to ; the evolution of competencies requiring a high level of abstraction takes place according to ."

4. EMPIRICAL STUDY

4.1. INTRODUCTION

This study is based upon a sub-sample of the sample previously described. This sub-sample is composed of more than 300 pupils of the 7th, 8th and 11th years of school, taught by two teachers (X_3 and X_7) in Biology (7th year), Ecology (8th year) and Human Physiology (11th year). The middle school group (7th and 8th years) was taught by these two teachers; teacher X_3 taught a 7th year class and teacher X_7 taught four 7th year classes and three 8th year classes. The upper school group (11th year) was taught by teacher X_3 . The two schools where these two teachers taught were sited in large urban centres and were a former 'liceu' (teacher X_3) and a former technical school (teacher X_7).

The two teachers were chosen for their competence and knowledge of educational psychology and their understanding of the theory and practice of science teaching which included a higher than usual command of new science teaching methods.¹⁵ They were, therefore, teachers able to distinguish clearly, *within the limitations of the distinction*, *A* competencies and *U* competencies, they were capable of setting questions in tests appropriate to the respective objectives and developing strategies for the acquisition of these objectives. The classes were those that had been distributed to them in school and were not especially chosen for the purpose of this study.¹⁶

First an appropriate diagnostic test for *A* competencies which referred to the general objectives 'Knows terms' and 'Knows facts' was given to all classes. It was possible to ascertain the specific objectives which the pupils failed to reach. A selection of these failed objectives was made, which comprised two terms and two facts, for each group of classes. Further for *U* competencies, we selected one or two concepts from the concepts the class was expected to learn during the course. These concepts constituted part of the sample of *U* competencies and referred to the general objective 'Applies concepts to new situations'. A second objective of *U* competencies, 'Interprets results', was also included. For the general objectives 'Knows Terms' and 'Knows Facts' a specific objective was selected and for the general objectives 'Applies Concepts to New Situations' and 'Interprets Results' an adequate sample of specific objectives was obtained. The researcher and both teachers X_3 , X_7 agreed on the selected objectives for *A* and *U* competencies. Where appropriate (according to the sequencing of the teaching) questions were inserted in the test papers given throughout the year. These questions formed the basis for the study of the evolution of learning of *A* and *U* competencies.

The teaching, learning and evaluation¹⁷ of this subsample of objectives was carried out in the normal class context throughout the year *but* the selected *A* and *U*

objectives were *selectively emphasised* by both teachers relative to the whole sample of objectives for each of the courses.

The objectives we chose were central to the understanding of the syllabus. The selective attention given to these objectives entailed extending the time available for their acquisition, designing effective strategies and ensuring adequate 'revision'. The selected objectives were covered by each teacher virtually in every lesson during the period of time devoted to their learning.

In this way every attempt has been made for *A* competencies to ensure that all pupils in a class were in a condition of general ignorance of the objectives and that of equal importance both teachers were not only highly competent but also took pains to ensure effective learning of the objectives. As a consequence it would be difficult to argue that the pupils failed to learn because of inadequate teaching.

It is important to note that the teaching-learning process for these selected objectives created *more explicit criteria and sequencing rules and weaker pacing (rate of acquisition) relative to the whole sample of objectives taught by teachers X_3 and X_7 .*

The tables in Figure 3.5 and in Figure VI.1 of Appendix VI show the objectives chosen and the tests (dates) and questions for: (a) the four 7th year classes and the three 8th year classes taught by teacher X_7 , and (b) the 7th year class and the five 11th year classes taught by teacher X_3 . When two questions are shown added (eg. 6.2+6.3) this means that respective marks were added for each pupil, for it was considered that these questions besides being in accord with the same general objective and the same specific objective, were in fact equivalent. Every time this was not the case the questions were kept separate. It is for this reason that sometimes for the same date more than one mark is seen for each objective (see results). The reader should take this into account when the evolution of the learning is analysed;

| OBJECTIVES | | TESTS (DATES) AND QUESTIONS | | | | | |
|-----------------|--|---------------------------------|------------------|------------------|---------------|-------------|-----------------|
| | | 2nd TERM | | | | 3rd TERM | |
| | | January 1981 (Diagnostic) | February 1981 | March 1981 | April 1981 | May 1981 | June 1981 |
| A 1st 2nd | G.O. - Knows terms | | | | | | |
| | S.O. - Defines the Term Terms: a) <i>Heterotroph</i> b) <i>Producer</i> | 1.1 1.3 | - - | - 3.1 | - 1.1 | 1.2 1.3 | 1.3 1.1 |
| A 3rd 4th | G.O. - Knows Facts | | | | | | |
| | S.O. - Identifies Important Events or Phenomena Fact a) <i>'Green' plants are the first living things of a food chain</i> | 3. | - | 3.3 | 6.5 | - | 6.2 |
| | S.O. - Points out the fact underlying a given phenomenon Fact b) <i>'Green' plants change inorganic matter into organic matter</i> | 6. | - | - | - | 2.8 | 6.1 |
| U 5th | G.O. - Applies Concepts to New Situations Concept a) <i>Ecosystem</i> ²⁰ | | | | | | |
| | a) S.O. - Makes a Prediction using the Concept | - | 4.1 | 3.4;4 | 7.4 | - | 5;6.3 |
| | b) S.O. - Solves Problems using the Concept | - | 3.1 | - | 2.1+2.2 | 5.1;5.2 | 4.2 |
| U 6th | G.O. - Interprets Data | | | | | | |
| | a) S.O. - Relates Data Expressed in Graphs, Tables, etc. | - | 6.2+6.3 | 6.4;2.1 + 2.2 | 6.2+6.3 | 6.1+6.2 | 7.1;7.3; 9.1 |
| | b) S.O. - Describes the Trend of a Curve in a Graph | - | 6.4 | 6.5 | 6.4 | 6.3 | 9.2 |
| | c) S.O. - Draws Conclusions from Data | - | 6.5;5.2 | - | 3.2 | 6.5 | 9.3 |
| | d) S.O. - Points out the Data on which a Conclusion is based | - | - | 6.6 | - | - | - |

G.O. - General Objective

S.O. - Specific Objective

Figure 3.5 - Objectives assessed: questions in different tests of Teacher X₇, Year 7, Classes A,B,E,M

questions corresponding to different dates should be distinguished from those corresponding to the same date.

In Appendix V the questions are presented as they appeared in the tests. To facilitate reading each of the questions appears with reference to the respective general objectives, specific objectives and dates, and also to the teachers and classes.

4.2. RESULTS

The results are organised in the following manner:

4.2.1. Summary Statistics (Figure 3.6 and Figures VI.2-VI.9 of Appendix VI)

- (a) In the horizontal dimension, columns show each of the questions, grouped according to objectives and in chronological order from the first testing to the last:
- Teacher X_7 , Year 7: Columns 1 to 55 across four tables. For the general objectives 'Applies concepts to new situations' and 'Interprets results' the specific objectives are presented separately (columns 16-26 for the former and columns 27-45 for the latter) and grouped together (columns 46-50 for the former and 51-55 for the latter).
- Teacher X_7 , Year 8: Columns 1 to 39. For the general objective 'Interprets results' the specific objectives are presented separately (columns 27-34) and grouped together (columns 35-39).
- Teacher X_3 , Year 7: Columns 1 to 31. For the general objective 'Interprets results' the specific objectives are presented separately (columns 11-27) and grouped together (columns 28-31).
- Teacher X_3 , Year 11: The first four specific objectives are kept separately from other objectives and their respective questions are shown in column 1-13. Questions corresponding to the 5th and 6th objectives are shown in

columns 1-10 for class C, 1-13 for class D, 1-11 for class E, 1-13 for class F, 1-11 for class G. For the general objective 'Interprets results' the specific objectives are presented separately (columns 11-19 for class C, 14-21 for class D, 12-21 for class E, 14-23 for class F, 12-19 for class G), and grouped together (columns 20-24 for class C, 22-25 for class D, 22-26 for class E, 24-27 for class F, 20-24 for class G).

- (b) The vertical dimension shows the marks for questions on a scale of 1 to 4. Each pupil's marks for each question was first transformed to a scale of 0 to 100 and then reduced to a scale of 1 to 4 in which:

$$\begin{aligned} 1 &- 0 \leq x < 25 \\ 2 &- 25 \leq x < 50 \\ 3 &- 50 \leq x < 75 \\ 4 &- 75 \leq x \leq 100 \end{aligned}$$

Initially a scale of 1-10 was constructed and was abandoned owing to limitations of space. As a consequence there is some loss of information.

- (c) In each cell we first show the number of pupils who obtained the mark in the question, and second the percentage of pupils, relative to the total number of pupils, who took the test. For each one of the objectives the mark for each answer was drawn from the respective class matrix - where the teacher had registered the marks attributed to each pupil; a filled-in example of a class matrix is shown in Figure III.1 of Appendix III.
- (d) For each column in the lower part of the table we show:
- the total number of pupils in the column (pupils who took the test)
 - pupils who were absent
 - the *mean* marks obtained
 - the *standard deviation*
 - the *skewness*, showing inclination of the curve to the right or to the left, respectively negative and

positive values (relative to the Gaussian curve, whose skewness is 0).

- the *kurtosis*, showing the greater or smaller flattening of the curve (relative to the Gaussian curve, whose kurtosis is 0).

4.2.2. Histograms (Figure 3.6 and Figures VI.2-VI.9 of Appendix VI)

- (a) Marks from 1 to 4 indicate the degree of achievement and are represented on the X-axis, and the percentage of pupils is represented on the Y-axis.
- (b) The columns in each histogram refer to the same objective tested at different times throughout the year and the percentages of pupils attaining the score are given at the top of the column. The number of the column (1, 2, 3, etc.) refers to the time of testing. Further information about both the content of the objectives and the pupils' achievement may be obtained from tables of Figure 3.5, Figure VI.1 of Appendix VI, test questions in Appendix V and tables of summary statistics.
- (c) A histogram representation was chosen because it seemed to us that in this way the reader could obtain a rapid visual idea of the number of pupils gaining each score. If the top of each of the columns is joined, the curve relative to each of the questions is obtained.

4.3. INTERPRETATION

Because of limitations of space we shall select from the total data presented only the following objectives of the 7th year classes taught by teacher X_7 : (a) evolution of the objective 'Defines the term *Producer*'; (b) evolution of the objective 'Identifies the phenomenon '*Green*' plants are the

SUMMARY STATISTICS

| | 1st OBJ | | | | 2nd OBJ | | | | 3rd OBJ | | | | 4th OBJ | | |
|--------------|---------|-------|-------|-------|---------|-------|-------|-------|---------|-------|-------|-------|---------|-------|-------|
| VALUE | 1 | 21 | 31 | 41 | 51 | 61 | 71 | 81 | 91 | 101 | 111 | 121 | 131 | 141 | 151 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % COL | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1 | 112 | 21 | 17 | 104 | 40 | 12 | 7 | 2 | 98 | 67 | 37 | 43 | 96 | 29 | 20 |
| % COL | 99.12 | 18.75 | 16.01 | 92.04 | 35.71 | 10.62 | 6.25 | 1.77 | 86.73 | 59.82 | 34.51 | 38.05 | 84.96 | 26.13 | 24.70 |
| 2 | 0 | 0 | 0 | 1 | 0 | 2 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| % COL | 0.00 | 0.00 | 0.00 | .80 | 0.00 | 1.77 | .99 | 0.00 | 0.00 | .89 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 3 | 0 | 5 | 4 | 5 | 14 | 21 | 14 | 13 | 4 | 2 | 0 | 0 | 1 | 0 | 0 |
| % COL | 0.00 | 4.46 | 3.54 | 4.42 | 12.50 | 18.59 | 12.50 | 11.50 | 3.54 | 1.79 | 0.00 | 0.00 | .88 | 0.00 | 0.00 |
| 4 | 1 | 36 | 20 | 3 | 53 | 70 | 20 | 20 | 11 | 42 | 74 | 70 | 16 | 82 | 85 |
| % COL | .88 | 76.79 | 79.65 | 2.65 | 51.79 | 69.83 | 80.36 | 86.73 | 9.73 | 37.50 | 65.42 | 61.95 | 14.16 | 73.87 | 75.22 |
| VALUE | JAN | MAY | JUN | JAN | MAR | APR | MAY | JUN | JAN | MAR | APR | JUN | JAN | MAY | JUN |
| TOT. PUPILS: | 113 | 112 | 113 | 113 | 112 | 113 | 112 | 113 | 113 | 112 | 113 | 113 | 113 | 111 | 113 |
| MISSING : | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 |
| MEAN : | 1.93 | 3.39 | 3.46 | 1.18 | 2.86 | 3.46 | 3.67 | 3.63 | 1.36 | 2.17 | 2.95 | 2.36 | 1.44 | 3.22 | 3.26 |
| STAND. DEV.: | .28 | 1.17 | 1.13 | .63 | 1.37 | .78 | .79 | .59 | .75 | 1.45 | 1.43 | 1.46 | 1.06 | 1.32 | 1.30 |
| SKEWNESS : | 10.49 | -1.51 | -1.67 | 3.51 | -4.46 | -1.75 | -2.58 | -3.30 | 2.26 | 4.45 | .65 | -1.49 | 1.98 | -1.89 | -1.17 |
| KURTOSIS : | 108.01 | .38 | .94 | 11.08 | -1.67 | 1.76 | 3.69 | 16.72 | 3.34 | -1.77 | -1.58 | -1.76 | 1.95 | -1.82 | -1.63 |

| | 5th OBJ a) | | | | | 5th OBJ b) | | | | | | | | | |
|--------------|------------|---------|---------|---------|---------|------------|---------|---------|---------|---------|---------|---------|---------|---------|--|
| VALUE | 161 | 171 | 181 | 191 | 201 | 211 | 221 | 231 | 241 | 251 | 261 | 271 | 281 | 291 | |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| % COL | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| 1 | 66 | 50 | 89 | 16 | 47 | 33 | 77 | 27 | 32 | 34 | 50 | 45 | 45 | 4 | |
| % COL | 58.93 | 44.64 | 79.46 | 15.93 | 41.59 | 27.20 | 68.75 | 23.89 | 28.57 | 30.36 | 44.25 | 40.19 | 40.19 | 3.57 | |
| 2 | 39 | 21 | 0 | 32 | 6 | 27 | 18 | 23 | 0 | 19 | 6 | 0 | 0 | 2 | |
| % COL | 33.93 | 18.75 | 0.00 | 28.32 | 5.31 | 25.66 | 16.07 | 20.35 | 0.00 | 9.93 | 5.31 | 0.00 | 0.00 | 1.79 | |
| 3 | 5 | 25 | 0 | 26 | 17 | 39 | 5 | 32 | 0 | 59 | 29 | 34 | 0 | 32 | |
| % COL | 4.46 | 22.32 | 0.00 | 23.01 | 15.04 | 34.51 | 4.46 | 34.51 | 0.00 | 52.69 | 25.66 | 30.36 | 0.00 | 28.57 | |
| 4 | 3 | 16 | 23 | 37 | 43 | 12 | 12 | 24 | 80 | 9 | 23 | 33 | 67 | 74 | |
| % COL | 2.68 | 14.29 | 20.54 | 32.74 | 38.05 | 10.62 | 10.71 | 21.24 | 71.43 | 8.94 | 24.78 | 29.46 | 59.82 | 66.07 | |
| VALUE | FEB 161 | MAR 171 | MAR 181 | APR 191 | JUN 201 | JUN 211 | FEB 221 | APR 231 | MAY 241 | MAY 251 | JUN 261 | FEB 271 | MAR 281 | MAR 291 | |
| TOT. PUPILS: | 112 | 112 | 112 | 113 | 113 | 113 | 112 | 113 | 112 | 112 | 113 | 112 | 112 | 112 | |
| MISSING : | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | |
| MEAN : | 1.51 | 2.86 | 1.62 | 2.73 | 2.50 | 2.27 | 1.57 | 2.53 | 3.14 | 2.38 | 2.31 | 2.49 | 2.79 | 3.57 | |
| STAND. DEV.: | .71 | 1.12 | 1.22 | 1.09 | 1.36 | 1.00 | .79 | 1.08 | 1.36 | 1.01 | 1.27 | 1.27 | 1.43 | .71 | |
| SKEWNESS : | 1.48 | .50 | 1.46 | -1.19 | -1.03 | -1.10 | 1.68 | -1.14 | -1.95 | -1.35 | -.14 | -1.13 | -1.40 | -1.75 | |
| KURTOSIS : | 2.25 | -1.20 | .13 | -1.29 | -1.91 | -1.16 | 1.18 | -1.24 | -1.10 | -1.28 | -1.67 | -1.67 | -1.84 | 4.94 | |

| | 6th OBJ a) | | | | | 6th OBJ b) | | | | | 6th OBJ c) & d) | | | | |
|--------------|------------|---------|---------|---------|---------|------------|---------|---------|---------|---------|-----------------|---------|---------|---------|--|
| VALUE | 301 | 311 | 321 | 331 | 341 | 351 | 361 | 371 | 381 | 391 | 401 | 411 d) | 421 | 431 | |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| % COL | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| 1 | 40 | 7 | 34 | 63 | 39 | 80 | 63 | 36 | 55 | 70 | 59 | 72 | 73 | 55 | |
| % COL | 35.40 | 6.25 | 30.09 | 55.75 | 34.51 | 71.43 | 56.25 | 31.36 | 49.11 | 61.95 | 52.69 | 64.29 | 65.19 | 48.67 | |
| 2 | 32 | 0 | 26 | 10 | 0 | 19 | 12 | 16 | 13 | 4 | 7 | 16 | 19 | 33 | |
| % COL | 28.32 | 0.00 | 23.01 | 8.85 | 0.00 | 16.96 | 10.71 | 14.16 | 11.61 | 3.54 | 6.25 | 14.29 | 16.07 | 29.20 | |
| 3 | 26 | 26 | 13 | 4 | 0 | 1 | 10 | 18 | 24 | 5 | 10 | 6 | 3 | 11 | |
| % COL | 23.01 | 23.21 | 11.50 | 3.54 | 0.00 | .89 | 8.93 | 15.93 | 21.43 | 4.42 | 8.93 | 5.36 | 2.69 | 9.73 | |
| 4 | 15 | 79 | 40 | 36 | 74 | 12 | 27 | 43 | 20 | 34 | 36 | 19 | 19 | 14 | |
| % COL | 13.27 | 70.54 | 35.40 | 31.86 | 65.49 | 10.71 | 24.11 | 38.05 | 17.86 | 30.09 | 32.14 | 16.07 | 16.07 | 12.39 | |
| VALUE | APR 301 | MAY 311 | JUN 321 | JUN 331 | JUN 341 | FEB 351 | MAR 361 | APR 371 | MAY 381 | JUN 391 | FEB 401 | FEB 411 | MAR 421 | APR 431 | |
| TOT. PUPILS: | 113 | 112 | 113 | 113 | 113 | 112 | 112 | 113 | 112 | 113 | 112 | 112 | 112 | 113 | |
| MISSING : | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | |
| MEAN : | 2.14 | 3.50 | 2.52 | 2.12 | 2.96 | 1.51 | 2.01 | 2.60 | 2.08 | 2.83 | 2.21 | 1.73 | 1.70 | 1.86 | |
| STAND. DEV.: | 1.05 | .79 | 1.25 | 1.37 | 1.43 | .76 | 1.29 | 1.29 | 1.19 | 1.37 | 1.37 | 1.13 | 1.11 | 1.03 | |
| SKEWNESS : | .41 | -2.19 | .03 | .55 | -1.65 | 1.85 | .67 | -1.14 | .48 | .66 | .39 | 1.22 | 1.33 | .97 | |
| KURTOSIS : | -1.07 | 4.37 | -1.63 | -1.57 | -1.58 | 2.10 | -1.29 | -1.67 | -1.37 | -1.48 | -1.70 | -.15 | .15 | -1.30 | |

Figure 3.6 - Evolution of learning in different types of competences: Results of Teacher X₇, Year 7, Classes A, B, E, M

first living things in a food chain'; (c) evolution of the objective 'Applies the concept of *Ecosystem*'; (d) evolution of the objective 'Interprets Data'. On the basis of this interpretation the reader can make an interpretation of all data available and displayed.

We shall carry out two analyses for *U* competencies, one where we shall combine the specific objectives and a second where each specific objective will be analysed separately. Although this involves a very lengthy analysis it is necessary in order to see whether the Gaussian curve holds in each case.

4.3.1. Initial Findings

In the description of the initial findings the evolution of learning in time is analysed for each of the objectives separately, by relating the values obtained to the respective questions.

4.3.1.1. 2nd Objective

General objective: Knows the term 'Producer'

Specific objective: Defines the term

Observation of the summary statistics (Figure 3.6)

- columns 4-8 corresponding to times of testing respectively January, March, April, May and June - and observation of the histogram (Figure 3.6) - curves 1-5 - shows that:

- (a) In the diagnostic test in January 92.04% of the pupils did not know how to define the term 'producer', 2.65% knew how to define that term and the remainder knew how to define it only in a partially correct way. The mean is very low (1.18). The curve's inclination is strongly to the left (skewness 3.51). There is a clearcut *I* curve.
- (b) As time advances these values change progressively, the number of pupils who know how to define the term

increases up to a maximum value in June when 86.73% define it correctly, only 1.77% give an incorrect definition and the remainder define in a partially correct way. The mean which stood at 1.18 in the beginning of the learning stands at 3.83 at the end. The curve's inclination has moved from left to right (skewness -3.80), having passed in March through a value close to 0 (time at which the mean was 2.80). There is in the end a clearcut *J* curve.

4.3.1.2. 3rd Objective

General Objective: Knows the fact "'Green' plants are the first living things in a food chain"

Specific Objective: Identifies the fact

Observation of the summary statistics (Figure 3.6) - columns 9-12 corresponding to times of testing respectively January, March, April and June - and observation of the histogram (Figure 3.6) - curves 1-4 - shows that:

- (a) In the diagnostic test in January 86.73% of the pupils did not know the fact, 9.73% knew it and the remaining 3.54% knew it imperfectly. The mean is low (1.36). The curve's inclination is strongly to the left (skewness 2.28). There is a clearcut *I* curve.
- (b) As time advances these values change progressively, the number of pupils who know the fact increasing up to a maximum value in April when 65.49% identify the fact correctly and 34.51% do not identify it. The values in June seem to show there is stability of acquisition of knowledge with respect to this objective; the values appear similar to the values in April. When we examine the time of maximal achievement we see that: the mean at the beginning was 1.36 and is 2.96 at the end; the inclination has passed from left to right (skewness $-.65$). There is in the end a *J* curve.

4.3.1.3. 5th Objective

General Objective: Applies the concept of 'Ecosystem'

We shall first analyse the evolution of learning of the general objective combining the objectives 'Makes Predictions' and 'Solves Problems'. Observation of the summary statistics (Figure 3.6) - columns 46-50 corresponding respectively to times of testing in February, March, April, May and June - and observation of the histogram (Figure 3.6) - curves 1-5 - shows that:

- (a) In the first testing, in February, the pupils inadequately apply the concept of Ecosystem: 67.26% do not know how to apply it and the remaining pupils apply it in a more or less imperfect and never completely correct way. The mean is very low (1.44). The curve is of the Gaussian type with an inclination to the left (skewness 1.43).
- (b) As time advances these values change progressively and the competency to apply the concept increases up to maximum values in April and May (means respectively 2.50 and 2.49). At this time only 19.47% and 30.09% of the pupils show themselves to be incapable of applying the concept and 20.35% and 23.89% can be considered capable of applying it. All other pupils distribute along the mark scale. The last testing, in June, seems to show a small regression. However, the curves are always of the Gaussian type, with greater or smaller inclination to the right or to the left and greater or small kurtosis.

We will now analyse each specific objective separately:

Specific objective: Makes predictions

Let us start by separating in the summary statistics (Figure 3.6) - columns 16-21, corresponding to times of testing in February, March (columns 17 and 18), April and June (columns 20 and 21) - and in the observation of the histogram (Figure 3.6) - curves 1-6 - the questions corresponding to columns, 16, 17, 19 and to curves 1, 2, 4

which refer to questions 4.1. in February, 3.4. in March and 7.4. in April (see Appendix V). Such a separation will allow us to analyse questions of the same type whose degree of difficulty has increased in the course of time. Observation of these data shows that:

- (a) In the first testing, in February, the pupils have difficulty in making the prediction: 58.93% are not successful, only 2.68% make a correct prediction and the remainder's predictions are incomplete. The mean is very low (1.51). The curve is of the Gaussian type very skewed to the left.
- (b) As time advances these values change progressively, the competency to make predictions increases up to a maximum value in April when the mean is 2.73, only 15.93% of pupils are incorrect and 32.74% are correct, the remainder distributed in between. The curves are of the Gaussian type displaying in this last test a very low skewness (-.19).

On the other hand, observation of questions of a different type - columns 18, 20, 21 and curves 3, 5, 6 shows that:

- (a) Question 4. tested in March (column 18 and curve 3) produced great difficulty: 79.46% of pupils did not make the prediction adequately and only 20.54% were successful; there are no intermediate values because it was a multiple choice question. The mean is very low, 1.62, and the curve approaches an *I* curve.
- (b) In question 5. and 6.3., tested in June, the competency to make predictions seems to increase with respect to question 4. in March. The competence is stable relative to the maximum values attained for the first type of questions analysed above. The means are respectively 2.50 and 2.27 and the curves are of the Gaussian type with skewnesses near 0.

Specific objective: Solves problems

Observation of the summary statistics (Figure 3.6) - columns 22-26, corresponding to times of testing February, April, May (columns 24 and 25) and June - and observation of the histogram (Figure 3.6) - curves 1-5 - shows that:

- (a) In the first testing, in February, the pupils have difficulty in solving problems: 68.75% are incapable of solving the problem, only 10.71% solve it correctly and the remainder display a greater or smaller degree of achievement. The mean is low (1.57). The curve is of the Gaussian type with an inclination to the left (skewness 1.60).
- (b) The degree of achievement rises in the subsequent testing, ie. in April, when the mean is 2.53. In general terms, we can say that progress in this competency seems to remain stationary in the course of the two tests which follow. There appears, however, very high values for question 5.1. done in May, with mean 3.14 and with a curve approaching the *J* curve. With the exception of this case the curves are of the Gaussian type with weak skewness.

4.3.1.4. 6th Objective

General objective: Interprets data

Let us first analyse the evolution of learning of the general objective combining the specific objectives 'Relates data expressed in graphs or tables', 'Describes the trend of a curve in a graph', 'Draws conclusions from data' and 'Points out the data on which a conclusion is based'.

Observation of the summary statistics (Figure 3.6) - columns 51-55 corresponding to times of testing respectively February, March, April, May, June - and observation of the histogram (Figure 3.6) - curves 1-5 - shows that:

- (a) In the first testing, in February, pupils display a low degree of achievement in interpretation of data: 41.59% are incapable of interpreting, and only 7.96% interpret adequately; the majority of pupils fall within the lower marks, the mean is 1.93. The curve is of the Gaussian type.
- (b) In the following testing, in March, the competence to interpret results increased. The mean moved to 2.22 and only 22.12% are incapable of interpreting. This competence remains stable across future tests. The curves are always of the Gaussian type with progressively reduced skewness.

We will now analyse each specific objective separately:¹⁹

Specific objective: Relates data expressed in graphs, tables, etc.

Let us start by separating in the summary statistics (Figure 3.6) - columns 27-34, corresponding to times of testing in February, March (columns 28 and 29), April, May and June (columns 32, 33 and 34) - and in the observation of the histogram (Figure 3.6) - curves 1-8 - the questions corresponding to columns 27, 28, 30, 31, 34 and to curves 1, 2, 4, 5, 8. These numbers refer to questions 6.2.+6.3. in February, 6.4. in March, 6.2.+6.3. in April, 6.1.+6.2. in May and 9.1. in June (see Appendix V). Such a separation will allow us to analyse questions of the same type, for they all relate to 'relating data expressed in the graphs'. Observation of these data shows that:

- (a) In the first testing, in February, 48.18% of pupils are not able to relate data in the graph for they do not answer the two questions asked, 29.46% are capable of relating data and 36.36% are only partly capable. Already at this time the mean is not very low (2.49). The curve is of the Gaussian curve type.
- (b) As time advances a certain irregularity in pupils' competency to relate data emerges. Thus, in March,

although the percentage of pupils not able to relate data is the same as before (40.18%), the percentage of those who are successful has risen and is now 59.82%; the mean is 2.79. In April there seems to be a regression for the whole of the pupils, as although only 35.40% are incapable of relating the data also only 13.27% can be considered capable; the mean fell to 2.14. In May there is great improvement as only 6.25% of the pupils are unsuccessful in relating data and 70.54% are successful; the mean is now 3.58. In June there seems to be again a regression, 34.51% are unsuccessful in relating the data and 65.49% are successful. The mean is 2.96. The curves of the Gaussian curve type approach in some cases the *J* curve.

On the other hand, observation of questions of a different type - columns 29, 32, 33 and curves 3, 6, 7 - shows that:

- (a) Questions 2.1. and 2.2. tested in March (column 29 and curve 3) indicate an already quite high degree of competency. Only 3.57% are incapable of relating data in the table and 66.07% are capable. The mean is very high (3.57). The curve has a strong inclination to the right (skewness -1.95) and tends towards a *J* curve.
- (b) Later on, in June, answers to questions 7.1. and 7.3. which again refer to 'relating data expressed in tables', shows a regression relative to the March question as 30.09% and 55.75% respectively of the pupils are unsuccessful and only 35.40% and 31.86% are successful. The means are respectively 2.52 and 2.12. The curves are of the Gaussian curve type.

Specific objective: Describes the trend of a curve in a graph.

Observation of the summary statistics (Figure 3.6) - columns 35-39 corresponding to times of testing February, March, April, May and July - and observation of the histogram (Figure 3.6) - curves 1-5 - shows that:

- (a) In the first testing, in February, only 10.71% of pupils know how to describe the trend of the curve and 71.43% cannot so describe. The degree of competency is therefore very low, the mean being 1.51. The curve has a strong inclination to the left (skewness 1.85) and tends towards an *I* curve.
- (b) As time advances, the degree of competency rises up to a maximum value in April when 31.86% of pupils are incapable of describing the trend of the curve, 38.05% are capable and the remainder display different degrees of competency. The mean which was 1.51 passed to 2.60 and skewness almost reaches a value of 0. This improvement, however, suffers a regression in May and June when, respectively, 49.11% and 61.95% of pupils are incapable of describing the trend of the curve and only 17.86% and 30.09% are capable. The means fall to 2.08 and 2.03 and the curves are again skewed to the left.

Specific objective: Draws conclusions from data

Let us start by separating in the observation of the summary statistics (Figure 3.6) - columns 40, 41, 43, 44, 45 corresponding to times of testing February (columns 40 and 41), April, May and June - and in the observation of the histogram (Figure 3.6) - curves 1, 2, 4, 5, 6 - the questions corresponding to columns 40, 44, 45 and to curves 1, 4, 5. These numbers refer to questions 6.5. in February, 6.5. in May and 9.3. in June (see Appendix V). Such a separation will allow us to analyse questions of the same type, for they all relate to drawing conclusions from data expressed in graphs. Observation of these data shows that:

- (a) In the first testing, in February, the pupils have some difficulty in reaching the conclusion; 32.14% reach the conclusion correctly but 52.68% are incapable of reaching any conclusion, even partially correct. The mean is 2.21. The curve is of the Gaussian curve type with a small inclination to the left (skewness .39).

- (b) As time passes, competence seems to decrease, since: the percentage of pupils incapable of reaching the conclusion, even though suffering a slight decrease in May, increases in June (62.83%); the percentage of successful pupils decreases all along reaching 8.85% in June; the mean which was 2.21 falls to 1.64. The curves are always of the Gaussian curve type with successively greater inclination to the left.

On the other hand, observation of questions of a different type - columns 41, 43 and curves 2, 4 - shows that:

- (a) The pupils have a low degree of achievement in both cases, ie. in February and in April, there seems to have been no improvement or regression since the values are similar: 64.29% and 48.67% of pupils were not capable of relating the data; only 16.07% were capable in both cases; the means are 1.73 and 1.86; the curves are of the Gaussian curve type with an inclination to the left.
- (b) If these two questions are considered in conjunction with the previous ones (taking conclusions from data expressed in graphs) a similar evolution to that pointed out for those questions is noticed.

4.3.2. Interpretation

Evolution of Learning in Different Types of Competencies

4.3.2.1. Evolution of learning in competencies requiring a low level of abstraction (A competencies)

Analysis of the evolution observed with the 2nd and 3rd objectives shows that:

- (a) In the beginning of learning the majority of pupils do not master the knowledge and there is only a small number of pupils who master it. There is a clearcut

I curve.

- (b) In the course of the transmission-acquisition process the number of pupils who master the knowledge increases steadily. There is in the end a clearcut *J* curve. The intermediate curves do not show the typical form of a Gaussian curve, but they show intermediate positions passing from *I* curves to *J* curves. This is due to the fact that the objectives chosen, and consequently the questions testing them, leave little room for a wide range of answers, and are mainly of the right/wrong type of answer.
- (c) As we saw previously for the 3rd objective, the June values seem to show a stability in the acquisition of knowledge with respect to the objective, for the values appear very similar to April ones. However, an analysis of the questions (see Appendix V) shows that the way the question was asked in June was *different* from the way it was asked previously: from "what are the first beings..." it became "what is the position...". The pupils still have to identify the fact "green plants are the first beings in a food chain" but the change in the question's form can, we suggest, be responsible for the apparent stability in acquisition. This seems to suggest that if the question in June had been stated in the same form as in the previous occasions, the progression would have continued to take place as before and the percentage of pupils capable of identifying the fact correctly would have been higher than 61.95%, so giving rise to an even more marked *J* curve. This does not imply that rote learning takes place, rather it may mean that some pupils do not understand the question "what is the position..." (lack of recognition rules).
- (d) The passage from the *I* curve to a *J* curve, with the simultaneous emergence of a high percentage of pupils displaying a thorough mastery of *A* competencies, depends

on time; some pupils will learn faster than others but all should learn within a given period within the course of a school year.

- (e) However these conclusions can be drawn only for objectives of the type we have examined, ie. objectives of the lower levels within *A* competencies.
- (f) Our conclusions can be presented with some confidence because they also hold for our analysis of the *total* data which we cannot present here owing to the amount of space which would be required.

4.3.2.2. Evolution of learning in competencies requiring a high level of abstraction (*U* competencies)

Analysis of the evolution observed with the 5th and 6th objectives shows that in *the case of general objectives* (with sampling of combined specific objectives):

- (a) In the beginning of learning the degree of achievement is low and the pupils distribute according to a curve of the Gaussian type. *I* or *J* curves never appear.
- (b) In the course of the transmission-acquisition process a progression can be noted; the number of pupils capable respectively of 'applying the concept of ecosystem' and of 'interpreting data' rises. In the former case (5th objective), however, there seems to be a slight regression at the last testing and in the second case (6th objective) after an initial progress the competence to interpret data appears to remain stable. The curves are always of the Gaussian type and never approach *I* or *J* curves.
- (c) As was seen previously, for the 5th objective, June values seem to show some regression in the competence to 'apply the concept of ecosystem'; the values appear

slightly lower than in May. An analysis of the June questions (see Appendix V) shows that, on the whole, they present a higher degree of difficulty. It is also true that, on the whole, all the questions designed to test this general objective increased steadily in degree of difficulty. This procedure was deliberate for it was intended that the goal should move forward to lead the pupils progressively to higher levels. The progress taking place corresponds to a substantial development of the competency in question, because the greater demand elicited a growing degree of achievement in the set of pupils. The small regression noted in June can only mean that the degree of demand was somewhat too high with respect to the pupils' rate of learning.

On the other hand, for the 6th objective 'Interpreting data' the values obtained after the first testing seem to show that, after clear initial progress, there is a stability in the competence to interpret data. Analysis of the questions (see Appendix V) shows that, on the whole, the degree of conceptual demand rose steadily and therefore even though the scores were similar progress had been maintained.

- (d) The constant presence over time of Gaussian curves, moving successively to the right (towards a greater degree of achievement) or remaining stable shows that progress (for there was always progress) depends both upon time and clearly on the quality of teaching. General development of *U* competencies does not yield a *J* curve of learning.

In the case of specific objectives (considered separately):

- (a) In the beginning of learning the degree of achievement is low and the pupils distribute according to Gaussian curves, most of which show considerable inclination to the left, even approaching in some cases an *I* curve (see first testing of questions of the second type of 'Makes predictions' and 'Describes the trend of a curve in a

graph'). An exception appears (see first testing of questions of the second type of 'Relates data expressed in graphs, tables, etc.') where there is a distribution showing a J curve.

- (b) In the course of the transmission-acquisition process great irregularity in the degree of achievement appears, increasing in some cases, increasing and then becoming stable in others and even decreasing in others. The curves are generally of the Gaussian type which, sometimes, even approach I curves (see 'Describes the trend of a curve in a graph' and 'Draws conclusions from data'). J curves appear very rarely (see question 5.1. 'Solves problems' and some questions of the first type 'Relates data expressed in graphs, tables, etc.').
- (c) We have seen that there are a few *discrepant* cases where a J curve appears. Questions 2.1. and 2.2. referring to the objective 'Relates data expressed in graphs, tables, etc.' showed in the beginning a J curve. It should be noted that this mode of interpretation had already been extensively made earlier in the first term; therefore this first testing corresponds in fact to the final one. It seems therefore that we can conclude, from this case, that at the end of the teaching-learning process it is possible to attain a J curve. A careful analysis of these questions shows however that they do not relate to high U competencies for they require a low level of understanding, and perhaps are nearer to A competencies.

Question 5.1. referring to the objective 'Solves problems', should have also been marked as A competencies. Analysis of those questions of the first type of the objective 'Relates data expressed in graphs, tables, etc.' which also yielded a J curve, shows that they correspond to lower levels within the U competencies and this accounts for the appearance of this type of curve. Further all these questions are in a multiple choice form and as a consequence there is always the possibility of getting the answers right by chance.

If this were to be the case it would increase the probability of a *J* learning curve.

- (d) We are well aware that one cannot infer achievement in a general objective from a specific objective. For example, one cannot conclude that a pupil is capable of *interpreting data* because he is capable of relating data (or any other behaviour).

We carried out our analysis of the learning curves for specific objectives in order to submit the hypothesis of the association of Gaussian curves with *U* competencies to a more rigorous test. The analysis shows that, even in the case of specific objectives, the evolution of learning follows a similar pattern to that found for general objectives. The explanations made in (c) for general objectives are also applicable here to our explanation of progressions and regressions. The occasional emergence of *J* curves is to be expected in empirical studies and of course discrepant results require explanation (see c above). However we must base our general conclusions on the total set of cases.

- (e) The conclusion that the development of *U* competencies generate Gaussian curves certainly holds for our data and for the level of competence examined. However, it is plausible to predict that for even higher competencies (not only of the cognitive domain, but also of the psychomotor and the affective domains) the conclusions would be similar.
- (f) Our conclusions can be offered with some confidence because they also hold for our analysis of the *total* data which as we have previously stated cannot be presented because of limitations of space.

5. FINAL MODEL

As we have already said (2.) our previous work on the evolution of learning,^{20, 21} was fundamentally theoretical, and the data on which it was based were not the result of an empirical study properly structured for that purpose. The results we have obtained here through our more systematic empirical study support the hypothesis we formulated (3.). Repetition of studies of this type would be highly desirable to test further the conceptual scheme and to provide a more secure base.

5.1. DEVELOPMENT OF COMPETENCIES REQUIRING A LOW LEVEL OF ABSTRACTION

The evolutionary pattern presented in 2.1. has been supported by our results. The evolution of learning of *A* competencies takes place according to a scheme similar to that presented in Figure 3.2: *in the beginning of learning pupils start by distributing according to an I curve; this passes gradually to a J curve, a curve which is attained at the end of learning.* It is likely that in the intermediate phases, the higher the *A* competencies the closer their resemblance to a Gaussian curve (the two examples we have presented relate to the lowest level - knowledge of terms and facts).

Competencies at this level can therefore be taught at the 'minimum essentials' level. It is for these competencies that a well determined goal can be defined, a goal which, as we saw, will be attainable at the end of a shorter or longer period of time but within a course taught during an academic year.

This means, therefore, that given the individual characteristics of each child, it is to be expected that each objective will not be simultaneously attained by all pupils. It also means that successful learning at the 'minimum

essentials' level depends on *time*. It should not be concluded from this fact, however, that the progression of teaching-learning is conditioned only by time. The teacher has to seek ways to reduce the time taken by pupils who, owing to various circumstances (not only psychological but also sociological)²² may be slow acquirers by creating more appropriate teaching strategies. The quality of teaching is thus crucial.

Mager²³ and others identify mastery objectives with behavioural objectives and believe that all learning goals can be defined as behavioural objectives and therefore defined, according to them, as tasks to be carried out by the children. For these authors, a behavioural objective has to be precise and observable and is complete only if it is operationalised, ie. if it contains the following three components: (a) a behavioural definition or action verb; (b) conditions of performance; (c) a pattern of performance. Thus, the very simple example often presented in books "writes on an electric typewriter, 40 words per minute, without mistakes, of a typed text", is complete because it includes the three components those educators demand. The teaching model emphasised is the well-known "formulates the specific objective → teaches the specific behaviour → tests the specific behaviour", used in programmed teaching and in teaching at the training level. The system of evaluation is such that the marks are used to indicate the pupil's absolute level of achievement: the marks should be referred to a criterion.^{24, 25, 26}

The idea supported by these educators, that all objectives have to and can be defined in this way is highly questionable and is responsible, at least in great part, for the reaction many teachers show against the defining of objectives. In effect, only very concrete tasks of the psychomotor domain or objectives of the lower levels of the cognitive domain can be taught at this training level.²⁷

Even when teaching is being carried out at the 'minimum essentials' level (ie. when the specific objective is formulated, the specific objective is taught and the specific objective is tested), it is still arguable whether it is always possible or even useful to establish a pattern or the conditions of performance in the terms expressed above. For example, in the science field, it seems far more reasonable and useful to define the pattern of performance for a *set of objectives* instead of defining it for each separate objective.

What has been said so far does not mean, however, that teaching at the 'minimum essentials' level does not have a place in education carried out in schools. It certainly has a place and it is an important one (objectives of the lower level are also essential), but it should be kept in perspective.

5.2. DEVELOPMENT OF COMPETENCIES REQUIRING A HIGH LEVEL OF ABSTRACTION

The evolutionary pattern of learning presented in 2.2. has been supported by our results. The evolution of learning of *U* competencies takes place according to a scheme similar to that displayed in Figure 3.4: *the pupils' scores give a distribution which yields a Gaussian curve in the course of the whole learning process; these curves move gradually to the right as the process takes place, showing the development of a progression.* This happens even when the demand for competence increases. However, if demand increases faster than the possibility of progress of pupils (depending on psychological and sociological factors) the curves move rapidly to the left and may approach an *I* curve.

We could say that we should consider two rates: the possible learning rate and the demand rate. When there is an equilibrium between the two, stable curves of the Gaussian curve type appear. Only when the demand rate maintains

itself at a slightly lower level than the learning rate, do curves of the Gaussian type appear moving to the right so indicating a greater degree of achievement. When the demand rate is higher than the learning rate the curve moves to the left indicating a lesser degree of achievement. When the demand rate is lower than the learning rate the curve moves rapidly to the right so indicating a greater degree of achievement. However, in this case the movement does not show real progression.

The above holds even if we consider separately the specific objectives.²⁸ The emergence of *J* curves in exceptional cases shows that either the demand rate was much lower than the learning rate (and in this case the teaching is not fulfilling its purpose in developing competencies) and/or the questions are of a very low level, within *U* competencies, and therefore approach *A* competencies and show their evolutionary learning pattern. Nevertheless, as we have previously argued, attaining a specific objective is no basis for inferring that a general objective has been acquired.

Competencies requiring a high level of abstraction are, then, learning goals to be taught at the developmental level. For these competencies a well-determined goal cannot be defined within a given time period as in the case of competencies requiring a low level of abstraction. This does not mean that there is no progression. As we have seen, on the contrary, the existence of a progression is essential to learning at this level. Indeed it is a progression of the development of competencies towards goals which are never totally attained. It may be a development entailing the course of the individual's whole life. In this case the prior establishment of a well-determined goal would prevent a true progression. If teaching quality is crucial for *A* competencies it is even more so for *U* competencies and the rate of learning depends fundamentally on that quality. This teaching quality is far more difficult to acquire as it may

depend upon the teacher's sensitivity to both the psychological characteristics and the social context of the pupil *and* the ability to adjust teaching strategies accordingly.²⁹

There is also some misunderstanding of what is, in fact, a behavioural objective. The meaning attributed by Mager and others to behavioural objectives is in a way different from the meaning attributed by Gronlund³⁰ and others. Terms such as 'knows', 'understands', 'appreciates', 'recognises', etc., considered to be behavioural objectives by the latter are not so by the former. According to Gronlund these objectives have to be specified into observable specific objectives (obviously also behavioural)^{31, 32, 33} but however they already represent behaviours as well. This difference in terminology has also been partially responsible for the confusion about the concept of objective.

Irrespective of whether they are called 'behavioural', it is important to consider objectives such as, for example, Appreciates good music, Applies concepts to new situations, Recognises the limitations of science, Understands and accepts his/her own possibilities and limitations. Even after these have been specified as observable behaviours they cannot be operationalised as Mager proposes. However they should *not* be excluded. As V. and G. Landsheere³⁴ say, "the weak spot of many recent publications about educational objectives is that they avoid the problem raised by cognitive objectives of a higher level and by affective objectives".

As a consequence of realizing that they are not capable of operationalising these objectives, teachers often fall into one of two extreme positions: either they dismiss their importance or they give up defining objectives altogether. It is difficult to say which of these is the worst and most dangerous attitude; both have shown themselves to lead to grave errors.

It is obvious that, with respect, to *U* competencies, a pattern of achievement cannot be previously defined since, as we said, it is not expected that all the children attain the same pattern of achievement, but that instead they will reveal different degrees of achievement within a given time.

The teaching model is also very different from that used at the 'minimum essentials' level.^{35, 36} Here, the first step is to "Formulate the general objective and a sampling of specific behaviours"; then to "Direct teaching towards the general objective" (ie., the total set of behaviours) and finally to "Base the test's questions on the sampling of specific behaviours". The marking system is such that marks are used to indicate the pupil's relative degree of achievement: marking referred to a criterion is not applicable as a previous pattern of achievement is not defined. The marking procedure appropriate for competencies requiring a high level of abstraction is marking referred to a norm.^{37, 38, 39, 40}

The fact that objectives at the developmental level are complex goals and consequently cannot be completely attained by the children should not serve as a reason for their exclusion. It should instead be understood that the teacher, when drawing up his list of objectives, should establish a balanced set of objectives of both levels of competencies (*A* competencies and *U* competencies) according to the subject he/she teaches, pupils' age, etc. It seems, on the other hand, that the percentage of 'minimum level' objectives (at least in initial courses) should be higher than the percentage of 'developmental level' objectives, because this will bring out a feeling of greater confidence and security in the children. Indeed, when too great an emphasis is placed on 'developmental level' objectives, children feel incapable and often lose interest exactly because they do not manage to 'master' them.

In experimental sciences, for example, a reasonable distribution could be 50% to 60% of *A* competencies and 50%

to 40% of *U* competencies. It should be noted, however, that this percentage will necessarily vary according to age, competencies already developed, children's former type of learning, as well as their psychological and sociological characteristics; and so any distribution of educational objectives between these two levels of competency can only be adequately made by the teacher himself/herself. The importance of establishing objectives demanding competencies of a high level of abstraction must not be forgotten here, an importance which derives essentially from the fact that these objectives constitute goals which tend to be retained for a longer period of time and which are necessary for the application of knowledge to new situations. Such competencies are important for individual development and for self-learning.

To conclude these considerations on *U* competencies we think it might be useful to present metaphorically, a description of their evolution. Imagine a set of pupils in the process of their learning as a moving train. Pupils with different levels of competence, as to the competency in question, distribute themselves like a train's carriages. Just as all carriages advance, so all pupils advance; however never does the front carriage stop to wait for the ones behind it to catch up. This would be the same as trying to stop the pupils' minds, which, besides being psychologically and sociologically unacceptable, would be, from a substantive point of view, utterly impossible. It is true that, as the passengers in one carriage may pass into another while the train is moving, so there may be and in fact there are, pupils who make progress faster than others (or regress). This does not mean, however, that, at a given time, they will all be at the same point with respect to the development of the competency.

6. EVALUATION OF THE OBJECTIVES MODEL

6.1. The objectives model of curricular development is an important theory that implies that the process of transmission and acquisition of knowledge and development of competencies follows a well-determined direction: definition of objectives; search for strategies to attain those objectives; selection of evaluation techniques to measure the extent the objectives are attained.

Such a procedure constitutes a quite comprehensive technique which, however, has given rise to extensive controversy among many educators. Indeed, in the objectives model, the objectives have been seen as mastery objectives (the same has happened to the so-called behavioural objectives) and many supporters of this model have reduced all teaching to the latter. On the other hand, many educators, feeling that education cannot be reduced to such a narrow dimension, fall into the other extreme and, attacking the objectives model, advocate that objectives cannot be defined *before* the teaching-learning process has taken place and defend a process model. And it is in this way that the 'war' of objectives has gone on during recent years: Popham⁴¹ argues against ten reasons that have led educators and teachers to attack the objectives model; L. Stenhouse⁴² attacks Popham's arguments.

As is usually the case with extreme positions both are wrong, which does not mean that the debate is not useful: from the confrontation it may be possible to move towards a balance.

Further to the central purpose of this chapter which we defined in the introduction, we have tried to show how the potential usefulness of the objectives model has been obscured by a warped and narrow understanding of the concept of objective. Teaching at two different levels of competencies are both important dimensions of the

transmission-acquisition process and corresponding learning goals should be formulated beforehand: firstly broad aims and secondly more specific objectives.

Both of these positions we have discussed may well have arisen from the move by the State to demand greater accountability and therefore greater control over the curriculum and teaching process. Behind the debate may be oppositions of a more profound political nature.

6.2. It is not difficult to understand the criticisms the objectives model has suffered⁴³ if we understand the extent to which it has been identified with the theory of teaching at the 'mastery level'. If, however, the concept of objective is appropriately broadened, it becomes difficult to accept arguments like "little emphasis is given to the really important goals in education because they are difficult to operationalise" or "objective and mechanistic measurement of behaviours is dehumanising".

The argument that it is undemocratic to plan in advance exactly how the learner should behave after instruction is also a misunderstanding of the objectives model. In fact, it would seem to be perfectly possible to have prior objectives but at the same time to create a space where the pupils' learning would be more contingent upon their special interests and development. Further because objectives are not explicitly stated it does not mean that they are not implicitly held. And if they are held implicitly they are not available for public discussion, scrutiny and criticism. The pupils may be in a situation where they are at the mercy of a teacher's ideology without either the teacher, pupils, parents, etc. being aware that an ideology exists.

The widely accepted argument that realistic expectations must be established for teachers since teachers rarely specify their goals in terms of measurable behaviours, also

deserves special attention. It is a good thing that the teachers do not specify *all* their goals in terms of measurable behaviours; for as we saw only teaching at the mastery level allows such a specification. When teachers tend to treat *all* objectives as 'minimum essentials', simpler learning aims are in fact strengthened and teaching and testing tend to focus on very specific aspects of learning. However, some teachers emphasise only developmental level objectives; they place such an emphasis on these more complex learning aims that they overlook basic knowledge and competencies which are pre-requisites for a higher level of learning. As we said before, both levels of objectives should be taken into consideration.

The problem is not that teachers do not specify their goals in terms of measurable behaviours but that they do not specify them at all. Such a fact is certainly responsible for the lack of direction often displayed by teaching. Defining objectives is a constituent part of the teaching-learning process: if you don't know where you're going, how do you know when you've arrived? How do you choose activities? What are you evaluating?⁴⁴

Teachers and pupils always work towards objectives, be they explicit or implicit. Even traditional teaching had certain objectives (albeit implicit), amongst them being, for example, 'Recalls terms and facts' and 'Is disciplined'. Objectives have always existed and must exist in any type of educational system. Why then not formulate them clearly? If they are clearly formulated it will become evident whether or not they make up a balanced set, ie., if important goals are not being overlooked or if the same are not being overvalued. The current argument that there have always been good teachers who do not need to define prior objectives, shows only that these teachers were capable of carrying out good teaching *not without* prior defined objectives but without objectives previously written on a piece of paper. But how many teachers can do that? And

even for these 'good' teachers is there not the possibility of overlooking some important objectives?

There are many levels involved in the definition of objectives. The broad aims established at national level and the more specific goals at regional or school level may promote effective teaching. Further the defining of objectives at these levels can produce an integration of the practice of teaching across subjects.⁴⁵ The defining of objectives in *specific observable terms* is clearly a matter for the teacher and should assist the teacher in the improvement of the teaching-learning process.

The process model which has been proposed to solve the problems raised by the objectives model seems a wrong direction to take. In effect, encouraging teachers to start off by choosing activities (ie. strategies) and verifying the objectives attained *only* after they have been carried out encourages them to promote totally unstructured teaching. We believe that such teaching has a place in school and *a place that should be kept*, but reducing all work at school level to such teaching surely is inappropriate: *there are always objectives in mind when a strategy is chosen, and when they have not been made explicit they may be the wrong objectives.*

7. CONCLUSION

Our findings allow the conclusion that the evolution of learning is, in general, made according to our model. The findings support the hypothesis formulated initially. *For competencies of a low level of abstraction the majority of pupils acquire complete competence after a shorter or longer period of the transmission-acquisition process. For competencies of a higher level of abstraction the competence acquired by pupils is distributed unequally, along the time*

dimension of the transmission-acquisition process up to its final stage. The form of the Gaussian learning curve is a function of the rate of conceptual demand relative to the learning rate of pupils. A *J* curve is not produced because there is by definition no fixed goals for this type of competency.

Now that we have found *patterns of pupils' achievement* in *A* and *U* competencies we shall use these patterns in further analyses in the main body of the thesis. The information we have obtained will provide us with one means to characterize the teacher's pedagogical practice for we have criteria to judge the effectiveness of teachers in teaching *A* and *U* competencies. Differences between teachers in this respect are crucial to the understanding of differential achievement of different groups of pupils. We are now able to compare *A* and *U* learning curves of *all the teachers for the whole range of objectives* with the *A* and *U* curves we have found for the two teachers in our study of selected objectives.

Further, in the teaching of these selected objectives we introduced special teaching strategies different from the strategies used in the normal process of teaching. Criteria and sequencing rules were made more explicit and the pacing of the transmission (rate of expected acquisition) was weakened. We shall go on to compare the achievement of pupils for the *whole sample of objectives* with the achievement of the pupils in *the selected objectives* for the two teachers who carried out the particular study.⁴⁶

8. NOTES AND REFERENCES

1. A. Domingos, 1979, pp. 60-66.
2. A. Domingos *et al*, 1981, pp. 89-95.
3. *Ibid.* 1, p. 61.

4. *Ibid.* 2, p. 90.
5. *Ibid.* 2, p. 90.
6. *Ibid.* 2, pp. 90-91.
7. *Ibid.* 1, p. 61.
8. *Ibid.* 2, p. 91.
9. N. Gronlund, 1970, p. 32.
10. *Ibid.* 1, p. 64.
11. *Ibid.* 2, p. 92.
12. *Ibid.* 2, p. 93.
13. *Ibid.* 1, p. 65.
14. *Ibid.* 2, p. 93.
15. See Chapter four of this thesis where, for the eleven teachers, the following parameters are measured:
(a) degree of agreement in the classification of questions in *A* and *U*; (b) degree of agreement in the classification of pupils' answers; (c) patterns of achievement in *A* and *U* competencies. See also Appendices II and IV, where, for the eleven teachers, the following data are presented: (a) a summary *curriculum vitae*; (b) a sample of tests.
16. Only this can justify the existence of a single 7th year class taught by teacher X_3 , whose isolated results would not be very significant given the small number of pupils involved.
17. A criterion-referenced marking was made even for *U* competencies, taught at developmental level, because it appeared to us the best way to test the hypothesis
18. The concept of 'Community', which preceded the concept of 'Ecosystem' in the learning process, as far as this study is concerned, is considered within this last concept.
19. The objective 'Points out the data on which a conclusion is based' is not analysed, because it was tested only once and so does not allow any evolution to be observed.
20. *Opus cit.* 1.
21. *Opus cit.* 2.
22. See Chapters six and seven of this thesis on Gender

and achievement and social class and achievement.

23. R. Mager, 1962.
24. *Ibid.* 2, pp. 95-97.
25. N. Gronlund, 1976, p. 33.
26. N. Gronlund, 1973.
27. *Ibid.* 2, p. 96.
28. Although not a very correct procedure (*Ibid.* 2, pp. 61-64), it was used in this study to allow us to examine what happens if we treat competencies of this type as mastery objectives.
29. See Chapter four of this thesis on Teacher's pedagogic practice.
30. *Ibid.* 25, pp. 29-30.
31. *Ibid.* 2, pp. 61-64.
32. *Ibid.* 25, pp. 40-49.
33. *Ibid.* 9, pp. 7-17.
34. V. and G. Landsheere, 1977, p. 275.
35. *Ibid.* 25, pp. 31-33.
36. *Ibid.* 9, pp. 34-36.
37. *Ibid.* 2, pp. 98-100.
38. *Ibid.* 26.
39. *Ibid.* 17.
40. There is an ideology of grading underlying this model. It could be in principle possible to develop high level competencies without grading by scores.
41. W. Popham *et al*, 1969, pp. 33-52.
42. L. Stenhouse, 1977, pp. 72-77.
43. See for example, *Ibid.* 42.
44. *Ibid.* 23, pp. 5-6.
45. *Ibid.* 2, pp. 23-24.
46. *Ibid.* 22.

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CHAPTER FOUR
TEACHER'S PEDAGOGIC PRACTICE

1. INTRODUCTION

One of the main objectives of the thesis is to relate differences in patterns of pupil's achievement to a series of sociological variables. Patterns of achievement refer to a general score and to two sub-scores for two groups of competencies: Acquisition of knowledge and Use of knowledge. Our aim is to analyse the relationship between success and failure as indexed by the general score and by the two sub-scores and the sociological variables. As the general score is the mean of the two sub-scores the latter are the main focus of our analysis.

The value of the study and therefore of the conclusions depends essentially on the accuracy with which achievement is measured, which itself depends upon the validity and reliability of the teachers' marking and the criteria they use. This constrained us to establish some initial basic guidelines:

- (a) The marks of the three terms of the year (the three stages which are considered here) are, for the purpose of this study, *exclusively based on the results of tests* administered during the year. Although there is a high degree of subjectivity in the marking of tests these are still the most objective measure of pupils' achievement. Other forms of assessment used by teachers were not taken into account. The overall evaluation of pupils includes homework, oral assessment, classroom participation. However the test mark plays a crucial role in the final assessment.
- (b) The criteria used by different teachers in classifying test questions in *A* (Acquisition of knowledge) and *U* (Use of knowledge) should be: (1) as similar as possible; (2) as near to the criteria relevant to the purpose of this study. Our assessment of the teachers will entail a comparative analysis of the consensus between teachers in their *recognition* of

A and *U* questions.

- (c) The teachers must show common marking procedures. We shall attempt to assess similarities and differences between teachers in their marking of questions.

Both assessments, (b) and (c), are equally necessary if the test scores are to provide a valid and reliable basis for the sociological comparisons between the different social groups of pupils. Further the analysis of the teachers' marking practice should also permit inferences about *their pedagogic practice*. This will supplement other information we were able to collect about the teacher's background, training and experience.

Further, our assessment of teachers requires us to establish the kind of teaching-learning process in which the teachers are engaged. This involves a study of:

- (a) How teachers differ in distinguishing between *A* and *U* competencies in their daily pedagogical practice, ie. in the transmission-acquisition process *and* in the assessment process.
- (b) How teachers differ in the *weight* they give to *A* and *U* competencies in their pedagogical practice and in the *level of abstraction* of *U* competencies they require of their pupils (in other words the degree of conceptual demand).
- (c) The efficiency of teachers in bringing pupils to attain the level they set.

We can obtain the data for this study from:

- (a) Assessment of teachers in classifying *A* and *U* test questions.

- (b) Analysis of differences between patterns of achievement in *A* and *U* competencies for each teacher's pupils.
- (c) Analysis of each teacher's tests (tests reflect the type of teaching they carried out).
- (d) Assessment of teachers marking of pupils' answers.

This chapter is therefore devoted to the *Characterization of Teachers' Pedagogic Practice* and will deal with the analyses carried out to enable such a characterization.

We will begin by assessing the teachers' degree of competence in distinguishing *A* and *U* competencies. This will be followed by an analysis of the teachers' degree of conceptual demand as indexed by the marking of their pupils' answers. Finally, we will examine patterns of achievement in *A* and *U* competencies obtained by different teachers' pupils. Our conclusion will attempt a synthesis of the main findings.^{1, 2}

2. TEACHER'S DEGREE OF COMPETENCE IN DISTINGUISHING *A* AND *U* COMPETENCIES

The teachers' degree of competence in distinguishing *A* and *U* competencies is measured here by statistical methods which are complemented by a more qualitative method of evaluation. In devising a method to measure that competence we assumed that since tests reflect the teacher's pedagogical practice, having teachers classifying each other's questions would not only give us a degree of their agreement in recognising *A* and *U* questions, but also it would give us a measure of their pedagogical practice. For if one teacher's *U* questions are another teacher's *A* questions then we feel justified in inferring that such differences in discrimination will have a bearing on the

emphasis and perhaps focus of the teacher's pedagogic practice.

We measured reliability in discrimination twice during the year: at the end of the second term and at the end of the year. The objective of the first analysis was: (a) to find out how far teachers were from each other in the criteria they had been using; (b) to find out how far teachers were from the criteria created for the purpose of this study; (c) based on (a) and (b) to try to improve teacher's recognition criteria. The objective of the second analysis was to find out if any improvement had taken place in the recognition criteria, ie. to see if teachers were nearer each other and nearer the criteria which had been set.

The third term marks indicate the level achieved by the pupil as a result of one year of learning. These marks are therefore, the most relevant results from the point of view of our study, and they are the crucial marks to be taken into account. Therefore it seemed wise to improve teachers' recognition criteria for the third term. It is true that by improving the discrimination of teachers prior to the third term tests, we have introduced errors in any comparison of the marks on the basis of the three terms. We have, however attempted to ensure that, for the *crucial* third term testing, the conditions for greater reliability between teachers existed.

2.1. FIRST STAGE OF PROCEDURE - THE DATA

- (a) Over one hundred tests were given by teachers (eleven) to pupils during the first and second terms, which means an average of ten tests per teacher. Further over fifty tests were given during the third term which gives an average of five tests per teacher. All tests were filed, each with its own planning and marking matrix. They were numbered with a code

number.³

- (b) Two tests were chosen at random from each teacher at the end of the second term and at the end of the year thus making a sample of twenty two tests for each one of our analyses. However, two conditions were imposed before the random choice was made: (1) the two tests would have to be of two different years when teachers were teaching more than one year; (2) for the first analysis (end of the second term), second term tests were favoured as they better represented the recent criteria used by teachers. All elements that could relate a test to a teacher (name of school, etc.) were removed.
- (c) A table for each teacher was constructed (Figure III.2 Appendix III) where the vertical dimension refers to tests selected and the horizontal dimension to categories of abilities. Eleven tables were therefore made.
- (d) A meeting (for each of the two analyses) with *all* teachers was held which lasted two days.⁴ At that meeting teachers classified as *A* or *U* each question of each of the twenty-two tests including their own.
- (e) A table (Figure III.3 in Appendix III) had been constructed for each test. The vertical dimension refers to questions and the horizontal dimension to teachers.
- (f) Data from the first tables (tables of each teacher) were registered on the second ones (tables of each test). From this, twenty-two tables (2 tests x 11 teachers) were obtained.
- (g) The meeting held for the first analysis (end of the second term) concluded with a detailed discussion with all teachers with the objective of improving teachers'

criteria and general procedures. An important part of this meeting was the analysis that each teacher made of her own tests as classified by other teachers.

2.2. SECOND STAGE OF PROCEDURE - THE MEASURE OF TEACHERS' RELIABILITY

2.2.1. Treatment of Data

2.2.1.1. Basic definitions and notation

Let k be the number of test ($k=1,2,\dots,22$)

i be the number of the teacher ($i=1,2,\dots,11$)

j be the number of question ($j=1,2,\dots,22$)

$M_{i,j,k}$ = value of mark of teacher i , to question j in test k

= +1 if the teacher marked the question as A

= -1 if the teacher marked the question as U

= 0 if no mark is given either because the question did not exist or teacher did not answer

Example: If teacher number 5, marked question 10 in test number 16 as U , the value of $M_{i,j,k}$ is:

$$M_{5,10,16} = -1$$

With this notation the marks of each teacher may be arranged in matrix form for each test as:

Test number k

| | Number of question | | | |
|-------------------|--------------------|---|--------|----|
| | 1 | 2 | 3..... | 22 |
| Number of teacher | 1 | | | |
| | 2 | | | |
| | 3 | | | |
| | ⋮ | | | |
| | ⋮ | | | |
| | ⋮ | | | |
| | ⋮ | | | |
| | ⋮ | | | |
| | ⋮ | | | |
| | ⋮ | | | |
| | 11 | | | |

The whole set is thus formed by 22 matrices which correspond to tables for each test referred in the first stage of procedure. These are the *base data* which can be seen in Appendix X.

2.2.1.2. Selectivity of a question

The next step was to define a measure of selectivity for each question. The selectivity of a question is the fundamental definition for assessing relative reliability. The definition intends to set a standard of reference.

(a) Taking all teachers together to set the reference

This allows to verify how far teachers are from each other.

Selectivity of question in test k is defined as:

$$1) \quad S_{j,k} = \frac{1}{Q} \sum_{i=1}^{11} M_{i,j,k}$$

with Q meaning the number of non-zero answers (ie. non-zero values of $M_{i,j,k}$)

1) is equivalent of taking the average of each column in the matrices of answers.

From 1) it follows that if all teachers agree $|S_{j,k}| = 1$. If they divide equally between the two possible values of $M_{i,j,k}$ (in practice this is not possible because there is an odd number of teachers), $S_{j,k} = 0$, and as such this question has no value for assessing reliability.

By 'selectivity of a question' we are referring to the extent to which any question elicits a clear discrimination between A and U levels of competence.

(b) Taking one teacher as reference

This allows us to verify how far teachers are from the criteria necessary for the purpose of this study, ie. the criteria which considers A questions as knowledge requiring a low level of abstraction and U questions as knowledge requiring a high level of abstraction. In this case we assume that there is a teacher using such criteria and she is taken therefore as an absolute standard.

In this case *selectivity of question* in test k is defined as:

$$2) \quad S_{j,k} = M_{i,j,k}$$

with i being the reference teacher

If, for example, teacher X_3 is taken as reference:

$$3) \quad S_{j,k} = M_{3,j,k}$$

If teacher X_7 is taken as reference:

$$4) \quad S_{j,k} = M_{7,j,k}$$

(c) Taking two teachers as reference

This allows us to find out how far teachers are from the criteria selected by the researcher. There were two teachers who were near our criteria. They were teachers X_3 and X_7 .⁵ If teachers X_3 and X_7 are taken together as reference:

$$5) \quad S_{j,k} = \frac{1}{2} (M_{3,j,k} + M_{7,j,k})$$

As a consequence if both teachers agree on the mark of question j in test k , $|S_{j,k}| = 1$; if they disagree $S_{j,k} = 0$ and in such case the question has no value for assessing reliability.

In conclusion, criteria 1) and 2) represent two extremes for assessing the selectivity of a question. Definition 5) is intermediate. We could define a more progressive transition from 2) to 1) by taking more and more teachers in the definition of $S_{j,k}$. Only criteria 1), 2), 5) were used.

It is easily seen that definition 2) represents the most stringent screening of teachers and is also the most subjective in the sense that the reference teacher was chosen beforehand. However this is the criterion which gives crucial information for the study because the teachers are here evaluated against two specially effective teachers.

2.2.1.3. Reliability of teacher by test

Once the selectivity of question is found, reliability of teacher i in test k is defined as:

$$6) \quad R_{i,k} = \frac{1}{N} \sum_{j=1}^{22} M_{i,j,k} \cdot S_{j,k}$$

where N means the number of questions with non-zero selectivity

A second definition is used which differs from the previous one on the value of N . In this second definition, N is the number of non-negative values of $M_{i,j,k} \times S_{j,k}$:

$$7) \quad R_{i,k} = \frac{1}{N'} \sum_{j=1}^{22} M_{i,j,k} \cdot S_{j,k}$$

where N' means the number of non-negative values of $M_{i,j,k} \times S_{j,k}$

The meaning of each definition is the following:

If selectivity is -1 and teacher answer is -1:

$$M_{i,j,k} \times S_{j,k} = 1$$

If selectivity is -1 and teacher answer is +1:

$$M_{i,j,k} \times S_{j,k} = -1$$

As a consequence, on the first criterion, if the teacher answers correctly (ie. the same as taken for reference) each parcel in the sum is positive. If she answers incorrectly the sum is reduced.

For example, if the test had ten questions and half the answers were correct the first criterion would give $R_{i,j} = 0$ and the second would give 0.50. As such, both criteria keep the relative position of teachers, but the first spreads them more. However, for later use, the second reflects best the weight to be given to a teacher.

Both criteria were used. The first shows that all teachers are well above 0 and as such behave in a coherent fashion towards the correct discrimination side. The second criterion gives an absolute quantitative qualification. Results presented are based on this criterion.

2.2.1.4. The global reliability of the teacher

$R_{i,k}$ was established previously and represents reliability of teacher i in test k .

Because there are N_t tests, there are N_t measures for the teacher, the average of all tests being:

$$8) \quad G_i = \frac{1}{N_t} \sum_{k=1}^{N_t} R_{i,k}$$

with N_t the number of tests the teacher i classified.

Global Reliability of Teacher, G_i , is also the average by columns of $R_{i,k}$ matrices.

Values for G_i are presented in table of Figure VII.1 of Appendix VII.

2.2.1.5. The mean teacher and standard deviation

There are 11 teachers and each one has already a global measure of reliability given by G_i .

The Mean Teacher (or average teacher) is given by:

$$9) \quad S = \frac{1}{11} \sum_{i=1}^{11} G_i$$

The Standard Deviation was also computed. The Mean Teacher and Standard Deviation are summarised in tables of Figures 4.1 and 4.3 for the four criteria used.

2.2.1.6. Statistical measures

Having established a criterion for the reliability of the teacher by test based on the selectivity of each question, the usual statistical characterization was computed in which the previously defined global reliability is the usual mean. Besides the mean, the standard deviation, the skewness and kurtosis⁶ were found. Correlations between teachers were also found. These are summarized in the tables of Figure VII.2 (Appendix VII) for the mean teacher as reference and for teachers X_3

and X_7 as reference.

2.2.2. Analysis of Results - 1st Evaluation (end of 2nd term)

The table in Figure 4.1 summarizes the values for the Mean Teacher and Standard Deviation according to our previously defined criteria, ie. taking the mean, teachers X_3 and X_7 , teacher X_3 , and teacher X_7 , as reference.

| REFERENCE MEASURES | Mean | Teachers X_3+X_7 | Teacher X_3 | Teacher X_7 |
|-----------------------|------|-----------------------|------------------|------------------|
| Mean Teacher | .52 | .67 | .76 | .74 |
| Standard Deviation | .03 | .09 | .09 | .11 |
| SD / MT | 5.4% | 13.8% | 12.3% | 14.6% |

Figure 4.1 - Mean Teacher and Standard Deviation according to different criteria (1st evaluation)

An analysis of these values shows that:

- (a) The mean teacher differs according to the criteria used for selectivity of questions. Figures are higher when teachers X_3 and X_7 separately are taken as reference; these decrease when the number of teachers taken as reference increases, and are the lowest when the mean of *all* teachers is the reference.
- (b) The standard deviation varies considerably (more than the mean teacher) according to the criteria used for the selectivity of questions. Although the SD is similar when considering teachers X_3 and X_7 together

or separately, it shows a significant variation in relation to the mean when it is taken as reference. This is more accurately shown by SD/MT x 100: the standard deviation in relation to the corresponding mean teacher, with the mean taken as reference, is roughly half the value of values for other references.

An ordering of teachers was established on the basis of their relative values of Global Reliability (G_i) referred to above (2.2.1.4.); three groups were established, high reliability, medium reliability and low reliability (Figure 4.2). This ordering was made for the four references we have considered. The range of global reliability values is presented in brackets.

| TEACHERS REFERENCES | High Reliability | Medium Reliability | Low Reliability |
|--|---|---|-----------------------------------|
| Mean as Reference | | $X_3, \overline{X_2, X_4, X_6, X_7},$ $\overline{X_1, Z_2}, Z_3, X_5$ ($G_i = .56-.51$) | Z_4, Z_1 ($G_i = .47-.46$) |
| Teachers X_3 and X_7 as reference | $\overline{X_3, X_7}$ ($G_i = .83$) | $\overline{X_6, Z_2}, Z_3, \overline{X_2, X_4}$ $\overline{X_1, X_5}$ ($G_i = .70-.63$) | Z_4, Z_1 ($G_i = .58-.50$) |
| Teacher X_3 as reference | X_3^*, X_7 ($G_i = .83$) | $Z_2, X_6, Z_3,$ $\overline{X_1, X_2, X_4, X_5}$ ($G_i = .80-.74$) | Z_4, Z_1 ($G_i = .67-.61$) |
| Teacher X_7 as reference | X_7^*, X_3, X_6 ($G_i = .83-$.82) | $\overline{Z_2, Z_3}, \overline{X_2, X_4},$ X_5, X_1 ($G_i = .76-.68$) | Z_4, Z_1 ($G_i = .66-.56$) |

* Reliability 1.00 because they were taken as reference

Figure 4.2 - Ordering of teachers according to their global reliability (1st evaluation)

Once the reliability of a teacher was found (according to the above defined criteria) some *conclusions* could be formulated. Among them, the most interesting are:

- (a) The 'whole objective' choice of selectivity of question identifies teacher X_3 and X_7 among the most reliable (X_3 being the first and X_7 the fifth).
- (b) Taking teacher X_3 as reference gives teacher X_7 as the best and conversely
- (c) Using the most stringent screening gives consistent values for either teacher X_3 or X_7 taken as reference
- (d) On the most stringent screening global reliability is quite reasonable because the mean teacher is between .74 and .76, with standard deviation between .09 and .11 (12.3% and 14.6%).
- (e) The small standard deviation (.03 ie. 5.4%) around the mean, when the mean of teachers' answers is taken as reference, shows that teachers are not very far from each other (with the exception of teachers Z_4 and Z_1 ; without them the standard deviation would be still smaller). The higher standard deviation around the mean, when teachers X_3 and X_7 are the reference, shows that teachers are still far (although not too distant again except for teachers Z_4 and Z_1) from the criteria needed for our study.

2.2.3. Analysis of Results - 2nd Evaluation (end of the year)

The reader will remember that the second evaluation took place *after* the discussion following the first evaluation about discrimination between *A* and *U* questions.

The table of Figure 4.3 summarizes the values for Mean Teacher and Standard Deviation according to the previous defined criteria, ie. taking the mean, teachers X_3 and X_7 , teacher X_3 , teacher X_7 , as reference.

| REFERENCE MEASURES | Mean | Teachers X_3+X_7 | Teacher X_3 | Teacher X_7 |
|-----------------------|------|-----------------------|------------------|------------------|
| Mean Teacher | .64 | .71 | .82 | .79 |
| Standard Deviation | .02 | .05 | .06 | .08 |
| SD /MT | 3.1% | 7.0% | 7.3% | 10.1% |

Figure 4.3 - Mean Teacher and Standard Deviation according to different criteria (2nd evaluation)

The analysis of these values show that:

- (a) As in the first evaluation (end of second term):
The Mean Teacher differs according to the criteria used for the selectivity of questions. Figures are higher when teachers X_3 and X_7 are taken separately as reference. The figures decrease when the number of teachers used as reference increases, and are the lowest when the mean of *all* teachers is the reference. The Mean Teacher is always higher than in the first measure (end of second term).
- (b) The dispersion of teachers around the mean, ie. the standard deviation, varies with criteria used for the selectivity of questions. This variation is smaller than that for the first evaluation (end of second term). Similarly when we consider teacher X_3 and X_7 together or teacher X_3 alone, there is some variation

in relation to the mean when it is taken as reference. This is more accurately shown by $SD/MT \times 100$: the standard deviation in relation to the corresponding mean teacher when the mean is taken as reference, is half the value of the values for references Teachers X_3 and X_7 and Teacher X_3 and one third of the value for reference Teacher X_7 . However, the variation is considerably smaller than it was in the first evaluation (end of second term).

As before, an ordering of teachers was established on the basis of their relative values of Global Reliability (G_i) presented above (2.2.1.4.); three groups were established, high reliability, medium reliability and low reliability (Figure 4.4). This ordering was also made for the four references. The range of global reliability values is presented in brackets.

| TEACHERS REFERENCES | High Reliability | Medium Reliability | Low Reliability |
|--|--|---|--|
| Mean as reference | | $\frac{X_6, X_3, \sqrt{X_1, X_2}}{X_7, Z_2, Z_3, Z_4}$ ($G_i = .67-.64$) | Z_1, X_4, X_5 ($G_i = .63-.59$) |
| Teachers X_3 and X_7 as reference | $\sqrt{X_3, X_7}, X_6$ ($G_i = .80-.74$) | $\frac{Z_3, Z_4, X_1, \sqrt{X_2}}{X_4, Z_2}$ ($G_i = .71-.68$) | Z_1, X_5 ($G_i = .66-.62$) |
| Teacher X_3 as reference | $\frac{X_3^*, X_6, X_2, \sqrt{X_4}}{Z_2, Z_3, \sqrt{X_1, X_7}}$ ($G_i = .84-.80$) | Z_4, Z_1 ($G_i = .79-.78$) | X_5 ($G_i = .74$) |
| Teacher X_7 as reference | $\frac{X_7^*, X_6, Z_3, Z_4}{X_3}$ ($G_i = .84-.80$) | $\frac{X_1, X_4, \sqrt{X_2}}{Z_1, Z_2}$ ($G_i = .78-.74$) | X_5 ($G_i = .71$) |

* Reliability 1.00 because they were taken as reference

Figure 4.4 - Ordering of teachers according to their global reliability (2nd evaluation)

On the basis of the results shown above we can draw the following conclusions:

- (a) The 'whole objective' choice of selectivity of question identifies once again teachers X_3 and X_7 among the most reliable (X_3 being the second and X_7 the seventh). *Teachers are now very near one another, even the three who were grouped in the low reliability set are now quite near the others.*
- (b) When teachers X_3 and X_7 together are taken as reference teacher X_6 follows closely. If we take teacher X_3 as reference there now is a group of eight teachers who follow closely (in the first evaluation only X_7 was close to X_3). A similar pattern occurs when X_7 is taken as reference although fewer teachers follow closely (five teachers).
- (c) Teachers Z_1 and Z_4 who were very far from other teachers irrespective of the reference taken, in the first evaluation (end of second term) now show considerable improvement. Teacher Z_4 is either in the medium or in the high group and teacher Z_1 is either in the low (but with much higher values) or in the medium group. Teachers in the lower group (teacher X_4 only when the mean is the reference) show a smaller degree of improvement rather than deterioration.
- (d) Global reliability, on the most stringent screening is very good because the mean teacher is between .79 and .82, with standard deviation between .06 and .08 (7.3% and 10.1%).
- (e) The small standard deviation (.02, ie. 3.1%) around the mean, when the mean of the teachers' answers is taken as reference, shows that *teachers are not far from each other*; they are nearer than in the first measure (SD .03 ie. 5.4%) and teachers Z_1 and Z_4

no longer have the effect of increasing the standard deviation. The standard deviation around the mean when teachers X_3 and X_7 are the reference is still higher than when mean is the reference, but the differences are much smaller than in the first measure. This shows that *teachers appear to be nearer to the criteria of agreement needed for this study.*

2.2.4. Further Analysis of Results

We have so far established the degree of agreement between teachers in their ability to discriminate between A and U questions. We shall now develop our analysis to include:

- (a) Skewness - a measure of the extent to which teachers differ from each other.
- (b) Correlations between teachers X_3 , X_7 and the rest of the sample.

2.2.4.1. Skewness

A comparison based on the evolution of skewness was also considered; it is summarized in the table of Figure 4.5 with the mean teacher as reference. The other criteria give similar trends.

The analysis of the values shows that there was a significant reduction of skewness (with the exception of teacher X_5) in the second evaluation in relation to the first measure, with respect to the distribution of reliability. This shows that the improvement was not only a function of the increase in the mean reliability and the decrease in the dispersion (given by STD) as we have already seen, but also that now the distribution is closer

| TEACHERS MEASURES | X_1 | X_2 | X_3 | X_4 | X_5 | X_6 | X_7 | Z_1 | Z_2 | Z_3 | Z_4 |
|----------------------|------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | <i>1st</i> | -.76 | -.58 | -.49 | -.83 | -.08 | -.84 | -.53 | -.21 | -.71 | -.99 |
| <i>2nd</i> | -.13 | -.25 | .09 | .13 | -.39 | -.39 | -.12 | -.03 | -.35 | -.53 | .23 |

Figure 4.5 - Skewness values - mean teacher as reference (1st and 2nd evaluations)

| TEACHERS MEASURES | X_1 | X_2 | X_3 | X_4 | X_5 | X_6 | X_7 | Z_1 | Z_2 | Z_3 | Z_4 |
|----------------------|------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | <i>1st</i> | .57 | .63 | 1.00 | .49 | .67 | .81 | 1.00 | .37 | .75 | .62 |
| <i>2nd</i> | .77 | .72 | 1.00 | .57 | .66 | .80 | 1.00 | .58 | .70 | .62 | .77 |

Figure 4.6 - Correlation coefficients based on reliability taking teachers X_3 and X_7 as reference

to a normal distribution.

2.2.4.2. Correlation coefficients

Once the degree of agreement between teachers by test was found, we addressed the question of the possible correlation between teachers based on the measure of the coefficients of correlation. Correlations could have been found for any of the criteria used in defining the selectivity of a question because each criteria provides a reliability by test. However, not all of them would be meaningful. Because teachers X_3 and X_7 have already been found to be meaningful references for 'good' teachers, we took their mean as the reference criteria for the assessment of correlation.

The values found are presented in the tables of Figure VII.2 (Appendix VII) and are summarized in Figure 4.6.

As can be seen, with the exception of teachers X_5 , X_6 and Z_2 whose correlation coefficients marginally decreased, there is a significant improvement; an improvement which is clearly evident in those teachers who first were further from teachers X_3 and X_7 . The correlation coefficients which ranged from .37 to .81 now range from .57 to .80. It should be pointed out that $\sim .80$ is the maximum that can be reasonably expected in this kind of measurements. However teachers X_4 and Z_1 and to a lesser extent teachers X_5 and Z_3 are still far from this value.

2.3. ADDITIONAL CRITERION FOR THE ASSESSMENT OF TEACHERS' RELIABILITY

All the previous results are based on the concept of selectivity of a question when assessing the reliability of each teacher. Our approach however may be considered somewhat unconventional. To avoid possible criticisms we

carried out an assessment based on the usual approach of comparing the teachers after normalizing all the answers on each question. As this form of normalization is crucial to our later analysis of the teachers' marking of tests we will explain in some detail our procedures when this analysis is presented. Basically, the classifications of teachers are normalized by subtracting the mean and dividing by the standard deviation. Thus, the mean for each normalized mark becomes zero and the standard deviation becomes 1.⁷

With this normalization, mean, standard deviation, skewness and kurtosis are computed in the usual way.⁸ The tables in Figure VII.3 (Appendix VII) show the results; these tables also show correlations between teachers. The table in Figure 4.7 summarizes the results for mean and standard deviation.

On this criterion if all teachers are alike, the mean would be zero, as would be the standard deviation. Therefore, if the value is positive there is a tendency to consider questions as Acquisition and if it is negative as Use,⁹ whenever the mean teacher would consider the opposite.

On the whole, it can be seen that by the second test all teachers improved.

As these results do not contradict our analysis made on the basis of selectivity of questions we shall use the latter in our discussion of the findings because this measure relates the discrimination of a teacher to the discriminatory power of a question. This is not taken into account in the case of the normalization procedure.

| TEACHERS MEASURES | | X_1 | X_2 | X_3 | X_4 | X_5 | X_6 | X_7 | Z_1 | Z_2 | Z_3 | Z_4 |
|----------------------|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | | Mean | 1st | .16 | -.14 | .13 | -.07 | -.23 | .15 | .19 | -.07 | .15 |
| 2nd | .03 | | -.11 | -.08 | .01 | .01 | .06 | .12 | .05 | -.15 | -.02 | .10 |
| STD | 1st | .78 | .95 | .85 | .80 | .94 | .94 | .89 | .91 | .78 | .90 | .92 |
| | 2nd | .64 | .62 | .54 | .78 | .88 | .51 | .65 | .73 | .64 | .66 | .74 |

Figure 4.7 - Mean and Standard Deviation based on reliability after normalization by standard deviation

2.4. A QUALITATIVE ASSESSMENT OF TEACHERS' RELIABILITY

2.4.1. We have assessed teachers' reliability in classifying test questions in two different types of competencies, Acquisition of Knowledge and Use of Knowledge and a number of conclusions were reached. Two important assumptions underlie our procedures:

Firstly, we assumed that tests made by teachers were valid in the sense that they reflect teachers' pedagogical practice in the development of the relevant competencies. In our meetings with teachers we drew their attention to the importance of constructing valid tests. Those teachers who were not acquainted with the practice of constructing a valid test were shown how to use a table of specifications in order that the emphasis given in tests to different types of competencies (and contents) corresponded to the actual process of transmission which had taken place.¹⁰ We therefore assumed that tests given by our sample of teachers were valid tests especially those which were given to pupils in the third term, when teachers could be considered to have understood the concept of validity. Thus we consider that our teachers' tests tested competencies likely to have been developed in the classroom.

Secondly we assumed that if we have teachers classifying each others' test questions, that would not only give us a measure of their ability to distinguish questions within two types of competencies, but most important of all, would give us a measure of their pedagogical efficiency in the transmission of these two different types of competencies. This would mean that if we succeeded in bringing teachers nearer to each other and nearer to the intended criteria when classifying test questions, they would also be nearer in their pedagogical practice. It would also mean that the third term marks would have similar meaning for all teachers and that, therefore, the sample could be treated as a whole.

All our statistical findings led us to think that this aim had been attained and that, therefore, we had reached reasonable control of this variable (different criteria used by different teachers) when treating our sample of pupils as a whole.

2.4.2. However during the process of the collecting and the treatment of the data a qualitative assessment of teachers also took place. A continuous series of observations of teachers' tests, teachers' classification of tests and teacher' behaviour in meetings together with a more subjective judgement of teachers through our previous personal knowledge of them and/or informal talks with them, provided us with additional data and with an additional analysis. Important points of this analysis are the following:

- (a) A close analysis of the tests given by each one of the teachers,¹¹ show that the level of demand in U questions (even in third term's tests) varied enormously from one teacher to another. In other words, while some teachers' tests create a whole range of conceptual demands in their U questions (from those requiring a not very high level of abstraction to those requiring very high levels of abstraction¹²) some other teachers' tests show that their U questions test only the lowest levels of these competencies. Teachers X_1 , X_2 , Z_2 and especially X_3 and X_7 are good examples of the former; teachers X_4 , X_6 , Z_3 and especially Z_1 and Z_4 are good examples of the latter; teacher Z_1 , in fact, has virtually no *real* U questions in her tests (see b below). The importance of this observation is that it points to the fact that even when a fair degree of agreement in classifying questions is reached, a fair degree of agreement in the pedagogical practice does not necessarily follow.

On the basis of this information we can establish a new ranking of our teachers. This ranking although

apparently more subjective is important. In the analysis which follows we will use other qualitative information together with other quantitative data on the basis of which we will produce an adjustment of the ranking we obtained from our previous analysis.

- (b) Although the existence of random factors¹³ do not allow of the complete agreement between teachers *even* when teachers are similar to each other (e.g. teachers X_3 and X_7), a delicate analysis of the classification of each teacher's questions by *other* teachers shows that there are *some* teachers where the majority of their U questions were consistently classified by most teachers as A questions. The most flagrant case, is that of teacher Z_1 where almost all (or all in some tests) of her U questions were considered A questions by virtually all teachers.¹⁴ This of course means that the percentage of 50% U questions and 50% A questions was not achieved. As we have previously assumed that there is a relationship between the level of a question *and* the focus of the pedagogic practice, we therefore will argue that teacher Z_1 developed in the main A competencies. Further the concentration on factual knowledge would associate this teacher with a more traditional approach to science teaching.

2.4.3. It is interesting to point out the discrepancy which appears to exist between this last point and the conclusions we reached through our statistical analysis. In that analysis we noted that teacher Z_1 (taken as an example) was much nearer to other teachers in the second evaluation compared to the first. Now after our more subtle analysis she is placed at a great distance from many other teachers. The interpretation of these two different findings is clear: In the third term teacher Z_1 is more able to distinguish A and U questions when faced with *other* teachers' tests than she was before. However she does

not design *U* questions in her own tests or more *precisely* she does not develop this type of competency in her daily pedagogical practice. We suggest, on the basis of the evidence, that teacher Z_1 either is unable to teach at the level demanded by the higher competencies or working class country pupils act selectively on the focus of her teaching or both.¹⁵ We shall return to this point later in the thesis. It is also the case but to a lesser degree that a few teachers (e.g. Z_4) although able to recognize *A* and *U* questions, set in their tests *U* questions which either are low level *U* questions or do not belong in this category. Later analysis will provide further evidence for this statement.

The above should not lead us to conclude that after all no significant improvement took place. The statistical measures and our detailed analysis of the questions set by the teachers shows that on the whole an improvement did take place. *Teachers knew better the researcher's criteria which on the first evaluation was only effectively known by teachers X_3 and X_7 , i.e. they were better able to draw the line between *A* and *U* competencies; teachers were also nearer to each other. Unfortunately, however, this improvement did not necessarily lead to a change in their practice.*

2.4.4. We will now examine a further source of discrepancies between teachers (of which we were previously aware) and which became evident in the first meeting we held with the teachers when they met to classify questions.

U questions are questions which, by definition and no matter the degree of conceptual demand they entail, deal with *new* situations. To make this more explicit we should say that when a teacher designs a *U* question she should have developed the respective competency beforehand in the classroom but the situation given to the pupils in the test *must* be *new*. However we cannot always rely on every teacher

creating a question based upon new situations rather than familiar ones. From this it follows that *only* the teacher herself can have a secure knowledge that a question is *A* or *U* for she is the only one who knows if the situation is new. Put in extreme terms it might seem that the comparison between teachers we have been making has no meaning, but this of course is not the case. In fact what we have called here, *A* questions, are usually designed in a way which is both simple and direct so that any teacher should be able to say it is *A*. However this does not always turn out to be the case especially where teachers have not had an adequate training. This can lead to a disagreement between teachers arising out of the way the question is presented rather than a disagreement arising out of misrecognition of the type of question. To avoid these errors, our teachers were asked, after the first evaluation, to *avoid* designing 'beautiful' questions (with a sophisticated construction) when measuring *A* competencies so that other teachers would not be misled when classifying them. A further reason for this procedure was to ensure that *A* questions were not so elaborated in their construction that the understanding of their meaning requires in itself *U* competencies. Although these steps were taken, it is probable that some degree of the disagreement found between teachers is due to this factor. Such disagreement shows ignorance of what happens in other teacher's classrooms rather than a disagreement based upon failure to discriminate. On this basis we suggest that the general reliability obtained either by statistical measures or by a qualitative assessment is possibly greater than those measures have shown.

2.5. FINAL INTERPRETATION

The statistical analysis of the teachers' reliability in classifying test questions in *A* and *U* competencies allowed us to verify how far teachers were from each other and how far they were from the criteria useful for the

purpose of this study. Evaluations were made on two occasions in the year. By the end of the second term, with the exception of two teachers, all were nearer to each other but still distant from the researcher's criteria. By the end of the year however all teachers were much nearer to this criteria.

Comparison between the two evaluations shows that *a very great improvement took place*; indeed it was the best we could expect, taking into account the difficulties entailed in the *A* and *U* classification. Teachers' reliability, in this respect, is *much higher than it was before*, and it is probably near the maximum possible. We have reduced a major source of error and this permits us to have some confidence in the marks accorded to pupils on the basis of the teachers' division between *A* and *U* competencies. The third term marks, which indicate the level eventually achieved by pupils in both groups of competencies and which are therefore the most relevant for this study, could thus be accepted with a higher degree of confidence.

However, we cannot conclude that we have disposed of the question of reliability. In fact, as we have seen and as it will be seen later in this chapter, the teachers' teaching style remained unchanged and as a consequence the conceptual demand made of pupils by teachers varied. *The degree of demand within U competencies shows great variation between teachers*. There is one teacher (Z_1) whose conceptual focus is so low that the majority of teachers classified her *U* questions as *A* questions. However, by the third term there was a *high level of agreement between teachers in the discrimination between A and U questions*.

This shows *the limitations of considering the sample as a whole*, and such limitations should be taken into account when interpreting the data on the relationship between achievement in different types of competencies and our

social groups. We shall be dealing with this issue in the analysis to follow.

To conclude this part we should stress how important it was to complement the statistical analysis with a qualitative assessment which, although more subjective, revealed subtleties which not only modified our statistical judgement but also opened up productive lines for future analysis.

3. TEACHER'S DEGREE OF DEMAND IN THE MARKING OF PUPILS' ANSWERS

Simultaneously with the process of establishing the consistency of teachers in distinguishing between *A* and *U* questions, another test was devised to compare the eleven teachers when marking answers given by pupils in their normal classroom context. The degree of agreement in the *marking of pupils' answers* was measured at the end of the year. The main objective of this procedure was to verify the degree of similarity of the criteria used by different teachers in the marking of pupils' tests. As third term marks constitute the most relevant results of the level achieved by pupils, and because teachers were nearer in their ability to distinguish *A* and *U* competencies, only third term tests were used to measure teachers' degree of agreement in marking.

3.1. FIRST STAGE OF PROCEDURE - THE DATA

To fulfil the above purpose, the actual answers of pupils to tests were given to the different teachers for them to mark. To have all teachers marking all the tests actually given by all other teachers would have been an enormous task and an unjustified burden to the teachers, so

a sample of questions was chosen with the same number of answers to acquisition and use questions. Teachers only *marked answers of the subjects and years they were teaching*. The procedure we used to obtain the data now follows.

- (a) A random choice was made between two classes of each teacher, each class from a different year when teachers were teaching two different years. Three classes were chosen from teacher Z_1 because she taught three different years. This gave a total of twenty-three classes.
- (b) One test given to each one of the classes was chosen randomly. This made up twenty-three tests.
- (c) Pupils' answers to the tests were photocopied *before* teachers had corrected and marked them.
- (d) Two questions of 'Acquisition of Knowledge' and two questions of 'Use of Knowledge' were taken out from each test. The choice was made randomly within two constraints: as far as possible objective questions with a determinate answer were not chosen; questions to which there were a wide range of answers were favoured. As far as possible answers were chosen from questions which attracted a wide range of marks, from zero to the maximum mark. Ideally, therefore, each teacher would provide four *A* and four *U* questions. However because it was decided that teachers should mark only the subject(s) and year(s) of their classes some teachers provided more questions than others; this accounts for the small variation in the number of answers marked by each teacher (see *k* below). This made up a total of one hundred and twenty questions.
- (e) For each question, answers given by eight pupils were randomly chosen within the questions which attracted a wide range of marks. This made up a total of over 900 answers.

- (f) A table for each teacher was constructed (Figure III.4 in Appendix III) where the vertical dimension refers to tests, questions, pupils and marks and the horizontal dimension to categories of competencies.
- (g) In these tables each teacher's tests, questions, pupils and marks had previously been entered. Marks were converted to a scale of 0-10. The number of the question and the identification number of the pupil of other teachers' tests were also entered. Each teacher had to mark a maximum number of answers from five tests (32 answers x 5 tests = 160 answers) selected from those of the same year(s) she had taught.
- (h) A meeting with all the teachers was held during two days. At that meeting the teachers marked answers to other teachers' questions on a 0-10 scale and registered their marks in the tables.
- (i) A table (Figure III.5 in Appendix III) has been constructed for each test. The vertical dimension refers to answers (32, i.e. 4 questions x 8 answers - 16 Acquisition answers and 16 Use answers) and the horizontal dimension to teachers.
- (j) Data from the first tables (tables of each teacher) were entered on the second tables (tables of each test). From this, twenty-nine tables were made (2 tests x 9 teachers + 1 test of teacher X_3 + 3 tests of teacher Z_1 + 7 groups of extra questions that had to be selected, as explained above).
- (k) The total number of answers marked by each teacher, including her own, is:

| | | |
|-------------|-------------|-------------|
| X_1 - 288 | X_4 - 224 | Z_1 - 288 |
| X_2 - 288 | X_5 - 256 | Z_2 - 224 |
| X_3 - 224 | X_6 - 224 | Z_3 - 224 |
| | X_7 - 256 | Z_4 - 224 |

3.2. SECOND STAGE OF PROCEDURE - ANALYSIS OF TEACHERS DEGREE OF AGREEMENT

3.2.1. Treatment of Data

The aim of the analysis is to compare teachers' marking of answers on a dimension of benevolence and strictness. Because of the constraint that teachers should only mark their year(s) and subject(s) not all teachers marked the same answers. On the one hand this ensured that teachers marked answers related to their own teaching, on the other hand it made the comparison between teachers more difficult. On balance we decided that controlling for the teacher's experience was more important. However a criterion had to be selected which would make possible a statistically meaningful comparison of teachers.

To achieve this objective we normalized each answer by taking into account all the teachers who had marked it. The first step in this normalization considered only the deviations of each teacher from the mean of all teachers who marked the same answer. The second step normalized these deviations by division either by the mean itself or by the standard deviation which related to that particular answer. As there is some uncertainty about which of the two methods is the more reliable we chose to do both.

3.2.1.1. Basic definitions and notation

Let k be the number of test ($k = 1, 2, \dots, 29$)
 i be the number of teacher ($i = 1, 2, \dots, 11$)
 j be the number of answer ($j = 1, 2, \dots, 16$)
 A_{ijk} be the value of mark given by teacher i ,
to answer j in test k .

If teacher i , did not mark question j in test k , A_{ijk} is given *conventionally* a negative value (-111) and it is

treated as non-existent.

With this notation the marks of each teacher may be arranged in matrix form for each test as:

| | | Number of teacher | | | | | | |
|------------------------|----|-------------------|---|---|-----|----|-----------------------------|------------------|
| | | 1 | 2 | 3 | ... | 11 | | |
| Number of Answer | 1 | | | | | | Acquisition of Knowledge | |
| | 2 | | | | | | | |
| | ⋮ | | | | | | | |
| | ⋮ | | | | | | | |
| | 16 | | | | | | | |
| | 1 | | | | | | | Use of Knowledge |
| | 2 | | | | | | | |
| | ⋮ | | | | | | | |
| | ⋮ | | | | | | | |
| | 16 | | | | | | | |

The whole set is thus formed by 29 matrices which correspond to tables for each test referred in the first stage of procedure. These are the *base data* which can be seen in Appendix X.

3.2.1.2. Mean marks and standard deviations of normalized values

The mean mark for question j in test k is

$$1) \quad x_{j,k} = \frac{1}{N_{jk}} \sum_{i=1}^{11} A_{ijk} \cdot \delta_{ijk}$$

where

$$2) \quad \delta_{ijk} = 0 \quad \text{if } A_{ijk} < 0$$

$$\delta_{ijk} = 1 \quad \text{if } A_{ijk} \geq 0$$

$$3) \quad N_{jk} = \sum_{i=1}^{11} \delta_{ijk}$$

The deviation for teacher i , in answer j and test k is therefore

$$4) \quad \begin{aligned} D_{ijk} &= A_{ijk} - X_{jk} && \text{if } \delta_{ijk} = 1 \\ D_{ijk} &= -111 && \text{if } \delta_{ijk} = 0 \end{aligned}$$

The formal standard deviation is¹⁶

$$5) \quad \text{STD}_{jk} = \sqrt{\sum_{i=1}^{11} D_{ijk}^2 \cdot \delta_{ijk} / N_{jk}}$$

Two normalized marks for teacher i in answer j of test k can now be defined, using either STD_{jk} or X_{jk} as

$$6) \quad S_{ijk} = \begin{cases} D_{ijk} / \text{STD}_{jk} & \text{if } \text{STD}_{jk} \neq 0 \\ 0 & \text{if } \text{STD}_{jk} = 0 \end{cases}$$

if normalized by the standard deviation

$$7) \quad M_{ijk} = \begin{cases} D_{ijk} / X_{jk} & \text{if } X_{jk} \neq 0 \\ D_{ijk} & \text{if } X_{jk} = 0 \end{cases}$$

if normalized by the mean.

In either case, if $\delta_{ijk} = 0$, the code for missing value (-111) is given.

3.2.1.3. The meaning of standardized variables

Once we have removed the mean value, the results become comparable in absolute value. Further, normalization by the standard deviation introduces a relative weight, in the sense that if dispersion of marks for the same

answer is large, deviation becomes relatively smaller which means that marks will weight less on a global comparison. This is as it should be because a large dispersion would mean an unclear question for all the teachers who marked it.¹⁷

Normalizing by the mean, i.e. X_{jk} , establishes a percentage deviation, correcting the fact that, for example, a one point difference between teachers has a different meaning if the mean value is, for example, 20 or 80.

From the definitions it can be concluded that

$$8) \sum_{\substack{i=11 \\ j=15 \\ k=29 \\ i,j,k=1}} S_{ijk} \cdot \delta_{ijk} = 0$$

$$9) \sum_{\substack{i=11 \\ j=15 \\ k=29 \\ i,j,k=1}} M_{ijk} \cdot \delta_{ijk} = 0$$

3.2.1.4. Comparison of teachers

To compare the teachers, the mean, the standard deviation, the skewness and the kurtosis of the previously normalized values were computed based on either S_{ijk} or M_{ijk} . The most meaningful measure is, clearly, the mean, followed by the standard deviation. The other two measures are related to the deviation from a normal distribution and are included here only for completeness (Figure VII.4 in Appendix VII).

For each teacher we therefore compute the two means for Acquisition and for Use.

$$10) \quad \bar{M}_i = \frac{1}{A_i} \sum_{\substack{j=1 \\ k=1}}^{\substack{j=16 \\ k=29}} M_{ijk} \cdot \delta_{ijk}$$

$$11) \quad \bar{S}_i = \frac{1}{A_i} \sum_{\substack{j=1 \\ k=1}}^{\substack{j=16 \\ k=29}} S_{ijk} \cdot \delta_{ijk}$$

$$\text{where } A_i = \sum_{j,k} \delta_{ijk}$$

and identically the standard deviation, skewness and kurtosis, as usually defined for unbiased estimates based on normal distribution theory.¹⁸

As we have already stressed, the mean based on normalized values gives an indication of the relative benevolence or strictness of a teacher's marking. A positive value indicates 'benevolence', a negative one 'strictness'.

3.2.2. Analysis of Results

The tables in Figure 4.8 and 4.9 summarise teachers' means and teachers' standard deviations using normalization by standard deviation. The tables in Figures 4.10 and 4.11 summarise teachers' means and teachers' standard deviations using normalization by the mean. For each normalization the criterion used for the individual answers, the mean and the standard deviation are given for both *A* and *U* questions. It must be stressed that both the mean and the standard deviation, reported here for each teacher, are based on all standardised marks to answers given by her.

| TEACHERS QUESTIONS | X_1 | X_2 | X_3 | X_4 | X_5 | X_6 | X_7 | Z_1 | Z_2 | Z_3 | Z_4 |
|-----------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| <i>Acquisition</i> | .03 | -.01 | -.07 | .04 | .04 | .09 | -.28 | .17 | -.04 | .08 | -.08 |
| <i>Use</i> | -.09 | -.17 | -.37 | .08 | -.13 | .33 | -.38 | .36 | -.01 | .19 | .24 |

Figure 4.8 - Teachers' Means - Normalization by Standard Deviation

| TEACHERS QUESTIONS | X_1 | X_2 | X_3 | X_4 | X_5 | X_6 | X_7 | Z_1 | Z_2 | Z_3 | Z_4 |
|-----------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| <i>Acquisition</i> | .82 | .92 | .80 | .80 | .93 | .68 | .81 | .92 | .86 | .78 | .96 |
| <i>Use</i> | .82 | .87 | .90 | .82 | .97 | .88 | .87 | .89 | .78 | .98 | .89 |

Figure 4.9 - Teachers' Standard Deviations - Normalization by Standard Deviation

| TEACHERS QUESTIONS | X_1 | X_2 | X_3 | X_4 | X_5 | X_6 | X_7 | Z_1 | Z_2 | Z_3 | Z_4 |
|-----------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| <i>Acquisitions</i> | -.02 | -.02 | .01 | .02 | -.03 | .07 | -.15 | .13 | .01 | -.04 | .01 |
| <i>Use</i> | -.09 | -.12 | -.25 | .05 | -.01 | .26 | -.28 | .14 | .04 | .18 | .15 |

Figure 4.10 - Teachers' Means - Normalization by Mean

| TEACHERS QUESTIONS | X_1 | X_2 | X_3 | X_4 | X_5 | X_6 | X_7 | Z_1 | Z_2 | Z_3 | Z_4 |
|-----------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| <i>Acquisition</i> | .47 | .44 | .50 | .44 | .51 | .56 | .50 | .70 | .34 | .38 | .48 |
| <i>Use</i> | .54 | .46 | .61 | .79 | .78 | .66 | .51 | .61 | .45 | .81 | .59 |

Figure 4.11 - Teachers' Standard Deviations - Normalization by Mean

A primary analysis of these values with respect to the mean shows that:

- (a) The range of values is much higher for U than for A questions with any of the criteria used (-.38 to .36 in U as opposed to -.28 to .17 in A or -.28 to .26 in U as opposed to -.15 to .13 in A).
- (b) Teachers X_3 and X_7 are the most strict and similar in their strictness for U questions (-.37 and -.38 or -.25 and -.28 according to the criterion).
- (c) Teacher X_7 is the most strict for A questions (-.28 or -.15).
- (d) According to the criterion, the most benevolent teachers for U questions are either teachers X_6 and Z_1 (.33 and .36) or teacher X_6 (.26).
- (e) Teacher Z_1 is the most benevolent for A questions (.17 or .13 according to the criterion).

The significance of the means may be assessed by the standard deviation because the standard deviation is a measure of the spread of data around the mean. The standard deviation, as could have been anticipated, tends to be higher in U than in A questions with any of the criteria used. Its value, however, is somewhat different as is the range between teachers, depending on the normalizing criteria used. In this respect, normalization by the mean gives at the same time lower individual values for each teacher and a greater difference between teachers. With both criteria, however, the means are meaningful in the sense of allowing an ordering of teachers to be made from maximum benevolence to maximum strictness. Ordering results, using both normalizing criteria are presented in tables of Figures 4.12 and 4.13.

| TEACHERS QUESTIONS | Benevolent | Strict |
|-----------------------|---------------------------------------|--------------------------------|
| | ← Max. Min. → | ← Min Max → |
| Acquisition | $Z_1, X_6, Z_3, \sqrt{X_4, X_5}, X_1$ | X_2, Z_2, X_3, Z_4, X_7 |
| Use | Z_1, X_6, Z_4, Z_3, X_4 | $Z_2, X_1, X_5, X_2, X_3, X_7$ |

Figure 4.12 - Ordering of teachers by means according to their degree of demand on the marking of pupils' answers - normalization by standard deviation

| TEACHERS QUESTIONS | Benevolent | Strict |
|-----------------------|---------------------------------------|--------------------------------|
| | ← Max. Min. → | ← Min. Max. → |
| Acquisition | $Z_1, X_6, X_4, \sqrt{X_3, Z_2, Z_4}$ | X_1, X_2, X_5, Z_3, X_7 |
| Use | $X_6, Z_3, Z_4, Z_1, X_4, Z_2$ | X_5, X_1, X_2, X_3, X_7 |

Figure 4.13 - Ordering of teachers by means according to their degree of demand on the marking of pupils' answers - normalization by mean

On the basis of the results obtained and shown above important conclusions can be drawn. Among them it seems interesting to point out:

- (a) With either criterion of normalization teachers X_3 and X_7 are the most strict for U questions and at a great distance from other teachers. Teacher X_2 although strict is less so than teachers X_3 and X_7 .
- (b) With either criterion of normalization teacher X_7 is the most strict for A questions; she is at a great

distance from other teachers. In fact, she is the only one who can be considered very strict on A questions.

- (c) At the most extreme end of the dimension of benevolence for U questions are teachers Z_1 and X_6 ; followed by, but less extreme, are teachers Z_3 and Z_4 . However when normalization by the mean is the criterion then the spread is much narrower and teacher Z_1 is now near Z_3 and Z_4 .
- (d) With either criterion of normalization teacher Z_1 is the most benevolent for A questions; she is at a great distance from other teachers.
- (e) There is an enormous difference between the most strict teachers and the most benevolent ones, i.e. between teachers X_3 , X_7 and teachers X_6 , Z_1 for U questions, and between teacher X_7 and teacher Z_1 for A questions.
- (f) Teachers are nearer to each other for A than for U questions. However, in general, they tend to be either strict or benevolent for both types of questions except for those who are near the average. There are some exceptions, the two main are:
 Teacher Z_4 who is strict (or near the average according to the criterion) for A questions and very benevolent for U questions. Teacher X_3 who is extremely strict for U questions and much less so (or near the average according to the criterion) for A questions.

The analysis we have carried out is subject to a possible source of error. The questions that were marked were based upon each teacher's own classification of what was either a A question or a U question. As we have seen, although there is, in general, agreement between teachers in their ability to discriminate this is not so for some. As a consequence some teachers' A questions were U questions

but of more importance for our study some *U* questions were *A* questions. Since the agreement between teachers when marking *A* questions is higher than when marking *U* questions it follows that the *degree of benevolence or strictness should be more marked in U questions and less marked in A questions*. This applies only to those few teachers who showed a great difference between the marking of *A* and *U* questions. As a consequence we do not believe that this source of error is a major influence on the reliability of our analysis. We should like to point out that there was no way of avoiding this possibility of error once we had decided to work with the teachers' own questions rather than constructed researcher's questions which would have no reference to the teachers' practice.

3.3. FINAL INTERPRETATION

The analysis we have carried out allowed us to place the teachers on a benevolent/strict dimension.

A major conclusion can be drawn from our analysis: *Teachers differ greatly on their marking of answers to questions assessing U competencies; they differ much less on their marking of answers to questions assessing A competencies (with the exception of two teachers, the excessively 'strict' x_7 and the extremely 'benevolent' z_1).*

We believe that differences in benevolence or strictness are not simply a sign of a particular style of acceptance of pupils' answers but reflect a context of teaching in which teachers differ in the conceptual demand they make of their pupils with reference to the pupils' development of *U* competencies. Strict markers, we hypothesize, relative to generous markers make a higher level of conceptual demand. From this it would follow that *the degree of strictness or benevolence is an index of a differential pedagogical practice and this is true has*

profound sociological implications.

On the basis of our findings here we infer that teachers X_3 and X_7 direct their teaching to high levels of conceptual demand whereas teachers X_6 , Z_1 , Z_4 and even teachers Z_3 and X_4 direct their teaching to lower levels of conceptual demand. This inference is reinforced by our finding in the previous part (2.4.). The case of teacher X_6 is interesting. We found earlier in the analysis that she was very able to discriminate A from U questions but her own tests showed that her U questions tested in the main a very low level of U competencies. We now find that teacher X_6 is very benevolent from which we would infer that she makes a low level of conceptual demand which turns out to be the case. This makes clear that we cannot infer from the ability to discriminate between A and U questions the degree of conceptual demand.

These findings on the whole support our earlier conclusion: *the degree of conceptual demand within U competencies shows great variation between teachers.* Now we can see that there is also some, although small, *variation between teachers in the demands they make even when they are teaching A competencies.*

We inferred from our findings that patterns of marking would be related to the teachers' characteristics and to the sociological context where they teach. A tendency to be 'benevolent' or at least less 'strict' was an attribute of

- (a) the youngest and less experienced teachers, i.e.,
 Z_1 , X_4 , X_6 (an exception is teacher X_5)
- (b) teachers who teach in schools in the country, i.e.
 Z_1 , Z_2 , Z_3 , Z_4
- (c) teachers who teach in schools with a predominantly

working class population,¹⁹ i.e. Z_1, Z_2, Z_3, Z_4
(exceptions are teachers X_5 and X_7)

Figure 4.14 shows the inter-relations between young teachers and teachers working in the country and in working class schools.

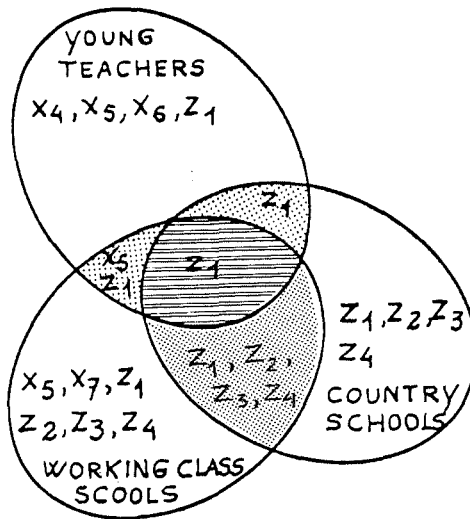


Figure 4.14 - *Diagram of inter-relations between young teachers, and teachers working in the country and in working class schools*

We can see more clearly from the diagram that our sociological inferences about the distribution of benevolent teachers turns out to be confirmed. *Benevolent (or at least less strict) teachers are either young, teaching in working-class schools or in the country with the exception of teachers X_5 and X_7 . Teacher Z_1 combines the three characteristics, young teacher in a working-class school in the country. She is also the most benevolent marker.*

We will now consider the exceptions. Teacher X_5 was trained the year before by the 'strict' teacher X_3 ²⁰ who

considered X_5 a highly competent teacher. Teacher X_7 is the more important exception for she makes, according to our analysis, the highest degree of conceptual demand of the whole sample (only followed by teacher X_3) yet she teaches in a working class school. Her *curriculum vitae* shows that she has taught for most of her teaching life in middle-class schools, she has been a teacher trainer and she has carried out research.²¹ It would seem that the standards of teacher X_7 are independent of the context in which she now teaches and are more related to the context of her previous experience.

We are not at this stage able to make a definite conclusion as to which of our variables country, working class school or young is dominant. However, it is clear that young teachers, independent of the location of their teaching, make relatively a lower level of conceptual demand and that in general teachers in the country and working class schools also make, relatively, a lower level of conceptual demand. It is likely that as the years go by a young teacher, in general 'benevolent', becomes 'strict' if he/she is in a middle-class school and maintains his/her benevolence if he/she is in a working-class school. This means that the achievement of some groups of pupils is dependent upon the context in which they are taught and/or the experience of teachers. In later chapters²² we will be able to check on these conclusions.

It is difficult to know whether teachers have low expectations of their pupils and so modify their conceptual demands or whether the pupils fail to meet high demands and so the teachers accordingly lower their demands, or both. Further we do not know whether the pupils do not fulfil the expectations of the teachers because they are not interested in school and/or because the teachers have not developed an effective pedagogical practice and so settle for a low level of demand which makes life 'comfortable' for both teacher and taught. Teachers Z_1 , Z_3 , Z_4 have nearly always

taught in schools in the country and therefore have no experience of other kinds of schools and pupils. Teacher Z_2 who is less benevolent than the other three (although less strict than some other teachers) has taught for some years in a large city middle-class school²³ just before the year of our study. Her professional history may also account for her reduced benevolence.

Later analyses²⁴ of the relation between social class and gender and achievement of pupils will show that the pattern of achievement of the pupils of teacher Z_2 indicates that she *must* make some conceptual demand of her pupils.

We shall see that the very 'strict' teacher X_7 in a working-class school produces a relatively high level of achievement in her pupils.²⁵ This leads us to believe that teachers' pedagogic practice is a crucial variable. *A teacher with a sound knowledge of educational psychology and teaching methods (like teacher X_7) improves achievement including that of working-class pupils.* However, at the same time as a later analysis will show *the gap between advantaged and disadvantaged pupils (gender, class) increases.* It would seem that a greater sociological sensitivity on the part of such a teacher would enable such differences to be reduced. This will be a major theme in a future discussion later in the thesis.

We believe that *teachers who make a very low level of conceptual demand have failed to understand the sociological implications of the transmission-acquisition process they are promoting.* Their pupils already disadvantaged when entering the school will be more so in the process of selection which takes place both inside and outside the school.

4. PATTERNS OF ACHIEVEMENT IN A AND U COMPETENCIES IN DIFFERENT TEACHERS' PUPILS

We have argued that differences in teachers marking of *U* questions (benevolent/strict) is an index of the level of conceptual demand of their pedagogic practice. We have found that 'benevolence' in marking is related to age of teacher, class context of the school and location (country). We have presented some evidence to suggest that the teachers who are exceptions, X_5 and X_7 , differ from their set in terms of their training (X_5) and professional career (X_7). We have hinted that there is a relation between the inferred degree of conceptual demand and pupils' achievement. We shall now examine this possibility.

In this analysis we shall look at the relation between teachers and the level of marks their pupils receive. We will be concerned with:

- (a) Marks teachers assigned to pupils in *A* and *U* competencies in the third term.
- (b) Relationship between *A* and *U* marks in the third term, i.e. the *A/U* ratio.
- (c) Progress of the pupils throughout the year, i.e. relationship between marks assigned in the three terms of the year both in *A* and *U* competencies.

We shall examine the teachers' pedagogic practice by comparing the extent to which their scores for *A* competencies approximate to a *J* curve and the scores for *U* competencies approximate to a Gaussian curve. Our justification for these criteria is based upon the analysis we made of the curves of teachers X_3 , X_7 when they concentrate on selected objectives.²⁶

4.1. THIRD TERM ACHIEVEMENT IN A AND U COMPETENCIES

4.1.1. Data

The marks which had formerly been given on a 0-100 scale were as we pointed out before, reduced to a 1-4 scale. The tables in Figure 4.15 and 4.16 summarize the percentage of pupils with a given mark for the third term and for each teacher. At the bottom of each column because of their importance for the analysis the mean of the marks and their skewness are also shown.

The data are not presented in graphs in order to save space and because it is fairly easy, from the values in the tables, to perceive the type of curve each teacher's group of pupils produces in each one of the two types of competencies. Only the percentage of pupils who attain pass level is graphed (Figure 4.17) so as to give a visual picture of pupils' achievement with the different teachers.

4.1.2. Interpretation of Data

The analysis of the values shows that:

- (a) For A competencies only teachers X_3 , X_7 , Z_1 in middle school and no teachers in upper school show a pattern with a trend to a *J* curve as should be expected;²⁷ other teachers show a bell-shaped curve. This can also be inferred from the skewness value: very high for teachers X_7 and Z_1 (respectively -1.16 and -1.42) and also high for teacher X_3 (-.77).
- (b) For A competencies teachers X_3 , X_5 , X_6 , X_7 , Z_1 in the middle school and X_1 in the upper school show the high means of marks we would have expected.
- (c) Failure in A competencies (marks <50%, grades 1 and 2) which we expected to be very low is *very high* for

| TEACHERS AND COMPETENCIES MARKS | X_1 | | X_2 | | X_3 | | X_4 | | X_5 | |
|---|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | A | U | A | U | A | U | A | U | A | U |
| 1 | 0.00 | 17.24 | 6.19 | 20.35 | 0.00 | 7.69 | 1.19 | 11.90 | 0.00 | 1.59 |
| 2 | 25.59 | 37.93 | 32.74 | 57.52 | 3.85 | 42.31 | 14.29 | 47.62 | 3.17 | 68.25 |
| 3 | 58.62 | 44.83 | 52.21 | 19.47 | 38.46 | 46.15 | 67.86 | 35.71 | 57.14 | 23.81 |
| 4 | 13.79 | 0.00 | 8.85 | 2.65 | 57.69 | 3.85 | 16.67 | 4.76 | 39.68 | 6.35 |
| Mean | 2.86 | 2.28 | 2.64 | 2.04 | 3.54 | 2.46 | 3.00 | 2.33 | 3.37 | 2.35 |
| Skewness | .11 | -.49 | -.28 | .38 | -.77 | -.21 | -.33 | .06 | -.04 | 1.18 |

| X_6 | | X_7 | | Z_1 | | Z_3 | | Z_4 | |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| A | U | A | U | A | U | A | U | A | U |
| .85 | 3.42 | 2.14 | 11.76 | 0.00 | 9.77 | 11.76 | 3.27 | 1.77 | 11.50 |
| 12.82 | 27.35 | 7.49 | 47.06 | 3.45 | 34.48 | 33.33 | 65.36 | 52.21 | 42.48 |
| 48.72 | 48.72 | 36.90 | 36.90 | 25.29 | 41.38 | 41.18 | 28.10 | 45.13 | 44.25 |
| 37.61 | 20.51 | 53.48 | 4.28 | 71.26 | 14.37 | 13.73 | 3.27 | .88 | 1.77 |
| 3.23 | 2.86 | 3.42 | 2.34 | 3.68 | 2.60 | 2.57 | 2.31 | 2.45 | 2.36 |
| -.50 | -.21 | -1.16 | .01 | -1.42 | -.10 | -.12 | .75 | .03 | -.34 |

Figure 4.15 - Marks given by teachers of middle school in A and U competencies

| TEACHERS AND COMPETENCIES MARKS | X_1 | | X_3 | | Z_2 | |
|---|-------|-------|-------|-------|-------|-------|
| | A | U | A | U | A | U |
| 1 | 0.00 | 0.00 | 4.03 | 14.52 | 3.64 | 19.09 |
| 2 | 7.41 | 40.74 | 17.74 | 45.16 | 31.82 | 51.82 |
| 3 | 55.56 | 59.26 | 53.23 | 33.87 | 55.45 | 28.18 |
| 4 | 37.04 | 0.00 | 25.00 | 6.45 | 9.09 | .91 |
| Mean | 3.30 | 2.59 | 2.99 | 2.32 | 2.70 | 2.11 |
| Skewness | -.22 | -.38 | -.52 | .12 | -.23 | 0.00 |

Figure 4.16 - Marks given by teachers of upper school in A and U competencies

teachers X_2 (38.93%), Z_3 (45.09%), Z_4 (53.98%) and Z_2 (35.46%).

- (d) For U competencies all teachers show the bell-shaped curve we expected. This curve is however extremely skewed to the left in the case of teacher X_5 who shows a definite trend to an I curve. This teacher is followed immediately by teacher Z_3 . Teacher X_2 's curve is also skewed to the left. An opposite pattern is found for teachers X_1 , Z_4 whose curves are skewed to the right.
- (e) A relative ranking according to mean marks in U competencies, places teachers X_6 and Z_1 in the middle school and teacher X_1 in the upper school at the top with very high means. Teachers X_2 and Z_2 are at the bottom with very low means.²⁸
- (f) Success in U competencies (marks $\geq 50\%$, grades 3 and 4) is very low for teacher X_2 and even for teachers X_5 , Z_2 , Z_3 : less than 31% of the pupils of any of those teachers reached this grade. Success is

PASS GRADE (MARKS \geq 50%)

ACQUISITION
 USE
 () MEAN OF MARKS

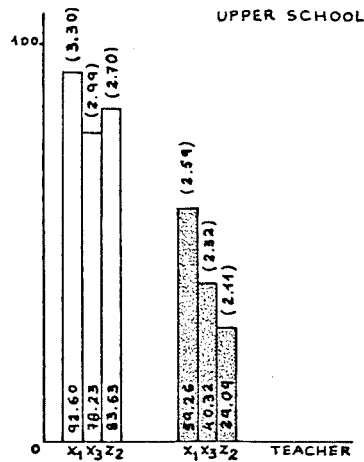
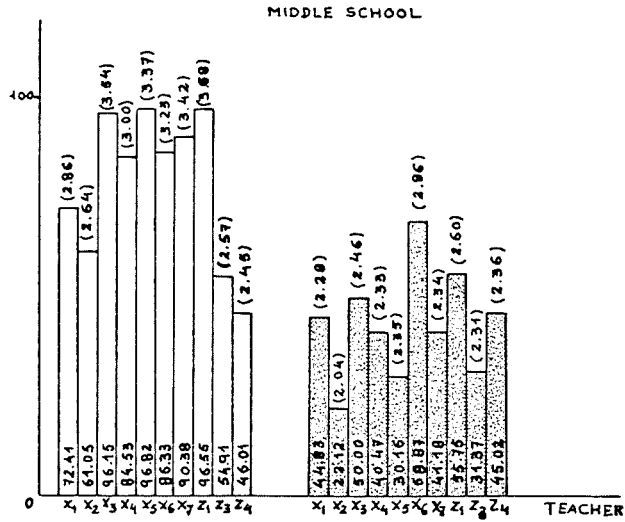


Figure 4.17 - Relation between teacher and achievement: All sample, Middle and Upper school

extremely high for teachers X_6 (69.23%), X_1 (59.26%) and Z_1 (55.75%).

From the above some *conclusions* can be drawn; we present them in the following paragraphs.

4.1.2.1. A competencies

Teachers X_2, Z_2, Z_3, Z_4 failed to bring their pupils to the mastery of the low level competencies entailed in 'Acquisition of Knowledge'. Teachers X_5, X_6 and X_1 (only in the upper school) *to some extent* enabled their pupils to master these competencies. When we consider that *A* competencies represent the minimum level of objectives to be attained and that these competencies should be achieved by the majority of pupils, it is surprising to find that only teachers X_3 (and only in the middle school), X_7 and Z_1 seem to have enabled their pupils to reach the level required; they were the only teachers whose pupils' scores approached to the *J* curve.

However, the success of teachers X_3, X_7, Z_1 is not comparable because these three teachers do not share a common pedagogic practice:

- (a) Teacher Z_1 has a very low level of demand even in *A* competencies²⁹ and therefore the success of her pupils is more apparent than real.
- (b) Teacher X_7 makes a high level of demand even in *A* competencies,³⁰ therefore we have good reason to believe that her *J* curves indicate real achievement of these competencies.
- (c) Teacher X_3 makes an average level³¹ of demand and produces a *J* curve *only* for her middle school class.

The above leaves teacher X_7 as the only one whose general teaching produced scores approaching the J curve. *Teacher X_7 is at the top of the scale ordering teachers according to the degree to which their pupils mastered A competencies.* And this achievement is even more surprising when we consider that teacher X_7 teaches in a working-class school where, according to our findings, we would expect a lower level of achievement.³²

It is interesting to note that teachers X_3 and X_7 were simultaneously involved in the special study concerned with the teaching and evaluation of selected objectives within A and U competencies.³³ Both teachers' pattern of pupils' achievement in A competencies was a J curve in the selected objectives. This may account for their success in the teaching of the whole sample of objectives; the strategies they had to develop to teach the selective objectives may have influenced the whole process of their transmission of knowledge. If this is the case then it was less so for teacher X_3 .

4.1.2.2. U competencies

As we have seen³⁴ we should consider two rates underlying the acquisition of U competencies: the possible learning rate and the demand rate. When there is an equilibrium between the two rates stable curves of the Gaussian curve type appear. The extreme values of skewness we find in some teachers' pupils scores can be interpreted as corresponding to a failure of that equilibrium. On the other hand, because U questions were criterion-referenced³⁵ U marks are not expected to be very high. Very high marks in mixed ability classes would indicate some kind of failure on the part of the teacher. On the other hand the marks should not be very low.

Our analysis with respect to U competencies will be based on these two factors, balance between teachers' demand and pupils' learning. We shall group teachers in three groups as follows.

(a) *Teacher's demand rate higher than pupils' learning rate*

Teacher X_5 level of conceptual demand does not match the process of transmission-acquisition in her classroom, and this occurs although to a lesser degree with teachers Z_3 and X_2 . The process of transmission is not efficient enough to achieve the level of demand these teachers are making which, as we have seen before, was relatively high for teacher X_5 but especially for teacher X_2 . In the case of teacher Z_3 were she not so 'benevolent' her curve would still be more skewed to the left so placing her nearer to teacher X_5 . The fact that teachers X_5 and Z_3 are in working-class schools where a lower achievement is to be expected is likely to account for part of the imbalance. This is not the case with teacher X_2 who is in a middle class school.

(b) *Teachers' demand rate lower than pupils' learning rate*

Teacher X_1 shows that her demand is below the rate of learning of the pupils; the same is evident in teacher Z_4 and to a much lesser extent in teacher X_6 . The high marks of teacher X_1 are certainly partially due to this factor. In the case of teacher Z_4 we noted that she is 'benevolent' in U competencies and that many of her U questions either do not test U competencies or test low level U competencies; both of these factors give rise to relatively high marks but *not high achievement* in U competencies. This is also the case for teacher X_6 whose very high marks cannot be taken as valid because, as we have seen, she is extremely 'benevolent' and some of her U questions either do not call for U competencies

or test low level U competencies.

(c) *Teachers' demand rate similar to pupils' learning rate*

Teacher Z_2 deserves special attention. Although she shows low marks in U competencies the value of the skewness of the marks seems to indicate a balance between the rate of demand and the rate of learning of her pupils. We saw before that she has an average level of demand which however seems to match the learning rate of her pupils. We consider that if the level of demand had been higher the marks would have been lower and if her demand had been lower the marks would have been higher indicating a false high level of attainment of her pupils. A balance seems also to exist in the case of teacher X_4 who shows an average level of demand. Although there is a balance between level of demand and rate of learning in teacher Z_1 her very high marks cannot be taken as a sign of high achievement in U competencies because, as we have seen, she has an extremely low level of conceptual demand.

Teacher X_7 also shows a balance between the rate of conceptual demand and the rate of learning of her pupils and her marks are average. If we consider the high level of demand she makes in U competencies (together with teacher X_3 she is the most demanding) and the fact that she teaches in a working-class school where we would expect a lower level of achievement,³⁶ we see that here again, as for A competencies *teacher X_7 is at the top of the scale which orders teachers according to their effectiveness in enabling pupils to acquire U competencies.* She is immediately followed by teacher X_3 , although this teacher shows a certain degree of imbalance specially in middle school between the level of demand and the rate of learning.

4.2. RELATIONSHIP BETWEEN *A* AND *U* COMPETENCIES

We shall consider another way of looking at pupil's marks to explore patterns of achievement. We shall examine the *A/U* ratio, i.e. the ratio between marks in *A* competencies and marks in *U* competencies. The ratio values are summarized in Figure 4.18.

| | | | | | | |
|--------------------------|----------------------|-------|-------|-------|-------|-------|
| TEACHERS COMPETENCIES | <i>Middle School</i> | | | | | |
| | X_1 | X_2 | X_3 | X_4 | X_5 | X_6 |
| <i>A/U</i> | 1.25 | 1.29 | 1.44 | 1.29 | 1.43 | 1.13 |

| | | | | | | |
|----------------------|-------|-------|-------|---------------------|-------|-------|
| <i>Middle School</i> | | | | <i>Upper School</i> | | |
| X_7 | Z_1 | Z_3 | Z_4 | X_1 | X_3 | Z_2 |
| 1.46 | 1.42 | 1.11 | 1.04 | 1.27 | 1.29 | 1.28 |

Figure 4.18 - Relationship between *A* and *U* competencies

The assumption which lies at the basis of this analysis is that, because *U* questions were criterion-referenced³⁷ *U* marks are not likely to be very high but *A* marks should be high and approaching a *J* curve. Thus the ratio *A/U* should be always higher than 1 and highest for better teachers. This assumption has of course evident shortcomings derived from the discrepancies which we have found between different teachers (e.g. *U* questions which do not test *U* competencies, etc).

With this in mind let us analyse the figures:

- (a) The highest value is for teacher X_7 immediately followed by teachers X_3 (only in middle school), X_5

and Z_1 .

- (b) The lowest value is for teacher Z_4 immediately followed by teacher Z_3 and X_6 .
- (c) The remaining teachers share similar ratios placed at mid distance between lowest and highest ratios.

We can now rank the teachers according to the relationship between the marks in A and U competencies they assigned to their pupils. Figure 4.19 shows that ranking.

| TEACHERS COMPETENCIES | High Ratio | | | | Medium Ratio | |
|--------------------------|------------|-------|-------|-------|--------------|-------|
| | X_7 | X_5 | Z_1 | X_3 | X_2 | X_4 |
| A/U | 1.46 | 1.43 | 1.42 | 1.37* | 1.29 | 1.29 |

| Medium Ratio | | Low Ratio | | |
|--------------|-------|-----------|-------|-------|
| Z_2 | X_1 | X_6 | Z_3 | Z_4 |
| 1.28 | 1.26* | 1.13 | 1.11 | 1.04 |

* Mean of ratios in their middle and upper school classes

Figure 4.19 - Ranking of teachers according to A/U ratios

Based on our previous analyses it is evident that the meaning of any placement on the scale will not be the same for each teacher. Thus for instance teachers Z_3 , Z_4 are placed at the bottom of the scale because they gave low marks either in A or U competencies whereas teacher X_6 is there because she gave high marks in both competencies.

Despite the apparent difficulties in giving an unambiguous meaning to any position on the scale, previous analyses in the chapter give us a principle of interpreting the meaning of any position. As an example, we can concentrate on teacher Z_1 who is placed as one of the first in this ranking and appears therefore as one of the most efficient teachers. However we have good reasons to believe that this teacher should be at the bottom end of the scale. First her ratio does not represent a valid A/U ratio because most of her U questions, as we have repeatedly said, do not test U competencies. This fact by itself should place her in the low ratio group. However, she is very 'benevolent' in A competencies which for her require very elementary knowledge. This explains the high marks in A competencies. On the other hand her marks in what she calls U competencies should be still higher (given that they are mostly A competencies) to follow her pattern of achievement in A competencies. Thus, she should be placed at the other extreme of the ranking as the A/U ratio should have been low.

4.3. PUPIL'S PROGRESS DURING THE YEAR

Finally we shall examine the progress of pupils throughout the year as another index of teacher's pedagogical practice.

Because we improved teachers' criteria in distinguishing A and U competencies we introduced an error when comparing marks of the three terms. As we pointed out before, if a teacher changes her criteria during the year, marks at different times do not have the same meaning. Thus progress throughout the year can be only accurately measured for teachers X_3 and X_7 who maintained the same criteria: for other teachers a measure of this kind will contain a basic error and therefore would be misleading. We will therefore only be able to consider teachers X_3 and X_7 for this analysis.

We will not graph the data because it is easy to visualize the type of curve from the values in the tables. Figures 4.20 and 4.21 show the data.

MIDDLE SCHOOL

| MARKS \ COMPETENCIES AND TERMS | <i>A Competencies</i> | | | <i>U Competencies</i> | | |
|--------------------------------|-----------------------|------------|------------|-----------------------|------------|------------|
| | <i>1st</i> | <i>2nd</i> | <i>3rd</i> | <i>1st</i> | <i>2nd</i> | <i>3rd</i> |
| <i>1</i> | 7.69 | 0.00 | 0.00 | 3.85 | 3.85 | 7.69 |
| <i>2</i> | 38.46 | 30.77 | 3.85 | 11.54 | 26.92 | 42.31 |
| <i>3</i> | 38.46 | 61.54 | 38.46 | 53.85 | 61.54 | 46.15 |
| <i>4</i> | 15.38 | 7.69 | 57.69 | 30.77 | 7.69 | 3.85 |
| <i>Mean</i> | 2.62 | 2.77 | 3.54 | 3.12 | 2.73 | 2.46 |
| <i>Skewness</i> | .03 | .06 | -.77 | -.74 | -.48 | -.21 |

UPPER SCHOOL

| MARKS \ COMPTENCIES AND TERMS | <i>A Competencies</i> | | | <i>U Competencies</i> | | |
|-------------------------------|-----------------------|------------|------------|-----------------------|------------|------------|
| | <i>1st</i> | <i>2nd</i> | <i>3rd</i> | <i>1st</i> | <i>2nd</i> | <i>3rd</i> |
| <i>1</i> | .81 | .81 | 4.03 | 4.03 | 8.87 | 14.52 |
| <i>2</i> | 2.42 | 7.26 | 17.74 | 55.65 | 52.42 | 45.16 |
| <i>3</i> | 67.74 | 54.84 | 53.23 | 37.90 | 34.68 | 33.87 |
| <i>4</i> | 29.03 | 37.10 | 25.00 | 2.42 | 4.03 | 6.45 |
| <i>Mean</i> | 3.25 | 3.28 | 2.99 | 2.39 | 2.34 | 2.32 |
| <i>Skewness</i> | -.18 | -.50 | -.52 | .22 | .16 | .12 |

Figure 4.20 - Pupils' progress of teacher X_3

| COMPETENCIES AND TERMS MARKS | <i>A Competencies</i> | | | <i>U Competencies</i> | | |
|------------------------------------|-----------------------|------------|------------|-----------------------|------------|------------|
| | <i>1st</i> | <i>2nd</i> | <i>3rd</i> | <i>1st</i> | <i>2nd</i> | <i>3rd</i> |
| <i>1</i> | 5.35 | 0.00 | 2.14 | 8.02 | 16.04 | 11.79 |
| <i>2</i> | 13.37 | 16.58 | 7.49 | 44.39 | 58.29 | 47.06 |
| <i>3</i> | 43.32 | 64.71 | 36.90 | 41.71 | 24.06 | 36.90 |
| <i>4</i> | 37.97 | 18.72 | 53.48 | 5.88 | 1.60 | 4.28 |
| <i>Mean</i> | 3.14 | 3.02 | 3.42 | 2.45 | 2.11 | 2.34 |
| <i>Skewness</i> | -.81 | -.01 | -1.16 | -.01 | .18 | .01 |

Figure 4.21 - *Pupils' progress of teacher X₇*

An analysis of these values shows that:

- (a) In *A* competencies teacher *X₃*'s pupils show progress throughout the year in the middle school. The bell-shaped curves of the first and second terms move towards a *J* curve (although not very pronounced) in third term, with mean values increasing throughout the year. In the third term, for upper school pupils, there is a small reduction of the previous progress.

Teacher *X₇*'s pupils show progress although lower achievement occurs in the second term. The pattern in the first and second terms is a bell-shaped curve which is very skewed to the right in the first term. The pattern for the third term is a clear *J* curve. The evolution is therefore similar to the evolution she obtained with respect to the objectives which were the object of our special study.³⁸

We can conclude that *teacher X₇* enabled her pupils to master the whole of *A* competencies as she did in the case of selected objectives. The same cannot be said of *teacher X₃* whose upper school pupils' scores did not achieve a *J* curve.

- (b) For the three terms for both teachers X_3 and X_7 the pattern is always a bell-shaped curve in U competencies.

A fall-off seems to have taken place in teacher X_3 's middle school pupils. She appeared to make a low level of demand in relation to the rate of learning in the first term which progressively tended to a balance by the third term (see Figure 4.20, skewness). Given the 'strictness' of this teacher this fact could be interpreted as her underestimating the capabilities of her pupils in the beginning of the year. Therefore it would seem perhaps inappropriate to conclude that progress did not take place.

In the upper school pupils of teacher X_3 show a stable mark pattern, although marks might well have been higher had this teacher not made such a high level of demand relative to the rate of learning. In fact observation of her syllabus showed that she was making a very high level of conceptual demand.

Pupils of teacher X_7 seem to have fallen-off during the second term although the imbalance between the rate of demand and the learning rate can account for that. This teacher appears to have managed a perfect balance between level of conceptual demand and learning rate for the first and third terms.

It should be noted that the same marks in the three terms or even slightly lower marks in the third term do not mean a regression, because of an increase in the demanded level of U competencies throughout the year, progress did take place.

Here again, as happened in the case of A competencies, *teacher X_7 followed more closely than teacher X_3 the pattern of U competencies found for the selected objectives.*³⁹

The general conclusion of the analysis of pupils' progress is that *teacher X₇ shows a higher competence than teacher X₃ in following the patterns defined by both teachers for the selected objectives*. This is even more remarkable when one considers that teacher X₇ teaches in a working-class school whereas teacher X₃ teaches in a middle-class school.

4.4. FINAL INTERPRETATION

In this section of the chapter we have made an analysis of the marks assigned to pupils in *A* and *U* competencies, the relation between these marks and pupils' progress during the year. This analysis has allowed us to add a further dimension to the characterization of teachers' pedagogical practice. We noted before, the importance of the level of conceptual demand by different teachers. Here we were able to see the extent to which teachers enabled their pupils to develop *A* and *U* competencies.

Our major conclusion is that *there is a great difference between teachers in their competence to enable pupils to master A competencies and to develop U competencies*. It is clear that over and above the question of the competence of a teacher in helping her pupils to attain a given level (the level she has set for the course), is *the social context of the school which is a powerful factor influencing the teachers' pedagogical practice*.

Teachers who teach in working class schools and/or schools in the country tend to be less effective (with the exception of teacher X₇). Teachers who are young and inexperienced not surprisingly, also affect the attainment of their pupils. Based on the relation between *A* and *U* marks, we ranked teachers, although here the unambiguous meaning of this ranking could only be understood by complementing the data with information obtained in the previous analyses in the chapter.

5. THE CHARACTERISING AND RANKING OF THE TEACHERS' PEDAGOGIC PRACTICE

5.1. In many surveys of the relationship between pupils' achievement, social background and school the crucial variable teacher's pedagogic practice is rarely systematically explored. In our case the sample was sufficiently large, the information both objective and subjective⁴⁰ was unusually sensitive. Further the researcher had detailed knowledge of the content of the syllabuses, the context of the schools, the inter-action of the teachers in their assessment of *A* and *U* competencies and the marking of test questions. All these different aspects are now available to enter into our final characterization of the teacher's pedagogic practice. This knowledge is important in itself for it makes us aware of the vital role of the teacher. For the purposes of our study it enables us to interpret the relations between family background, gender, type and location of school and pupils' differential achievement.

Let us start by summarizing the main findings contained in this chapter. First we improved teachers' discrimination in distinguishing between *A* and *U* competencies. Second we reached some important conclusions about their level of conceptual demand. Third we analyzed the patterns of achievement of each teacher's pupils. Let us ignore for a moment the qualitative assessments we made throughout the chapter and concentrate only on the objective measures. On the basis of these we can rank teachers according to three dimensions:

- (a) the measure of their competence in distinguishing *A* and *U* questions
- (b) the measure of their degree of 'strictness' or 'benevolence', i.e. the higher or lower level of conceptual demand
- (c) the measure of their competence in bringing their pupils to develop *A* and *U* competencies

The table in figure 4.22 summarizes these rankings.

| TEACHERS DIMENSIONS | Higher ← → Lower | | | | | | | | | | |
|---------------------------------------|------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| <i>A-U Distinction</i> ¹ | X ₇ | X ₃ | X ₆ | Z ₃ | Z ₄ | X ₁ | X ₂ | X ₄ | Z ₂ | Z ₁ | X ₅ |
| <i>Conceptual Demand</i> ² | X ₇ | X ₃ | X ₂ | X ₅ | X ₁ | Z ₂ | X ₄ | Z ₃ | Z ₄ | X ₆ | Z ₁ |
| <i>A/U Ratio</i> | X ₇ | X ₅ | Z ₁ | X ₃ | X ₂ | X ₄ | Z ₂ | X ₁ | X ₆ | Z ₃ | Z ₄ |

¹When teachers X₃ and X₇ were the reference (even when the mean is the reference these teachers are placed in first place)

²This ranking is of course based in the values for *U* competencies

Figure 4.22 - Ranking of teachers in three different dimensions

The analysis of the table shows that the three groups in which each dimension can be divided (indicated by a thicker vertical line) are not perfectly equivalent although there are teachers who appear consistently in the same group (lowest, mid or highest). Figure 4.23 in which these three measures are graphed complements the table. An analysis of both allows a characterization of teachers. For ease of understanding we represent only two dimensions of the graph; the third axis is below and should be visualized as vertical to the plane defined by the two axes above. Thus we have a tri-dimensional image. As it is difficult to read a three dimensional graph off a two dimensional image the positions will have to be visualized.

Let us first consider the two dimensions - conceptual demand and A/U ratio. In principle the level of conceptual demand should be related to the relation between A and U scores. We would then expect one of the following three situations:

- (a) a teacher is in the above right quadrant
- (b) a teacher is in the left below quadrant
- (c) a teacher is around the centre

Teachers X_2, X_3, X_5, X_7 are in position (a); teachers X_6, Z_3, Z_4 are in position (b); teachers X_1, X_4, Z_2 are in position (c). It is clearly evident that teacher Z_1 is 'out of place', i.e. she cannot make a low level of conceptual demand and *at the same time* have a high A/U ratio; a contradiction which has become more and more evident throughout this chapter. This confirms our previous qualitative (and subjective) judgement.

Let us now consider the third dimension, competence in discriminating between A and U competencies. In principle, one of these three situations should occur:

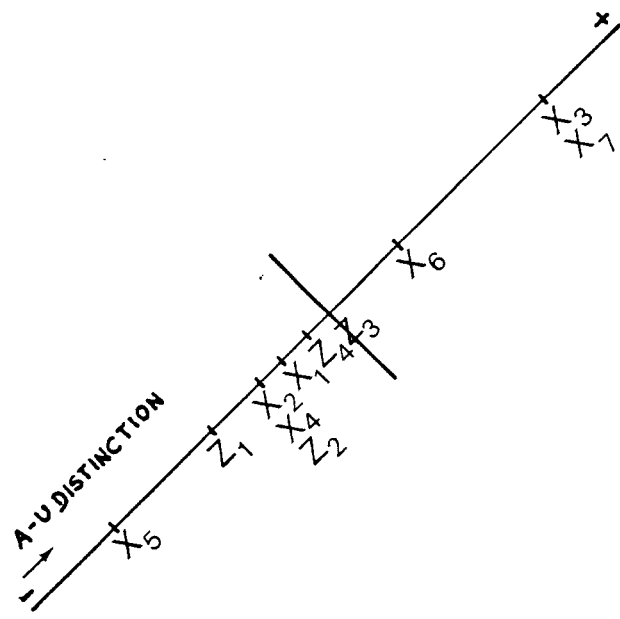
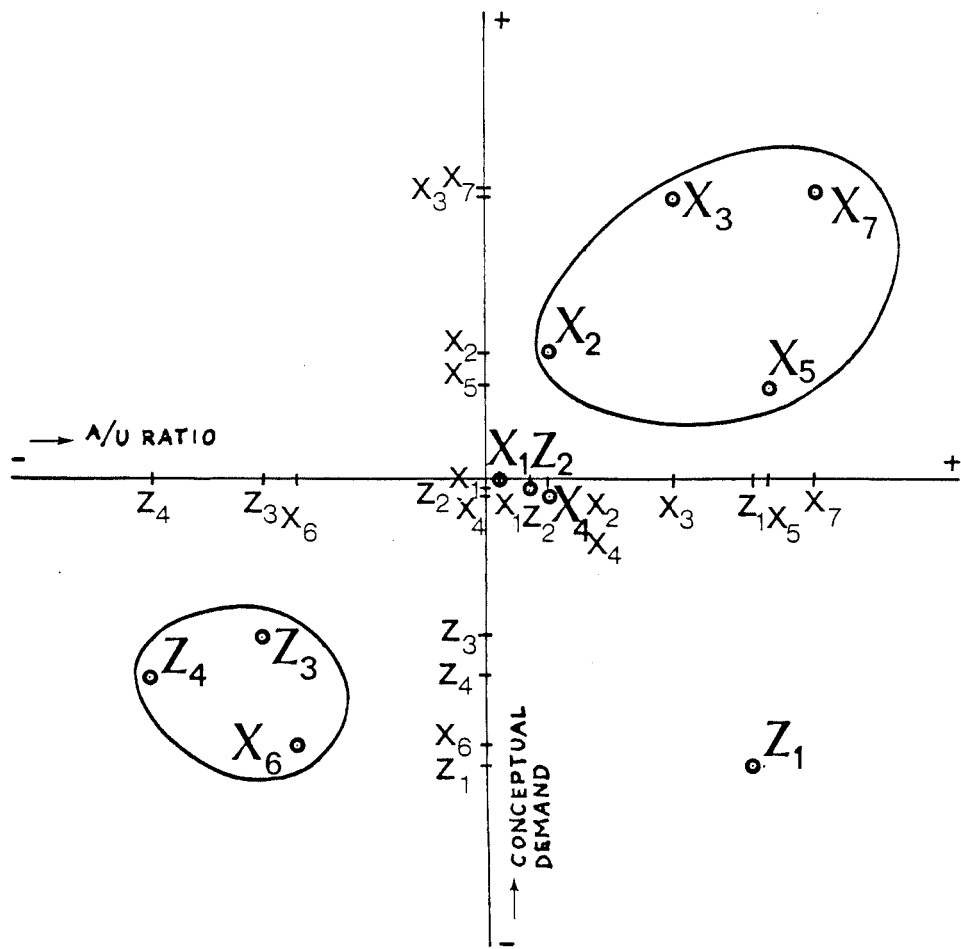


Figure 4.23 - Characterization of teachers through the use of three different measures

- (a) a teacher is placed in the back right sub-ordinate octant
- (b) a teacher is placed in the front left sub-ordinate octant
- (c) the teacher is around the centre

Teachers X_3 and X_7 are in position (a) and teacher X_2 is near to it; teachers Z_3 and Z_4 are near to position (b); teachers X_1, X_4, Z_2 are in position (c). It is clearly evident that teachers Z_1, X_5, X_6 are 'out of place'. This roughly confirms what had been said before.

If we now take into account both quantitative and qualitative assessments, i.e.:

- (a) teacher's conceptual demand
- (b) competence of the teacher in enabling pupils to achieve A and U competencies
- (c) researcher's knowledge of the contents of each teacher's syllabus, the structuring, level, A/U discrimination of each teacher's tests, teachers' discussions at meetings, their professional history and, perhaps much more subjective, knowledge of the teachers through informal relations with them
- (d) information on teacher's pedagogic practice obtained in other chapters.⁴¹

We can now rank the teachers of our sample in a meaningful way. We must point out that the ranking takes into account the social composition of the school; a given level of success in a working-class school is more difficult to attain than the same level in a middle-class school. There is some correspondence in the ranking between the objective scales and this final scale. The final ranking of teachers is shown in Figure 4.24.

| TEACHERS COMPETENCE | ← <i>Max.</i> <i>Min.</i> → | | | | | | | | | | | |
|------------------------|--|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | |
| <i>Scale Number</i> | | | | | | | | | | | | |
| <i>Identification</i> | X_7 | X_3 | X_2 | Z_2 | X_5 | X_1 | X_4 | Z_3 | X_6 | Z_4 | Z_1 | |

Figure 4.24 - *Teachers' ranking according to competence*

The above scale was the one we eventually used when teachers were entered as a variable in the relationship between sociological variables and achievement. We initially started with a 1-5 scale based on our subjective judgement of the teachers and their professional history.

As a result of the first findings of the stepwise regression and the crosstabulation analyses,⁴² it was clear that each teacher's pupils had to be considered a separate sample and therefore a more delicate scale than the original five point scale was required in order that the influence of *each* teacher could be gauged. The final scale is of course subject to errors, however it is the most rationale means of assessing differences in the effectiveness of teachers. We had no alternative but to construct such a scale, based on objective and subjective estimates, once we were aware of *the role of the teacher in concealing the true relationships between sociological variables and achievement*. For example when the middle school sample was treated as a whole the influence of a variable like gender and social class could hardly be noticed; only when each teacher's pupils were treated as a sub-sample could that influence be perceived. We have seen in this chapter *how great are differences between teachers*; for example teachers X_7 and Z_1 , who both teach in working-class schools and who have between them a large proportion of the sample, are at the extremes of the dimension of level of conceptual demand and are at the extremes of our new scale.

5.2. The analysis which we have carried out suggests that *the realised 'competence' of the teacher is strongly related to the school context where he/she teaches*. It is that social context which makes teachers develop courses with a low or high level of abstraction to match what they consider to be attributes of the school population they encounter. A working class school and/or a school in the country acts selectively on the conceptual level of the teaching so as to produce a reduced conceptual demand and *focus* of the pedagogic practice.

It is likely that a young and inexperienced teacher who makes a low level of conceptual demand may become less demanding if he/she teaches in a working class school and/or a school in the country.

If we look at the several dimensions we have considered both in the objective analysis and in the qualitative assessment, we would like to suggest that the level of abstraction selected for a course is directly related to the social context of the school, whereas the competence to enable pupils to attain a *given* level in *A* and *U* competencies is directly related to what is commonly understood as teacher competence. Both selected level of abstraction and competence to bring pupils to a given level are influenced by the social context and the so-called common competencies of the teacher.

Thus, if we consider the teachers' pedagogic competence they may be well trained in the design of a curriculum which entails the necessary level of demand and they may have a sound basis in educational psychology to enable them to transmit effectively the competences to *many* of their pupils, but, as we shall see, such a competence *per se* may widen the difference between disadvantaged and advantaged groups.⁴³ It is only when the teacher is *aware of the role of the sociological context* of teaching that he/she will be able to *take steps to correct the depressing effect*

of that context upon the level of conceptual demand and upon the principles of marking. Such sociological knowledge is a necessary condition for the raising of the level of achievement of working-class children.

It is important to note how the same general syllabuses designed by the Ministry of Education can lead to such a different grading of courses in different schools and with different teachers. Some might claim that these differences are a sign that teaching is responding to the needs of local communities. Indeed in order to accomplish context-specific teaching practice, the above argument has been used for the abolition of national examinations in Portugal.⁴⁴ However this apparently wise measure defended by progressive teachers and educationalists may, according to our findings, *widen the gap between the kinds of teaching children receive in big cities and working-class and/or country schools.* If undiscovered, this gap will legitimate selection procedures for entrance to further education, university⁴⁵ and occupations. A child who steps into a school disadvantaged may leave it still more disadvantaged.

6. NOTES AND REFERENCES

1. We have placed in Appendix IV a sample of the tests given to the pupils and in Appendix II the biographical details of each teacher. The summary statistics of each teacher is in Appendix VIII.
2. We should remark that the term reliability of a teacher is used in this chapter to mean the degree of agreement of a teacher with other teachers with respect to the classification of questions into *A* and *U*.
3. See Chapter two where coding for tests is explained.
4. See details of these meetings in Chapter two on Introduction to the empirical study.
5. Teachers X_3 and X_7 were selected on the basis of the

researcher's knowledge that they were aware of the criteria required by the study. This was because these teachers and the researcher shared in previous research.

6. T. Yamane, 1973.
7. *Ibid.* 6.
8. *Ibid.* 6.
9. A positive 1 was arbitrarily assigned to *A* questions and a negative -1 to *U* questions.
10. See Domingos, A.M. *et al.* 1981, pp. 233-41. See also a filled-in example of a table of specifications in the matrix used by teachers to plan and mark tests in Appendix III, Figure III.1.
11. A sample of tests is presented in Appendix IV, and will provide the reader with a basis for an understanding of our assertion.
12. The highest competencies of the cognitive domain in Bloom's Taxonomy of Educational Objectives.
13. Random factors together with the difficulty of drawing a firm line between *A* and *U* competencies explain how it is that during the meetings all teachers changed their classifications of *A* and *U* questions with respect to a *small* number of their own questions.
14. See classification of all tests by all teachers in 'Base data' referred to before (2.2.1.1.) and presented in Appendix X (for teacher Z_1 see tests 15 and 16 in 1st and 2nd measures). See also the sample of all teacher's tests in Appendix IV, where questions are followed by each teacher's own classification and teacher X_7 's classification.
15. We can now understand how misleading it can be to take one behaviour as a sign of understanding: if the ability to distinguish *A* and *U* questions by teacher Z_1 had been taken as a sign of effective understanding of *A* and *U* competencies, we would have committed a serious mistake.
16. Usually it would be $(N_{jk}-1)$ as the unbiased STD for a normal distribution when estimating from a sample -

- Ibid.* 6.
17. With this normalization, the standard deviation for each answer becomes 1 and comparison between answers becomes meaningful - *Ibid.* 6.
 18. *Ibid.* 6.
 19. See sample for each teacher in summary statistics in Appendix VIII.
 20. See *curriculum vitae* of teacher X_3 in Appendix II.
 21. See *curriculum vitae* of teacher X_7 in Appendix II.
 22. See Chapters six and seven on Gender and Achievement and Social Class and Achievement.
 23. See *curriculum vitae* of teacher Z_2 in Appendix II.
 24. *Ibid.* 22.
 25. This will be developed in the next part of the chapter.
 26. See Chapter three on patterns of achievement in different types of competencies.
 27. *Ibid.* 25.
 28. In analyzing the mean values for U competencies one should remember that even for these competencies, marks were criterion-referenced; a procedure which was deliberately followed (*Ibid.* 25). Had this not been the case, the curves, although following similar patterns, would have been placed more to the right and the means would have been higher.
 29. See second part of this chapter.
 30. *Ibid.* 29.
 31. *Ibid.* 29.
 32. See Chapter seven on Social class and achievement.
 33. *Ibid.* 26.
 34. *Ibid.* 26.
 35. *Ibid.* 26.
 36. *Ibid.* 32.
 37. *Ibid.* 26.
 38. *Ibid.* 26.
 39. *Ibid.* 26.
 40. We are here referring not only to information described in this chapter but information obtained from other parts of the study and described in other

chapters (e.g. Gender and achievement, social class and achievement).

41. *Ibid.* 22.
42. See Chapter five on Quantitative analysis of sociological variables and achievement.
43. *Ibid.* 22.
44. Currently existent in the last year of secondary school only.
45. Although a systematic study has as yet not been carried out, the results of the national exams in the last year of secondary school show that the pupils of big cities and/or middle class schools always have the highest marks; as a consequence, now, more than ever, it is these pupils who are not only over-represented in the University but who have access to high status subjects leading to dominant occupational positions.

7. BIBLIOGRAPHY

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PART II

THE PUPILS

CHAPTER FIVE

QUANTITATIVE ANALYSIS OF SOCIOLOGICAL
VARIABLES AND ACHIEVEMENT

1. INTRODUCTION

1.1. This chapter addresses some of the formal details of the statistical treatment of the data on pupils' achievement and the sociological variables.

When using formal statistical methods and their underlying mathematical assumptions questions arise related to their meaning and use. Some early decisions were taken:

- (a) To use only standard and widely used statistical techniques as the aim of the thesis is not an exploration of applied mathematics or statistics.
- (b) To use the results of statistical analysis as a tool to uncover trends and/or associations to be used as a basis for a more delicate qualitative analysis of the influence of sociological variables.

1.2. The most widely used technique to find initial associations is that of correlation, and the use of multivariate analysis. This implies quantification of variables (dependent and independent) which raises the first difficulty as not all variables are easily amenable to quantification (e.g. father's occupation, gender, teacher, etc.). It was decided from the outset to consider achievement in each of the two types of competencies A and U as dependent variables. Further, the marks given by a pupil's teacher were considered to be meaningful from the point of view of either the absolute value or the relative ranking which could be subjected to normalization should comparison between teachers be required.¹

An attempt was made to use dummy variables for all other variables.^{2,3} This method of dealing with qualitative variables would make it possible, in principle, to overcome some of the restrictions on the use of quantitative methods

with non-directly quantifiable variables. As a matter of fact, it was found that in our particular case the use of dummy variables did not increase our understanding of the behaviour of the sample, nor did it increase the correlations. Further, the increase in the number of basic variables required by this technique would present such a burden to our computer resources that its use could only be justified if it showed indisputable advantages. This was not the case. Therefore, the use of dummy variables was not pursued further.

1.3. Having decided to drop the use of dummy variables, and considering the unavoidable use of quantification for each variable, we gave special attention to relative ranking. In some cases, a marked improvement resulted when the initial quantification (used initially for recording of data) was re-arranged to reflect ranking in a more meaningful way.⁴ After, and for each variable, a polynomial fit was attempted when achievement was regressed with it. No general improvement resulted. This showed indirectly that our results were not very sensitive to the quantitative expression of the ranking used.

1.4. With respect to the mathematical underlying principles of our statistical methods, the most important are those related to assumptions of a linear relationship between variables and to tests of significance. The assumption of linear relations can be accepted for a small enough range of each variable (the range in which a curve can be approximated by its tangent), and this range can, in principle, be extended through a non-linear transformation of the dependent variables. The polynomial approximation to which we have previously referred aimed at the sensitivity of the quantitative ranking in what concerns non-linearity, and allowed us to discard this possible source of error at least with respect to the relationship between each variable and the pupil's achievement.

We gave careful consideration to tests of significance. First of all, any measure of significance implies an underlying probability distribution which has to be inferred from the sample. Usually, a normal distribution is assumed when a first approach and/or preliminary test is performed. Once a probability distribution is assumed, confidence tests for a pre-defined degree of acceptance⁵ can be made. This usual practice is as good as the extent to which the real sample conforms with the assumed probability distribution, and this is another probability. On the whole, the global confidence test may not be as reliable as the numbers would suggest. As a matter of fact, if a number is found for the significance, either it has some practical meaning or not. A detailed research of this point would extend well beyond the aim of the thesis and therefore was not undertaken. We therefore assumed that it does have a practical meaning.

Thus, significance tests were made and the numbers used as a guide for inferring or rejecting underlying relations to be further scrutinized. Our attitude attempts to balance the views of leading schools of social scientists. In this respect we would like to stress our belief that currently available and used statistical techniques are not well suited to quantitative analysis in our field. Their indiscriminate use is likely to reinforce the criticism from that school of social scientists which rejects any use of mathematical tools, which is also certainly an untenable view. Although we would not want to rely exclusively upon a case study type of approach, we also reject total reliance on currently available quantitative methods. Recent trends in statistical treatment of data in the social sciences, mainly by the French school, support this view which can be inferred from work in this field.^{6,7}

2. ANALYSIS OF DATA BY STEPWISE REGRESSION

2.1. SOME THEORETICAL CONSIDERATIONS

2.1.1. For the first search of predictive variables of pupil's achievement the practice of using stepwise regression was followed. Stepwise regression has become fairly common since the use of digital computers allowed its almost automatic use. The underlying idea of stepwise regression is to assume a linear relationship between the dependent and the independent variables and to find the coefficients in that relationship which give the best fit in the least squares sense. When all variables are used, the result is equivalent to a multilinear regression on all variables. Stepwise regression may be viewed as a multilinear regression on a restricted set of independent variables, its aim being to find those independent variables which explain most of the observed behaviour. To find these independent variables a step-by-step procedure is used which is essentially equivalent to the addition of one independent variable in the regression at each step. The way in which this variable is found depends on the criteria chosen.

Since the main aim of stepwise regression is to discard those independent variables whose predictive value is minor, the criteria used to introduce a new variable in the stepping procedure may become critical. This is so because the increase in predictability which results from the inclusion of a new variable depends on all the variables already introduced. Because of this, a complete stepwise regression would require the consideration of all possible combinations in the order of introduction of variables. It must be noted that when all variables are included the coefficients in the regression are the same whatever the order in which they were entered, but when all the variables are not yet introduced the results depend on the order in which they are entered.

To consider all possible combinations would be an impractical task not only from a computing point of view but also because of the complexity of analysing the intermediate results. Therefore, stepwise regression is used in combination with some steering rules based on statistically meaningful criteria.

2.1.2. To explain the criteria, let y be the dependent variable and \hat{y} the regression function which exists at the end of step i :

$$\hat{y} = a_0 + a_1x_1 + a_2x_2 + \dots + a_ix_i$$

$x_1 \dots x_i$ being independent variables (predictors) already introduced.

At step $i + 1$ the regression would be:

$$\hat{y} = a_0 + \dots + a_ix_i + a_{i+1}x_{i+1}$$

The criteria used to choose the predictor x_{i+1} may be, for example:

- (a) To choose the x_{i+1} whose partial correlation with \hat{y} is maximum, when $x_1 \dots x_i$ are already considered (this means to choose the one which gives the maximum increase in explanation when the previous ones are considered).
- (b) To choose the one which produces the greatest increase in the multiple correlation between y and the selected predictors.
- (c) To choose the one which makes the greatest decrease in the residual sum of squares.

- (d) To choose the one whose coefficient would have the greatest significance in the F-statistic sense.

All the above criteria used to choose the predictor to enter at step i are mathematically equivalent.

The procedure above for choosing x_{i+1} is called forward stepping because it starts with the predictor with the largest correlation coefficient with the dependent variable and proceeds by adding a predictor at a time. However a backward stepping may also be used. In this case, we start with a regression on all variables and proceed by deleting one by one using criteria similar to the ones already referred to but in the sense of deleting the least significant predictors. Forward and backward criteria produce generally different intermediate results. This is especially so when the dependent variable is an approximate linear function of the difference of two predictors each of which have a low correlation with the dependent variable.⁸ Both criteria can be used in combination forming a hybrid scheme.

In this thesis, forward stepping was first used. It is also the most common in statistical packages. Later on, the hybrid scheme as described by Jennrich⁹ was used. In this scheme each step corresponds to the removal or entry of a predictor. It proceeds as follows:¹⁰

- (a) Remove the predictor which is responsible for the least increase in the residual sum of squares
- (b) Enter the predictor that produces the greatest decrease in the residual sum of squares

Rule (b) is executed only when it is not possible to execute rule (a).

In both cases, a pre-fixed threshold for removal or

addition of predictors is used, allowing a test for the robustness of the predictors entered by allowing, for instance, more or less deletions.

2.2. RESULTS FOR SUMMARY STATISTICS AND CORRELATIONS

Stepwise regression is preceded by the computation of the matrix of the sums of cross products of deviations from the means:

$$(1) \quad A_{ij} = \sum_{t=1}^N (X_{ti} - \bar{X}_i) (X_{tj} - \bar{X}_j)$$

where X_{ti} is the observation of variable X_i for $i=1, M$ and $t=1, N$, M being the number of variables and N the number of observations.

In (1) \bar{X}_i is the mean of variable X_i and is given by:

$$(2) \quad \bar{X}_i = \frac{1}{N} \sum_{t=1}^N X_{ti}$$

The matrix of correlations is related to A_{ij} by

$$(3) \quad R_{ij} = A_{ij} / \sqrt{A_{ii} \cdot A_{jj}}$$

Although the numerical computation of the sums of cross products seems to be quite straightforward with a digital computer, care must be exercised due to the possible occurrence of round-off errors, especially when the sample is large. These errors originate in the finite number of digits used by the computer when carrying out the computations. Further, if some values are missing for one variable, say X , those values cannot be entered and

therefore that case drops out when computing the cross-products (or the correlation) involving X. This effect may be significant because for the same sample, some correlations are based on more cases than others.

To check numerical accuracy, means and standard deviations were computed directly from the table of summary statistics and also from the values obtained from the matrix of cross-products, using in both cases single and double precision arithmetics. Numerical results for all variables were similar in all cases.

The summary statistics and the correlations for the middle and the upper school are presented in the tables of Figures VIII.1 and VIII.2 in Appendix VIII. Those for each teacher within the middle and the upper school are presented in the tables of Figures VIII 3 and VIII.4 in Appendix VIII.

The tables for summary statistics give the number of cases and percentages for each value of the variable and also the total number of cases, mean, standard deviation, skewness and kurtosis for each variable. It must be noted that in summary statistics the father's and mother's occupation follow a scale 1-12 which for purposes of correlation was converted to 1-9 to give them a more meaningful ranking.¹¹

2.3. NUMERICAL COMPUTATION OF STEPWISE REGRESSION

Stepwise regression was computed using first unnormalized variables and later on by normalizing variables using the standard deviation. If X_i are the initial variables, the normalized ones become

$$(4) \quad Z_i = \frac{X_i - \bar{X}_i}{\sqrt{\sum_m (X_m - \bar{X}_m) / N_i}}$$

where \bar{X}_i is the mean of X_i and N_i the number of observations of X_i .

With this normalization, Z_i has zero mean and unit variance. Furthermore, its matrix of cross-products becomes identical to the one for correlations. The normalization changes neither the multiregression coefficient nor the order in which the variables are entered. The advantage of its introduction resides in the easier way of interpreting the results. In fact, the values of normalized variables are comparable and therefore their coefficients in the regression give a quantitative idea of their importance and sense of variation. In the new variables, the regression has the form:

$$(5) \quad y = \sum_i a_i z_i$$

with y expressing the normalized dependent variable.

For the computations, the dependent variable was either A competencies or U competencies, the other being deleted because it would make no sense to our study to include it as a predictor. This is so because they are both dependent variables and neither should be used as predictor for the other. Also, as could have been expected, they are correlated between themselves well above the correlation with other variables. For the same reason, global achievement was not considered either. Fifteen predictors were used for both Acquisition and Use.

As mentioned previously, we may set pre-defined levels related to the significance of each predictor to allow it to be entered or removed. Basically, a variable had to attain a minimum level of significance to be allowed to enter and had to be under a certain level to be deleted. Before choosing these levels, the effect of their variation was assessed and the result was to have some changes in the 'later' variables entered. However, it was found that

approximately five predictors accounted for most of the explanations and usually the first three would not change when making addition and deletion more strict. Therefore, thresholds for entering-deletion were chosen to allow an approximate ranking of ten variables. Of these, the first 3-5 would not change by changing these thresholds. The others could have changed but because they would only contribute a small amount to the multiple correlation coefficient it was not worth attempting to rank them in a more precise way. The same thresholds were used for all tests reported. These are summarized in the tables of Figures IX.1, IX.2 and IX.3 in Appendix IX.

Each table gives the summary results and shows, for each step, the multiregression coefficient, the F statistic and the coefficient which the entered variable would have if the regression stopped with it. The next column gives the standard deviation for the previous coefficient followed by the significance level for the whole regression up to and including the entered variable. The last column is a reference parameter which is -1 for an entered variable and +1 for a deleted one. The significance level is based on the F distribution and has the usual meaning.¹²

As previously stressed, all these measures have underlying assumptions about the probability distribution of the population and presume the existence of linear relations. Once the whole procedure of stepwise regression is based on them, reference to the significance level has a meaning. In simple terms, the number shown is equivalent to an uncertainty about the multiple regression, being the result of pure chance. Following a widespread view, we rejected inferences based on more than $\sim 5\%$ uncertainty.

2.4. ANALYSIS OF RESULTS

2.4.1. As can be seen from the tables, stepwise regression on *upper school* gives a final multiple regression with five predictors similar for *A* and *U*, with the same criteria for addition and deletion. Final multiple regression is also at a similar level. Significance level is fairly good for both. Though similar on a global predictive level, the predictive variables are somewhat different. *Acquisition* is associated with parents' education and occupations and the influence of school area. *Use* is associated with father's qualification and repetition, with gender giving only a marginal increase in values.

For the *middle school*, whose sample is so large as to almost remove any effect of chance, there is a strong difference between global levels of multiple regression when *A* or *U* are considered: .40 for *A* and .29 for *U*. In addition, the first five predictive variables entered are not very different. For *Acquisition* it seems that, apart from the influence of the school, the most striking influence is the teacher. Further, three variables only (school type, school area and teacher) give a global multiple regression of .37 with the following nine variables increasing this value by .03 only. For *Use* the teacher comes in first place with father's qualification, gender and school giving some increase in values; the global multiple regression is smaller than for *A*.

To gain further insight, stepwise regression for the subset of pupils of each teacher was performed. For each subset, correlations were found (referred to in paragraph 2.2.) and stepwise regression performed. Results for stepwise regression are shown in Appendix IX (Figures IX.1, IX.2 and IX.3) and are condensed in the tables of Figures 5.1 and 5.2. For ease of comparison, the initial groupings (all middle school and all upper school) are also included.

| | | Whole sample | | X_1 | | X_2 | | X_3 | | X_4 | |
|---------------|--------|--------------|-----|-----------------|-----|-----------|-----|-----------------|---|----------|-----|
| | | Var. | R | Var. | R | Var. | R | Var. | R | Var. | R |
| Acquisition | 1 | Sch.Type | .17 | F.'Qual. | .45 | Sib. | .28 | Not significant | | M.'Sch. | .22 |
| | 2 | Sch.Area | .29 | M.'Qual. | .49 | M.'Qual. | .38 | | | Gend. | .30 |
| | 3 | Teach. | .37 | M.'Occ. | .54 | Sib.P. | .45 | | | M.'Occ. | .34 |
| | 4 | Gend. | .38 | Rep. | .59 | M.'Occ. | .46 | | | F.'Occ. | .35 |
| | 5 | F.'Qual. | .39 | M.'Sch. | .63 | F.'Occ. | .46 | | | N.S. | |
| | Tot N. | 12 | .40 | 6 | .64 | 9 | .49 | | | 4 | .35 |
| Use | 1 | Teach. | .16 | Not significant | | M.'Qual. | .22 | Not significant | | M.'Qual. | .24 |
| | 2 | F.'Qual. | .21 | | | Sib. | .28 | | | M.'Occ. | .27 |
| | 3 | Gend. | .23 | | | Sib.P. | .33 | | | F.'Occ.* | .28 |
| | 4 | Sch.Area | .24 | | | Prim.Sch. | .36 | | | F.'Qual. | .34 |
| | 5 | Sch.Type | .28 | | | M.'Sch. | .37 | | | N.S. | |
| | Tot N. | 13 | .29 | | | 10 | .41 | | | 4 | .34 |
| Number pupils | | 1,059 | | 29 | | 113 | | 26 | | 84 | |

* Not significant by itself, significant only on the whole of variables entered

Figure 5.1 - Summary of stepwise regression results: whole Middle School and Middle school separated by teacher

| | | X_5 | | X_6 | | X_7 | | Z_1 | | Z_3 | | Z_4 | | | |
|---------------|---------|-----------------|-----|-------------|-----|----------|-----|-----------------|-----|-----------------|-----|----------|-----|-----------|-----|
| | | Var. | R | Var. | R | Var. | R | Var. | R | Var. | R | Var. | R | | |
| Acquisition | 1 | M.'Qual.* | .19 | M.'Sch. | .19 | Gend. | .19 | Not Significant | | Not Significant | | M.'Qual. | .24 | | |
| | 2 | F.'Qual. | .31 | F.'Sch. | .24 | M.'Qual. | .23 | | | | | F.'Qual. | .25 | | |
| | 3 | Gend. | .36 | Sib. | .27 | Sib.P. | .25 | | | | | Not Sig. | | | |
| | 4 | Sib. | .40 | F.'Qual. | .30 | F.'Occ. | .26 | | | | | | | | |
| | 5 | Prim.Sch. | .42 | M.Occ. | .32 | Rep. | .26 | | | | | | | | |
| | Tot. N. | 5 | .42 | 6 | .33 | 7 | .27 | | | | | 2 | .25 | | |
| Use | 1 | Not Significant | | M.Sch. | .18 | Gend. | .33 | Gend. | .20 | Gend.* | .15 | M.'Sch.* | .14 | | |
| | 2 | | | Not Signif. | | F.'Qual. | .40 | F.'Sch. | .25 | F.'Sch. | .25 | Sib.Pos. | .20 | F.'Qual.* | .20 |
| | 3 | | | | | M.'Sch. | .42 | F.'Occ. | .28 | M.'Sch. | .23 | F.'Occ. | .27 | | |
| | 4 | | | | | F.'Occ. | .43 | Prim.Sch. | .29 | F.' Occ | .25 | N.S. | | | |
| | 5 | | | | | Sib. | .43 | Sib. | .31 | | | | | | |
| | Tot. N. | | | | | 1 | .18 | 11 | .45 | 10 | .35 | 4 | .25 | 3 | .27 |
| Number pupils | | 63 | | 117 | | 187 | | 174 | | 153 | | 113 | | | |

* Not significant by itself, significant only on the whole of variables entered

Figure 5.1 (cont.)

| | | Whole sample | | X_1 | | X_3 | | Z_2 | |
|---------------|----------|--------------|-----|---------------------------|-----|-----------|-----|-----------|-----|
| | | Var. | R | Var. | R | Var. | R | Var. | R |
| Acquisition | 1 | M. 'Qual. | .27 | Not significant ↑ ↓ | | Sib. | .18 | F. 'Occ. | .36 |
| | 2 | Sch.A. | .32 | | | F. 'Occ. | .24 | M. 'Occ. | .41 |
| | 3 | F. 'Occ. | .34 | | | M. 'Occ. | .27 | Gend. | .45 |
| | 4 | M. 'Occ. | .36 | | | Sib.Pos. | .29 | M. 'Qual. | .46 |
| | 5 | Sib. | .37 | | | Rep. | .31 | Rep. | .47 |
| | Tot N | 12 | .39 | | | 6 | .32 | 11 | .49 |
| Use | 1 | F. 'Qual. | .31 | F. 'Occ. | .50 | F. 'Occ.* | .17 | F. 'Qual. | .38 |
| | 2 | Rep. | .35 | M. 'Sch. | .56 | Rep. | .24 | Gend. | .42 |
| | 3 | M. 'Occ. | .37 | F. 'Qual. | .59 | Sib.Pos. | .26 | Rep. | .47 |
| | 4 | Gend. | .38 | F. 'Sch. | .62 | M. 'Occ. | .28 | M. 'Qual. | .49 |
| | 5 | F. 'Occ. | .39 | Sib. | .63 | Sib. | .30 | M. 'Occ. | .50 |
| | Tot N | 13 | .40 | 5 | .63 | 5 | .30 | 10 | .51 |
| Number pupils | | 261 | | 27 | | 124 | | 110 | |

* Not significant by itself, significant only on the whole of variables entered

Figure 5.2 - Summary of stepwise regression results:
whole Upper school and Upper school
separated by teacher

For reasons already explained, only the first five variables entered were retained (sometimes less whenever their level of significance was below $\sim 5\%$). The global influence of the others may be assessed by the last row which gives the total number of variables entered (within the set level of significance) and the global multiple regression thus obtained.

For each variable entered, the multiple regression up to and including that variable only is retained. As can be seen from the tables, beyond the fifth variable increase in explanation is marginal with minor exceptions.

When the results are seen from this perspective the first striking effect is the loss of significance for one competence and not for the other. This loss of significance could, at first glance, be attributed to the low number of pupils in each teacher's sample. However, it seems more appropriate to search for an explanation at a deeper level as comparison of A for teachers X_7 and Z_1 suggests. If we consider the upper school pupils, it can be noted that the subset corresponding to teacher X_1 has no significant variable in A and a significant increase in multiple global correlation in U when compared to the whole sample; teacher X_3 's subset shows a decrease in A and U and teacher Z_2 's subset shows an increase in A and U in multiple global correlation.

The results of this division in subsets (even without any further analysis with respect to the predictors entered) strongly support the hypothesis of underlying structures which do not show up when *all* pupils are considered together. A close examination of the subsets also reveals that, for some, uncertainty tends to a minimum with the number of entered variables and then rises again if more variables are entered. This observation stresses the importance of considering groups of variables if a deeper understanding is to be obtained.

2.4.2. Reviewing results obtained so far we may notice that A and U competencies display different behaviour. Further if we consider, for example, the A competencies for middle school, with all pupils aggregated we note that three predictors - school type, school area and teacher - give a global multiple correlation of .37. For any subset formed, in which the teacher is the same, all three variables become constant and drop from the predictors. The effect here is to increase the global level of multiple correlation in A for teachers X_1, X_2, X_5 to decrease it for X_4, X_6, X_7, Z_4 with teachers X_3, Z_1, Z_3 losing all significant variables. This peculiar behaviour certainly has a deeper meaning. In order to understand this behaviour, we shall begin by reviewing some basic ideas.

First of all, even though one and only one school type and one school area corresponds to each teacher, the reverse is not true, which means that for the whole sample aggregated these variables can be considered independent.¹³

Secondly, the teacher is really a special variable because even when this variable is suppressed as a pure sociological variable, a direct effect of her existence still remains because pupils's marks were given by her and these marks are the dependent variable. This effect, it must be stressed, exists only because the teacher is not a perfect being giving marks in a wholly objective way. Since the teacher, in this respect, behaves as an imperfect measuring device, we may expect the marks given by her to reflect her own pedagogical practice: lower or higher conceptual demand, competence to bring pupils to attain a given level, etc. when compared with other teachers.

Taking this into account we must expect a different behaviour from each subset reflecting the specific influence of the teacher. It is because this was recognized earlier that we conducted the detailed research on teachers already reported.¹⁴ These results will be taken into

account in the ensuing analysis.

For the sake of the analysis, let us now assume that the teacher was totally objective in the awarding of marks, so as to allow us to consider the dependent variable (A or U) as a completely objective measure. This idealization allows us to separate clearly in the teacher her role of giving marks from her role of teaching. It is this sociological role of teaching which we intended to capture with the variable called *Teacher*.

Let us now consider that when all pupils are aggregated the results would give the reference level or the expected behaviour if an infinite number of cases was considered. With this reference set in mind, we may now attempt to interpret the behaviour of each subset. To do so, let us again consider, for the subset, two extreme behaviours:

- (a) the teacher is the dominant variable and the one structuring the relationships in the sample.
- (b) the role of the teacher is irrelevant or at least not an important variable.

With these two extremes in mind we may expect that if a stepwise regression is performed on a sample whose teacher is of type (a), no significant variables will appear or, at least, that a significant drop in the multiple correlation would occur; if the teacher is of type (b) an opposite trend must be expected because masking effects present in the whole sample become reduced in the subset or at least a great change from the whole sample is not to be expected. As can be seen from this conceptual example, the observed behaviour may have a deeper sense. To uncover it, we must now take into account the fact that no real teacher or sample would exactly conform to these extreme limits, and that

intermediate behaviour is likely to exist.

So far, we have not yet considered other variables and their interplay. For instance, if the teacher is of type (b) and the stepwise regression on the subset shows significant multiple correlation, the variables entered should reveal the underlying structure sought in the sample.

The conceptual framework for analysis of results of the stepwise regression on the subsets formed by the pupils of each teacher may now be summarized in the schematic table of Figure 5.3, where use is made of the previous information¹⁵ about the teachers. To make the analysis simpler the level of conceptual demand is the only characteristic of the teachers considered here. For further reference, the first two columns were given numbers allowing a synthetic identification of the main groups of classification. For example, we would say that results for teacher X_7 and Acquisition are type 1.2 and for the same teacher and Use they are type 1.3. Where the teacher's conceptual demand is low (3) the underlying structure would be unlikely to be the teacher; yet, as we already know, other characteristics of a teacher can maintain her as the underlying structure.

With this pre-classification we may look now for the type of variables entered and their meaning. In this respect, it seems more meaningful to group them under the three main categories of *School*, *Family* and *Teacher*. The results of this classification are shown in the tables of Figure 5.4 for middle school and Figure 5.5 for upper school. The tables also show the dominant variables for each sample as given by the variables entered.

| TEACHER'S DEMAND | VARIATION IN GLOBAL MULTIPLE CORRELATION IN TEACHER'S SUBSETS RELATIVE TO TOTAL SAMPLE | UNDERLYING STRUCTURE |
|-----------------------|--|--|
| 1 HIGH | 1 No significant variables | Teacher/School or unknown |
| | 2 Decreases but still significant variables | Teacher/School and Entered variable(s) |
| | 3 Increases | Entered variable(s) |
| 2 INTERMEDIATE | 1 No significant variables | Teacher/School or unknown |
| | 2 Decreases but still significant variables | Teacher/School and Entered variable(s) |
| | 3 Increases | Entered variable(s) |
| 3 LOW | 1 No significant variables | Teacher/School or unknown |
| | 2 Decreases but still significant variables | Teacher/School and Entered variable(s) |
| | 3 Increases | Entered variable(s) |

Figure 5.3 - *Conceptual framework for analysing the results of stepwise regression in the subsets of teachers*

| TEACHER | COMP. | TEACH. ' TYPE | STRUCTURE | DOMINANT VARIABLES | OBSERVATIONS |
|---------|-------|---------------|------------------------------|---|---|
| X_1 | A | 2.3 | Family | F. 'Qual., M. 'Qual. M. 'Occ., Rep. | Small sample Strongly marked Reg. |
| | U | 2.1 | Teacher/School | No significant variables | Small sample |
| X_2 | A | 2.3 | Teacher/School and Family | Sib, M'. Qual. Sib. P. | |
| | U | 1.3 | Family | M. 'Qual., Sib. Sib. P. | Marked Reg. |
| X_3 | A | 2.1 | Teacher/School | No significant variables | Small sample |
| | U | 1.1 | Teacher/School | No significant variables | Small sample |
| X_4 | A | 2.2 | Teacher/School and Family | M. 'Sch., Gend. M. 'Occ. | |
| | U | 2.3 | Teacher/School and Family | M. 'Qual., M. 'Occ., F. 'Occ., F. 'Qual. | |
| X_5 | A | 2.3 | Teacher/School and Family | M. 'Qual., F. 'Qual., Gend., Sib. | |
| | U | 1.1 | Teacher/School | No significant variables | |
| X_6 | A | 2.2 | Teacher/School and Family | M. 'Sch., F. 'Sch. Sib., F. 'Qual. | |
| | U | 3.2 | Teacher/School | M. 'Sch. | |
| X_7 | A | 1.2 | Teacher/School | Gend., M. 'Qual. | Low Reg. |
| | U | 1.3 | Family | Gend., F. 'Qual. | Strongly marked Reg. |
| Z_1 | A | 3.1 | Teacher/School | No significant variables | |
| | U | 3.3 | Teacher/School and Family | Gend., F. 'Sch., F. 'Occ. | |
| Z_3 | A | 2.1 | Teacher/School | No significant variables | |
| | U | 3.2 | Teacher/School and Family | Gend., Sib. P., M. Sch. | |
| Z_4 | A | 2.2 | Teacher/School | M. 'Qual. | Low Reg. |
| | U | 3.2 | Teacher/School and Family | M. 'Sch., F. 'Qual., F. 'Occ. | |

Figure 5.4 - Classification of each teacher's sub-sample on the basis of stepwise regression results: Middle school

| TEACHER | COMP. | TEACH. ' TYPE | STRUCTURE | DOMINANT VARIABLES | OBSERVATIONS |
|---------|-------|---------------|---------------------------|-------------------------------------|--------------------------------------|
| X_1 | A | 2.1 | Teacher/School | No significant variables | Small sample |
| | U | 2.3 | Family | F.'Occ.,M.'Sch.,F.'Qual. F.'Sch. | Small sample Strongly marked Reg. |
| X_3 | A | 2.2 | Teacher/School and Family | Sib.,F.'Occ.,M.'Occ. | |
| | U | 1.2 | Teacher/School | F.'Occ.,Rep. | Low Reg. |
| Z_2 | A | 2.3 | Family | F.'Occ.,M.'Occ.,Gend. | |
| | U | 2.3 | Family | F.'Qual.,Gend.,Rep. | Strongly marked Reg. |

Figure 5.5 - Classification of each teacher's sub-sample on the basis of stepwise regression results: Upper school

3. CONCLUSION

The quantitative results for correlations, further exploited through stepwise regression cannot be taken as definitely conclusive in a quantitative sense because of balancing influences among some variables, as may be seen from the signs of their regression coefficients. This may be partially due to somewhat equivalent variables in the sense that they capture different aspects of the same underlying sociological structure. This must not be understood as meaning that this quantitative approach is useless. On the contrary, *it points out clearly the dominant influences of family and teacher and unveils a role for gender* which only proved to be important when the whole sample was divided into subsets by teacher.

The exact nature of these relationships cannot be pursued in much more depth with such unsophisticated tools as correlations and stepwise regression. They are too crude for a deeper level of detail. *Once the main trends have been identified we must use a more disaggregating analysis on the main variables identified: teacher and school, social class, gender.*

To do so, the next step will be to use crosstabulation. The justification for crosstabulation is simple: for each crosstabulation table there corresponds one and only one correlation; for a given correlation value corresponds an infinite number of possible crosstabulations. Because a search through all the crosstabulations between variables for which data were collected would be an impossible task due to their number, the present use of stepwise regression had its whole *justification* in directing that search. At another level it may be stated that the use of crosstabulations (for two or more variables) will avoid the limitations of assumptions regarding linear relationships among variables.

It should be noted that *results of stepwise regression have other important limitations* derived from the fact that two or more variables can have the same or similar correlation values. In this case one of them is taken in the stepwise regression and the other (or others) do not appear because in the following step that second variable does not give any additional explanation. The consequence is that the second variable appears to be an unimportant variable, i.e. at first glance that variable seems to have no influence on achievement, when in fact its influence is equivalent to the first. This of course is also true when differences in correlation of variables are very small. This is very often the case with the variables father's and mother's qualification and occupation. One of them is chosen in the computing process, the one with a higher correlation (sometimes almost the same) or the one which is in the first place if they have the same correlation, and the others are left out or left to later steps because different variables are taken up by the computer. This can be detected through the analysis of the matrices of correlations (paragraph 2.2.). This phenomenon can be checked by performing a stepwise regression while deleting the variable from the two with the same or very similar correlation which had been chosen by the computer: the second will then appear with all its importance. We in fact, undertook such a procedure.

The importance of taking the above into account when analyzing results of stepwise regression, and when drawing conclusions from them to unveil relations between sociological variables and achievement, is evident. *For example, when we see in our tables that father's qualification is important in explaining differential achievement, the other three closely related sociological variables - father's occupation and mother's qualification and occupation - have in general a similar degree of importance though sometimes this is not evident in the tables.*

Finally we must point out that whilst we have been able to see the value of the stepwise regression analysis both at the level of the whole sample and in particular at the level of each sub-sample we should also be aware of the limitations of this form of analysis. What we shall do in the subsequent chapters, in order to obtain a *more delicate analysis of the complexity of the inter-actions*, is to introduce a procedure to assist us in identifying patterns of similarity and difference. Our procedure will entail the use of both quantitative and qualitative forms of analysis.

4. NOTES AND REFERENCES

1. See Chapter four on Teacher's pedagogical practice.
2. See N. Nie *et al.* 1975.
3. See T. Yamane, 1973.
4. See Chapter two on the Introduction to the Empirical Study.
5. This acceptance level expresses the degree, in probabilistic terms, that the results found are due to chance.
6. See P. Cibois, 1980.
7. See L. Lebart, 1982.
8. See R. Jennrich, 1977.
9. *Ibid.* 8.
10. *Ibid.* 8.
11. *Ibid.* 4.
12. *Ibid.* 3.
13. This is so because in the whole sample there is more than one teacher and more than one school area corresponding to each school type. There is also more than one teacher and one school type corresponding to each school area.
14. *Ibid.* 1.
15. *Ibid.* 1.

An Additional Note on the Statistical Significance of Crosstabulations

Crosstabulation techniques may be viewed as a first step to discover relations among variables through association, and as a quantitative assessment for the rejection of implied relations. For this assessment the chi-square test is commonly used (see T. Yamane, 1973), with the assumption that if the variables are independent and the universe to which they are supposed to belong obeys a normal distribution the chi-square with the relevant degrees of freedom would give a quantitative answer to the probability of having found by chance the observed number of cases per cell. Such tests are certainly useful whenever applicable although they give no proof that a relation among variables does really exist. Besides, such a test is unable to assess the strength of such relationship when it has not been ruled out.

In practical applications it may happen that the chi-square test is not feasible because the sample, by its very nature, cannot be large enough for the underlying assumptions to have a meaning (for example, the number of pupils by teacher cannot increase without limit). On the other hand, for samples large enough, the chi-square test tends to lose its usefulness because it tends to allow the possibility of relationships among the variables.

Due to these limitations, there is a tendency in the social sciences to disregard the usual significance tests associated with crosstabulation and to stress its nature as a fundamental building block in finding relations among variables through classification and association.

In our study before crosstabulations were created, sensitivity tests were performed on a compression of the range of the categories of variables in order to get the maximum cases per cell. The final range for each variable used was the minimum required to create a useful screening

device. With these preliminary assessments, the final results show the usual behaviour of significance tests: when the whole sample was taken together and the range of the relevant variables was small the number of cases per cell was high and the probability of finding those values by chance very small; when the sample was divided by teachers, however, the above mentioned compression still created cells with less than ~ 5 cases, which is usually understood as the lowest allowable limit for the chi-square test to have a meaning (see T. Yamane, 1973). In such circumstances, an analysis will have statistical significance if a particular crosstabulation is not considered in isolation, but as a member of a group and if care is exercised to exclude those cases in which the sample did not allow more than one or two for category of variable.

The theoretical proof of this statement could be made by starting from the observation that the final probability of a configuration is given not only by the product of the probabilities associated with having by chance the values observed for each variable in each class, but also, with the probability of those values following by chance a given pattern. Consider, for example, the results displayed in Figure 6.8 which represents the results of a crosstabulation in the 5-dimensional space of Pass grade, Gender, *A* achievement, *U* achievement and father's academic qualification. It is a matter of common sense that the probability of having such a regular pattern by pure chance would be very small and its formal quantification is of little value from a practical point of view. If, on the other hand, instead of such a regular and understandable pattern an erratic one was found, statistical significance for a relationship among variables could not certainly be found by quantification. Furthermore, comparison between samples is achieved through their representation by percentages instead of by the number of cases per cell and this corresponds to a particular type of normalization.

The main aim of the crosstabulation is to further insight into the behaviour of the sample and where the results appear coherent and consistent with the theoretical framework it did not seem worthwhile to seek formal translation in terms of quantitative probabilities. After all, such translation would have implied some precise assumptions regarding the underlying probability laws of the universe in observation, which by itself would require a different emphasis on the objectives of this thesis.

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CHAPTER SIX

GENDER AND ACHIEVEMENT

1. INTRODUCTION

When we first contemplated carrying out a study of school achievement in science in Portugal it did not occur to us to consider the influence of gender upon achievement as official statistics do not show great differences and the general consensus among teachers is that boys and girls perform equally well in all school subjects including science. However on coming to England we became acquainted with the research on differential achievement and choice of science subjects. The recent HMI' publication on the subject¹ is but one example of the studies highlighting the situation in England. A. Kelly's recent book² is an important example of attempts to deal with this serious problem. Another important attempt is the Girls into Science and Technology project which is being carried out in the University of Manchester by the Department of Sociology.^{3, 4} It is also clear that to different degrees differential gender achievement in the sciences appears to exist in many other countries.⁵

In our study we decided to include an exploration of gender differences in our general investigation of differential achievement. We start our analysis with a brief description of the organisation of the data and procedures of comparison. We shall present our analysis in the same sequence in which we actually carried it out. We started with the whole sample using the findings of the stepwise regression analysis and proceeded to develop the analysis as the basis of new problems and hypotheses which emerged at each stage. The reasons for differential gender achievement are explored. We shall also give the results of a special teaching programme as these affect the issue of differential gender achievement. Finally in the conclusion we will present the main findings of the chapter.

2. GENDER DIFFERENCES IN ACHIEVEMENT

2.1. DATA ORGANIZATION AND COMPARISONS

2.1.1. The crosstabulation between gender and achievement and between gender, achievement and social class are here presented in histograms. For ease of comparison boys' and girls' data appear in the same graph (1-boys, 2-girls). The percentage with respect to the total number of either boys or girls is indicated in each bar. Mean scores are indicated in brackets at the top of each bar. At the top of each bar a * sign indicates that the number of pupils is less than 5 in the cell which produced that bar; a number < 5 is not considered significant.⁶

2.1.2. Data comparison is organised as follows:

Within each one of the two groups, middle and upper school, a comparison is made between boys' and girls' achievement for either *A* or *U* competencies. Comparisons are also made across competencies and across the two sections of the school. Our analyses are based upon correlations between gender and achievement supplemented by the following data from the crosstabulations:

- (a) Mean scores
- (b) Pass grades (achievement higher than 50%, levels 3 and 4). Failure grades (achievement lower than 50%) can be inferred from the pass grades.
- (c) Failure grades < 25% (level 1) and Pass grades \geq 75% (level 4). This enables us to distinguish pupils who have either an exceptionally low or an exceptionally high achievement.

2.2. FIRST STAGE

We began with an *hypothesis* which can be stated as follows: "There is no relationship between gender and school achievement in sciences either for *A* or *U* competencies". This hypothesis is based upon both general assumption and official statistics in Portugal. There is a general consensus among teachers in Portugal (even male teachers) that there is no difference between boys and girls in school achievement including achievement in science. There is a high percentage of girls currently (and in the past) studying *all* science fields, either in secondary school or at higher levels of education.⁷ Official statistics indicate that girls are better at all levels of schooling both at the preparatory school level and the secondary level.⁸ Incidentally this is also true for France.⁹ Furthermore critical assessment of the literature on the prediction of academic performance made by D. Lavin in the USA associates girls with higher achievement than boys.¹⁰

2.2.1. Findings

The table in Figure 6.1 shows the correlation values for gender and third term's¹¹ achievement. The correlations are part of the first analysis of the data where we obtained a general matrix of correlations¹² for both the middle and the upper school.

| SECTIONS OF SCHOOL | COMPETENCIES | |
|-----------------------|--------------------|------------|
| | <i>Acquisition</i> | <i>Use</i> |
| <i>Middle School</i> | -.07 | -.11 |
| <i>Upper School</i> | -.04 | -.09 |

Figure 6.1 - *Correlation between Gender and Achievement*

The figures shown on histograms of Figure 6.2 which represent the relationship between gender and achievement in both middle and upper school and for both *A* and *U* competencies, were also obtained from our initial analysis.

2.2.2. Interpretation

Correlation coefficients have always a negative value and are higher for *U* competencies than for *A* competencies both in the middle and the upper school. This could mean that boys perform better than girls and that such a difference is more marked for *U* competencies than for *A* competencies. However, these correlation coefficients are so low that they can be considered statistically not significant (they are below .20). We can conclude that *there is no significant difference between boys and girls in school achievement in science* (Conclusion 1). We had already reached this conclusion as a finding of the step-wise regression analysis.¹³

An examination of the crosstabulation graphed in Figure 6.2 shows that:

Middle School - There is no significant difference in *A* competencies although boys are slightly better. The mean marks and percentages of pass grades are slightly higher for boys. Although the percentage of pass grades $\geq 75\%$ is higher for boys the percentage of failure grades $< 25\%$ is also higher for them. Some differences can be noticed for *U* competencies; boys are always better: mean marks, percentage of pass grades and percentage of pass grades $\geq 75\%$ are all higher for boys and the percentage of failure grades $< 25\%$ is lower for boys.

Upper School - Again there is no significant difference in *A* competencies, although boys are slightly better. The mean marks and percentages of pass grades are slightly

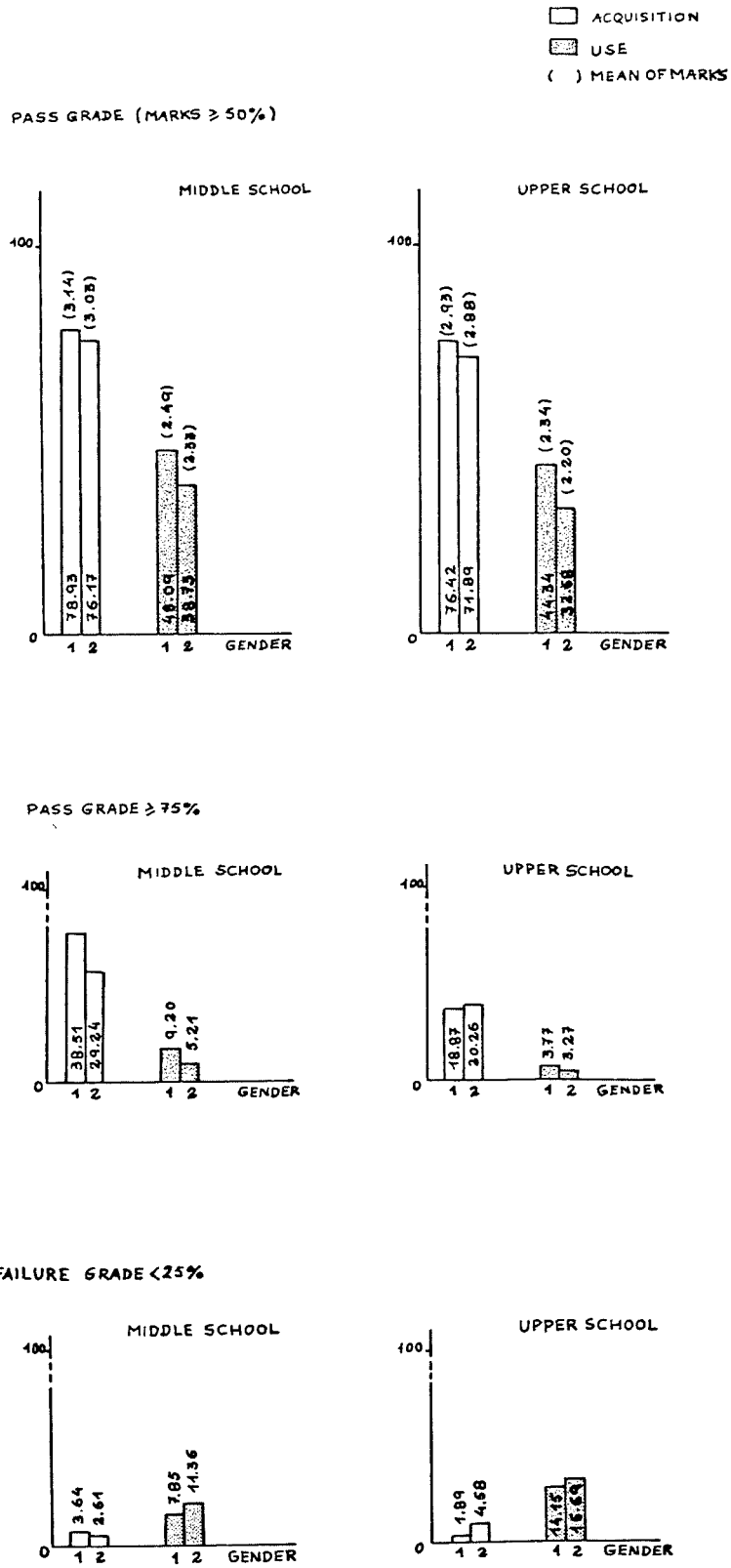


Figure 6.2 - Relations between gender and achievement: All sample, Middle and Upper School (1-Boys; 2-Girls)

higher for boys. Although the percentage of failure grades $< 25\%$ is lower for boys the percentage of pass grades $> 75\%$ is higher for girls. Some difference can also be noticed in *U* competencies: the mean marks and the percentage of pass grades are both higher for boys. However boys and girls are very much alike with respect to pass grades $> 75\%$ or failure grades $< 25\%$.

Based on this evidence we can conclude that *although slight, there is a differential pattern of achievement between boys and girls: boys seem to be better than girls, especially with respect to U competencies* (Conclusion 2).

Our final conclusion of this initial analysis depends upon which conclusion we accept as having greater validity. Thus if we take conclusion 1 based upon statistical significance of correlation our initial hypothesis is supported, however if we take conclusion 2 there is less support for our hypothesis. In fact when we carry out a more delicate analysis (crosstabulation) we can find a tendency for a pattern, i.e. boys are better than girls mainly for *U* competencies.

2.3. SECOND STAGE

We decided to develop our analysis despite the apparent contradictory findings of the analysis produced by correlations and crosstabulations. We were also puzzled because of the tendency in our data to depart from the current evidence on differential gender achievement in science in Portugal on the basis of which we expected no differences. We put forward a new *hypothesis*: "The reduced differential achievement found between boys and girls only exists with some teachers in some schools". The data on which this hypothesis is based were obtained from the initial analysis of the relationship between teachers and achievement where there was a marked difference in the

marks assigned to pupils especially in *U* competencies following the grading of the teachers into five levels of effectiveness. Such differences became clearer when we abandoned our five point scale for teachers and each teacher became a separate category of analysis in the scale.¹⁴ In a previous chapter we noted differences between teachers in the effectiveness of their pedagogic practice¹⁵ and these differences may affect pupils' differential achievement. We should also remember that when the stepwise regression was applied to the whole sample the influence of the teacher upon differential achievement was shown.¹⁶ The above gives us grounds for investigating our hypothesis.

From the above hypothesis we can reason: "If the small differential achievement between boys and girls is due to some teachers in some schools then when we separate pupils by teachers a differential relationship between gender and achievement (mainly for *U* competencies) should be evident". This we will now investigate.

2.3.1. Findings

The table in Figure 6.3 shows the correlation between gender and achievement for each of the different eleven teachers. Histograms in Figures 6.4 and 6.5 show the relationship between gender and achievement for both *A* and *U* competencies in the middle school (Figure 6.4) and the upper school (Figure 6.5) where pupils are divided by teachers.

2.3.2. Interpretation

Correlation coefficients vary from one teacher to another and the variation is higher for *U* competencies than for *A* competencies. Some values are very low in the middle school for teacher X_2 (*A* and *U*), teacher X_5 (*U*), teacher X_6

| SECTION OF SCHOOL & TEACHERS | | COMPETENCIES | |
|------------------------------------|-----------------|--------------------|------------|
| | | <i>Acquisition</i> | <i>Use</i> |
| Middle School | X_1 (1) | .07 | -.02 |
| | X_2 (2) | .02 | .05 |
| | X_3 (3) | .13 | .23 |
| | X_4 (4) | .16 | .07 |
| | X_5 (5) | -.13 | -.03 |
| | X_6 (6) | -.04 | -.09 |
| | X_7 (7) | -.19 | -.33 |
| | Z_1 (8) | .04 | -.20 |
| | Z_3 (10) | -.05 | -.15 |
| | Z_4 (11) | .00 | .01 |
| | Upper School | X_1 (1) | .16 |
| X_3 (3) | | .08 | -.03 |
| Z_2 (9) | | -.21 | -.20 |

Figure 6.3 - Correlation between Gender and Achievement: pupils divided by teachers

(A), teacher Z_1 (A), teacher Z_4 (A and U); in the upper school for teacher X_3 (U). Some others are quite high: in the middle school teacher X_3 (U), teacher X_7 (A and U), teacher Z_1 (U); in the upper school teacher Z_2 (A and U). These higher values are statistically significant.

We can conclude that in some cases there is differential achievement between boys and girls sometimes boys are better,

sometimes girls (conclusion 3). We had already reached this conclusion as a finding of the stepwise regression analysis.¹⁷

On the basis of the crosstabulation graphed in Figures 6.4 and 6.5 we can see that there is a definite pattern of differential achievement which allows us to conclude that *in many cases there is a differential achievement between boys and girls, sometimes boys being better sometimes girls, and that such difference is generally greater in U competencies than in A competencies* (Conclusion 4).

Although we might be reluctant to make strong inferences from the few statistically significant correlations, the crosstabulation analysis which allowed a more delicate examination shows some support for the hypothesis of differential gender achievement for both *A* and *U* competencies associated with different teachers *both* in the middle and in the upper school.

We should note that because the sub-samples of teacher/classes necessarily contain a small number of pupils, the probability of finding statistical significance is in some cases not high. We have found that many relations are indeed significant. However our major interest is in finding *patterns* of differences and similarities between sub-samples rather than in the isolated significance of one sub-sample.¹⁸

2.4. THIRD STAGE

At this point we have to look for explanations. The major question is: Why do girls and boys behave differently with different teachers (or may be in different schools?)

We then examined the data shown in the tables of Figure 6.3 and in the histograms in Figures 6.4 and 6.5.

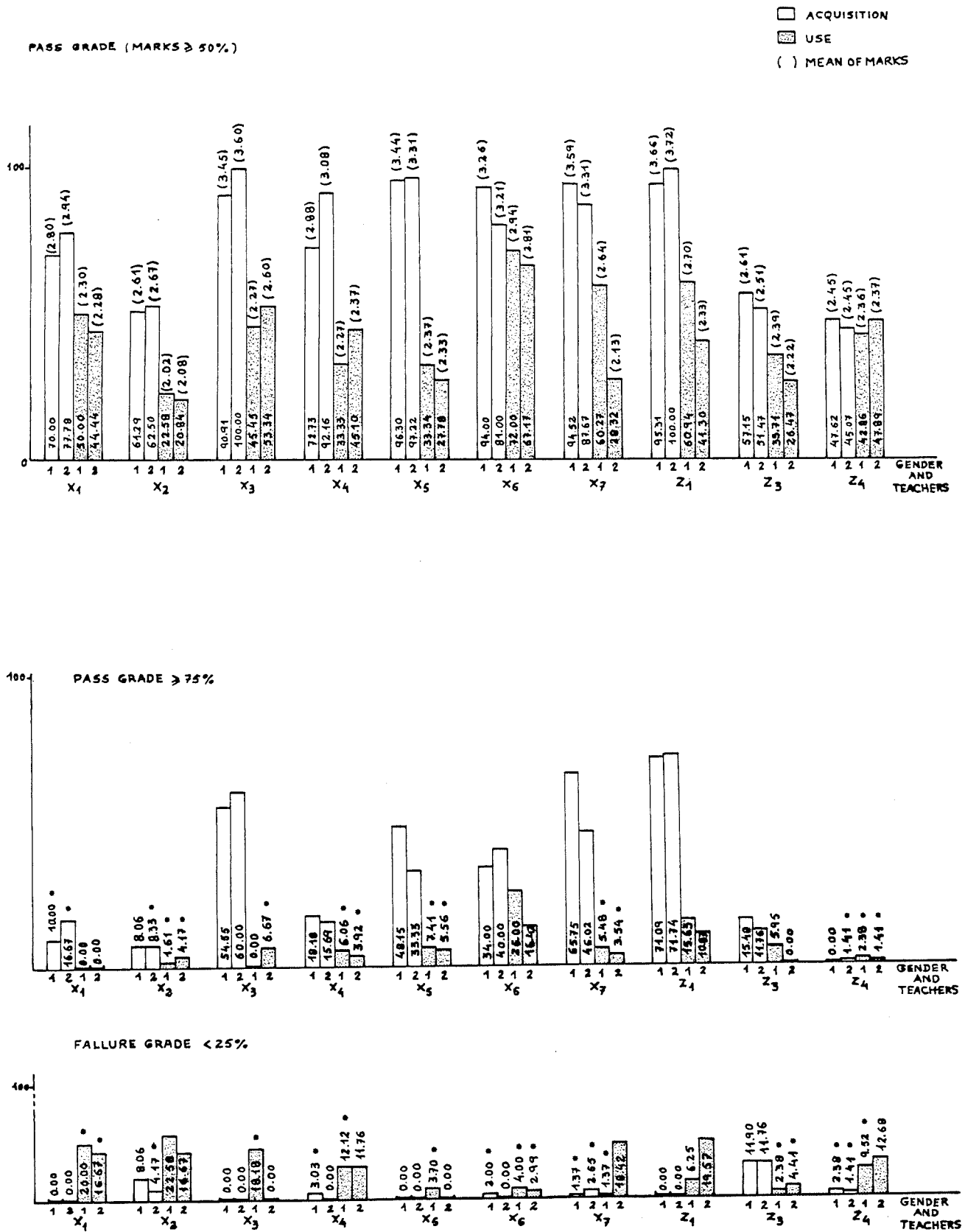


Figure 6.4 - Relation between gender and achievement: Middle school separated by teachers (1-Boys; 2-Girls)

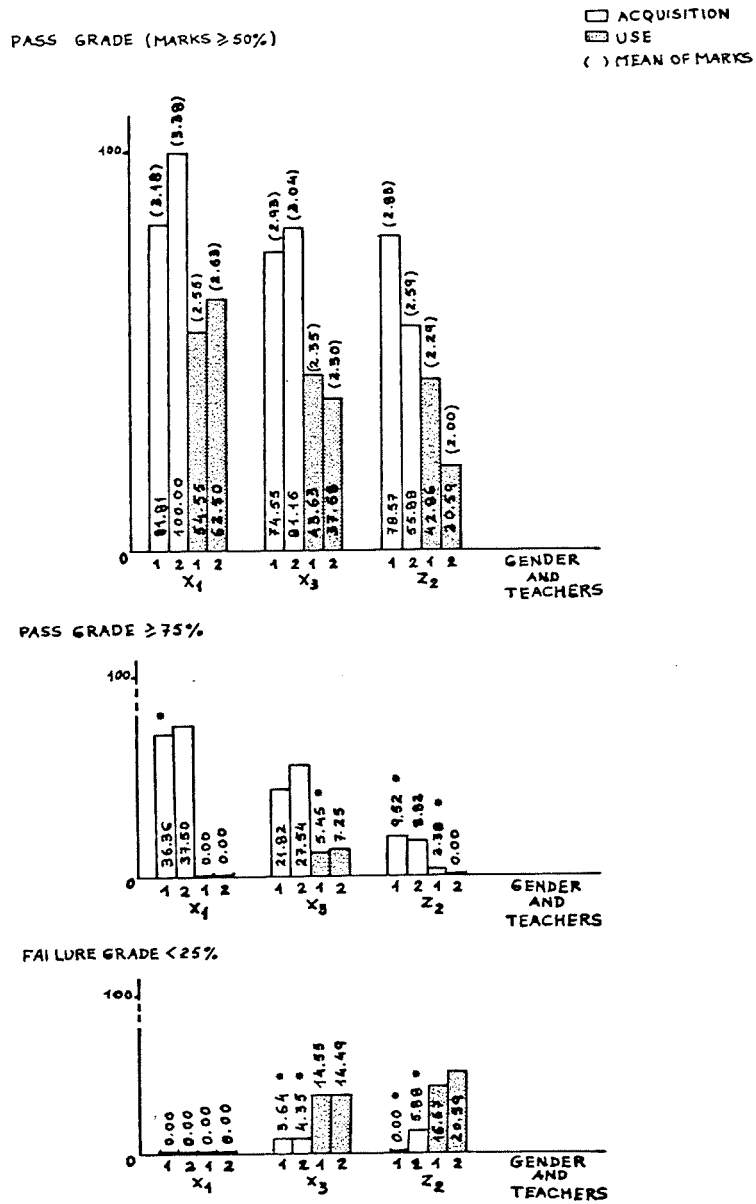


Figure 6.5 - Relation between gender and achievement: Upper school separated by teachers (1-Boys; 2-Girls)

The data suggested a possible relation between the social composition of the classes of the teachers and differential gender achievement. We show in the table of Figure 6.6 the social class mean indexed by parents' educational qualification for the classes of each teacher.

| SOCIAL COMPOSITION | | Father's Educ. Qual. (Mean) | Mother's Educ. Qual. (Mean) | Qualitative Scale |
|--------------------|--------------|-----------------------------|-----------------------------|-------------------|
| | | | | |
| Middle School | X_1 (1) | 3.97 | 3.59 | M |
| | X_2 (2) | 4.19 | 3.63 | M |
| | X_3 (3) | 4.31 | 3.50 | M |
| | X_4 (4) | 4.34 | 3.44 | M |
| | X_5 (5) | 3.33 | 2.68 | W^+ |
| | X_6 (6) | 4.76 | 3.93 | M |
| | X_7 (7) | 3.21 | 2.60 | W^+ |
| | Z_1 (8) | 2.21 | 1.92 | W |
| | Z_3 (10) | 2.55 | 2.12 | W |
| | Z_4 (11) | 1.95 | 1.76 | W |
| | Upper School | X_1 (1) | 5.15 | 4.33 |
| X_3 (3) | | 4.34 | 3.42 | M |
| Z_2 (9) | | 2.97 | 2.79 | W^+ |

Figure 6.6 - Social Composition of each Teacher's Classes

On the right hand side of the table a qualitative scale of the social class composition of each teacher's classes is indicated; the classification based on the mean

value has three degrees:

- M - Middle class school
- W^+ - Working class school (higher values)
- W - Working class school (lower values)

Bearing in mind that the scale for educational qualifications was a 1-7 scale we can see, from the mean figures, that middle class schools are social mixed schools and working class schools (especially these indicated as W are mainly working class schools).¹⁹

Teachers X_1, X_2, X_3, X_4, X_6 have classes of quite a high social level: means of father's educational qualifications range between 3.97 and 5.15 (mother's e.q. 3.42-4.33). Teachers X_5, X_7, Z_2 have classes of a low social level although not the lowest: means of f.e.q. range between 2.97 and 3.21 (m.e.q. 2.60-2.79). Teachers Z_1, Z_3, Z_4 have classes virtually composed of working class children: means of f.e.q. range between 1.95 and 2.55 (m.e.q. 1.76-2.12).

On the basis of inferences drawn from data in Figures 6.3, 6.4 and 6.5 and Figure 6.6 we formulated the following *hypothesis*: "Differential achievement is class based that is middle-class boys and girls perform equally well or girls perform better than boys whereas working-class boys perform better than girls".

Our next step is to see whether differential achievement between boys and girls relates to their social class. We should note that in the procedures we shall use in the carrying out of this analysis teachers are combined; and as we know that the teachers are pedagogically very different from each other (especially those in the middle school)²⁰ we must expect some blurring of our expected relations between gender, social class and achievement.

2.4.1. Findings

In order to investigate this hypothesis we had to use an index of the social class composition of the pupils in the classes of each teacher. We decided to use educational qualification as an indicator of the social class background for reasons explained in another part of the thesis.²¹ The sample was divided in four groups according to this variable:

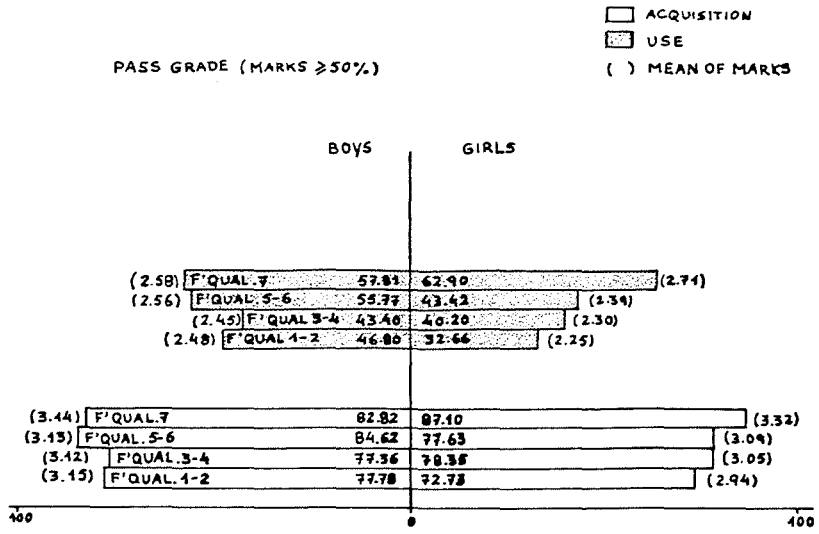
1st group - f.e.q. 1-2
 2nd group - f.e.q. 3-4
 3rd group - f.e.q. 5-6
 4th group - f.e.q. 7

We then examined achievement in relation to these four groups of pupils. Histograms in Figures 6.7 and 6.8 show the relationship between gender and achievement for both *A* and *U* competencies in the middle (Figure 6.7) and in the upper school (Figure 6.8) when pupils are divided into groups based upon their father's educational qualifications.

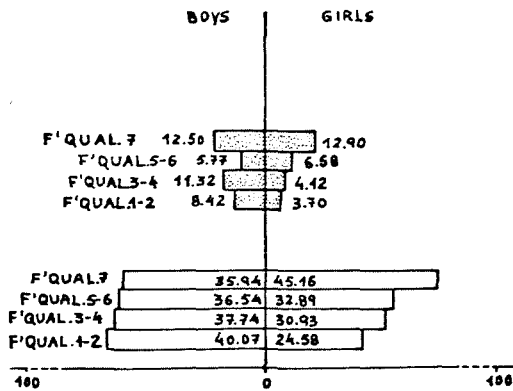
2.4.2. Interpretation

The interpretation of the histograms in Figures 6.7 and 6.8 is unambiguous and leads to the following conclusions:

- (a) When compared to girls, boys have a higher achievement, very marked in *U* competencies, in the lowest social group (lower working class). In the highest social group (upper middle class) girls are slightly better or equal to boys;
- (b) The comparatively lower achievement of lower working class girls is more evident in the *upper* than in the middle school;
- (c) In between these two extremes of the social class scale two different patterns according to type of competency



PASS GRADE \geq 75%



FAILURE GRADE $<$ 25%

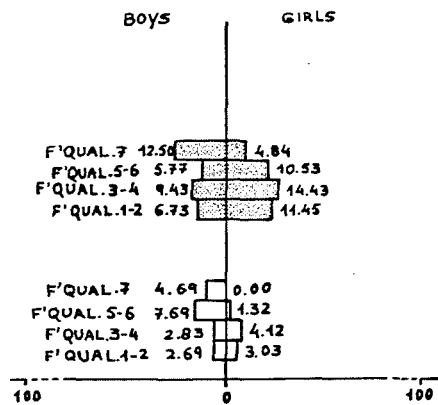
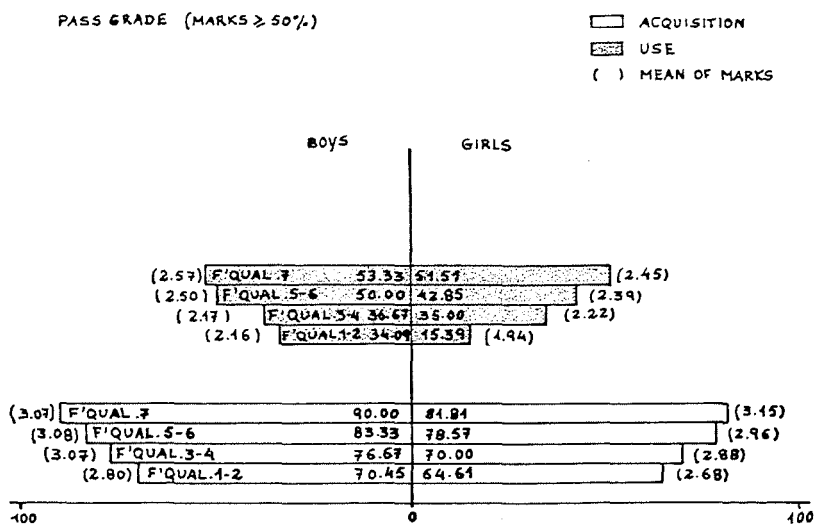
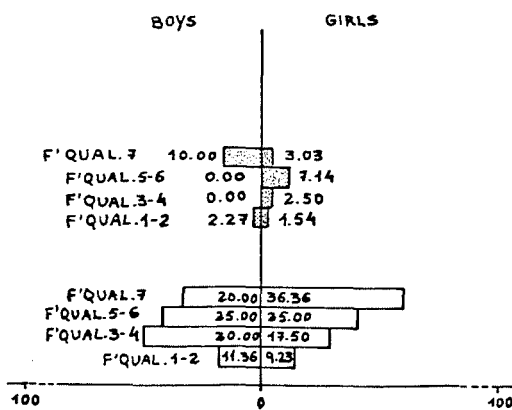


Figure 6.7 - Relation between gender and achievement: Middle school separated by father's academic qualification



PASS GRADE \geq 75%



FAILURE GRADE $<$ 25%

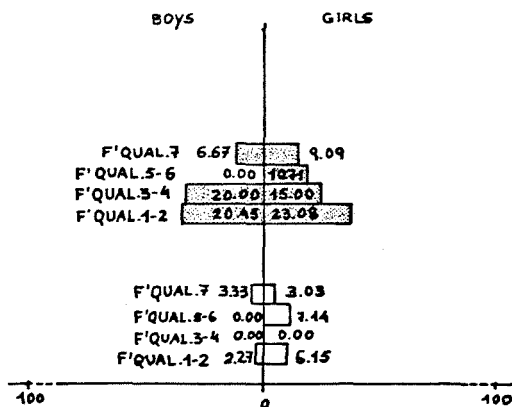


Figure 6.8 - Relation between gender and achievement: Upper school separated by father's academic qualification

appear. For *A* competencies boys and girls perform virtually equally in both middle and upper school. For *U* competencies boys and girls of the second social group perform equally whereas in the third social group boys perform better than girls in both middle and upper school;

- (d) Differential achievement in *U* competencies between boys and girls does not seem to follow a consistent pattern from bottom to top; there are two social groups (3-4 and 7) where the boys' performance is equal to girls and two social groups (1-2 and 5-6) where the boys are better than girls although this difference is much greater in the former social group (1-2);
- (e) If we consider the whole social class scale, there is a more marked and more consistent increase of relative competence in *U* competencies for girls than for boys; *for girls each increase in their social class position is associated with an increase in achievement in U competencies.*

On the basis of the above we can say that on the whole our hypothesis is supported, although the analysis has revealed new questions. It seems that at the top of the class scale girls are in general equal to boys but they are *not better* (or at least not significantly better) as hypothesized. Further it seems that in the section of the middle class immediately below the upper-middle class, boys are to some extent better than girls in *U* competencies.

The general conclusion that should be drawn is as follows:

Differential achievement in sciences is class based, upper-middle class boys and girls perform equally and lower-working class boys perform substantially better than girls especially in U competencies and in the upper school. The

reduction in differential gender achievement from the bottom to the top of the social class scale does not follow a regular pattern. There is a general increase in competence for boys and girls alike although it is more marked for girls (Conclusion 5).

As we pointed out before it is likely that some blurring of relations has occurred. If the teachers shared a similar pedagogical practice the conclusions might have been clearer.

We must point out that despite the general conclusion (5) there is one major discrepancy in the case of teacher Z_4 . Here girls perform as well as boys in a school which is essentially working-class. We might account for this in the following ways:

- (a) Some teacher Z_4 's U questions do not test U competencies (see previous analysis)²²
- (b) The level of conceptual demand is low (see previous analysis)²³

However neither (a) nor (b) hold because teachers Z_1 , Z_3 share these attributes with teacher Z_4 but boys do better than girls with these teachers. It may be that as working-class girls tend to have a higher rate of school drop-out by the 9th grade, those who remain are either self-selected or family directed and this might account for the similarity in achievement. It is also the case that the U scores of the girls of teacher Z_4 are higher than those of teachers Z_1 and Z_3 (see Figure 6.4), and this fact may support our argument that the girls in the classes of teacher Z_4 are more selected than in the case of the girls in the classes of teachers Z_1 and Z_3 .

2.5 FINAL STAGE

On the basis of the data obtained and of our interpretations and conclusions we can, however, go further in our reasoning. Let us consider the following set of propositions:

- (a) When teachers are separated²⁴ girls show similar or higher achievement than boys in middle class schools
- (b) When teachers are separated girls show lower achievement than boys in working class schools
- (c) When the whole sample is divided in four groups according to father's educational qualification, girls perform worse than boys in the lowest group but are *equal* to boys in the highest group. When the two highest groups (5-6 and 7) are joined together boys to some extent perform better.

From the above propositions we can now deduce the following: If girls are equal (*not better*) to boys at the top of the social class scale then middle class girls are as good as boys (or worse if we take the whole of 5-6 and 7 groups). In that case (a) can only be explained by admitting that working class girls are as good as boys (or maybe better) when they attend a middle class school. Based on this reasoning it seems that we can conclude:

The only working-class girls who have a lower achievement than boys are those who attend a working-class school; in middle class schools they perform as well as boys
(Conclusion 6)

Conclusion 5 can now be reformulated on the basis of conclusion 6 as follows:

Differential achievement in sciences between boys and girls is class based; upper-middle class boys and girls

perform equally. Lower-working class boys perform better than girls (especially in U competencies and in the upper school) only when they both attend working-class schools. Girls' achievement is strongly linked to social class whereas boys' achievement has a weaker and less well defined linkage to it (Conclusion 7).

This is the final conclusion which we suggest should be inferred from the data we have presented.

3. QUESTIONS ARISING OUT OF THE ANALYSIS

3.1. We started with the conviction that gender was not a relevant sociological variable in accounting for failure at school either in *A* or *U* competencies. We ended up with quite a different position. There is differential gender achievement in the sciences among lower-working class children which is more accentuated in *U* competencies. A most interesting finding was that such differential achievement is limited to working class schools. A section of the middle class, also shows differential achievement in favour of boys but for only *U* competencies. The question of differential achievement was not revealed in the analysis of the total sample and it is possible that it is for this reason (aggregation of teachers, school, pupils, areas) that differential achievement was not found in similar studies in Portugal. It is only when a more delicate analysis is carried out when we control for school, teacher, social class, that the differences are revealed.

From such findings important questions arise about relative failure: why only lower-working class girls? Why only those who attend working-class schools? Why only girls of a particular section of the middle class? Why is differential achievement more marked in *U* competencies? Why mainly in the upper school?

First of all the evidence seems to rule out the general influence of teachers and school as important sources of *pressures* and *expectations* affecting girls' underachievement. If general attributes of schools and teachers are important factors then all girls should be equally affected. For the same reason the evidence also rules out I.Q./gender association as the explanation for underachievement. On the other hand, girls in Portuguese secondary schools do not, as far as we know, see science as a male dominated preserve and so underachievement of girls cannot be attributed to this factor *per se*.²⁵ However, we do believe, and have grounds for arguing, that *specific* features of class position, geographical location, teacher's pedagogical attributes and the social composition of the school classes affect the differential achievement of boys and girls.

We are left, we suggest, with the following inter-related hypotheses:

- (a) Pedagogic contexts and practices in the first agency of pedagogical transmission (the family) are different for boys and girls according to social class position and especially in the lower-working class. The differential competence acquired in the family is enhanced or maintained in the working-class school and disappears when working-class girls attend a middle class school and/or a school in the metropolis.²⁶
- (b) Pedagogic contexts and practices in the family, especially in the working-class families, vary with geographical location: girls who normally attend a school in the metropolis experience reduced gender specific socialising practices at home and those who attend a school in the country experience more gender specific forms of socialisation at home.

We shall now attempt to investigate these hypotheses within the constraints of our data.

Let us begin by looking at the working class schools we have in our sample. Differential achievement between boys and girls in favour of boys is not the same in all schools. Accordingly we can divide schools in two groups; the first group (Group I) comprises schools where teachers X_7, Z_1, Z_2 ²⁷ teach and the second group (Group II) schools where teachers X_5, Z_3 teach. If we now relate these two groups of schools to the area of the school we can see that the first group corresponds to schools placed in the south, centre and north of the country (including the city of Porto where teacher X_7 teaches), whereas the second group corresponds to schools in the area of Lisbon.²⁸ Greater differential achievement occurs in the first area as compared to the second. On the other hand in the middle class schools of our sample (group of schools III), which are all located in Lisbon, if differential gender achievement exists it favours girls. The diagram in Figure 6.9 shows the distribution of teachers and schools in three different groups to make clear the increasing differential achievement in favour of boys as the school's distance from Lisbon increases.

We are suggesting that differential concepts of masculine and feminine are linked to aspirations, orientations, motivations of pupils in school and that in general *irrespective* of social class a more patriarchal concept of gender practice is linked with the country in Portugal than with the metropolis. Thus we *find that for all teachers in the country (with the exception of Z_4) there is differential gender achievement, however this is much less marked for schools in the Lisbon area and disappears in Lisbon itself.* It is possible that the selection of working-class families migrating to Lisbon and/or the cultural context of Lisbon affects the gender socialising practices within these families.

So far we have evidence that location is associated with differential gender achievement. However the picture

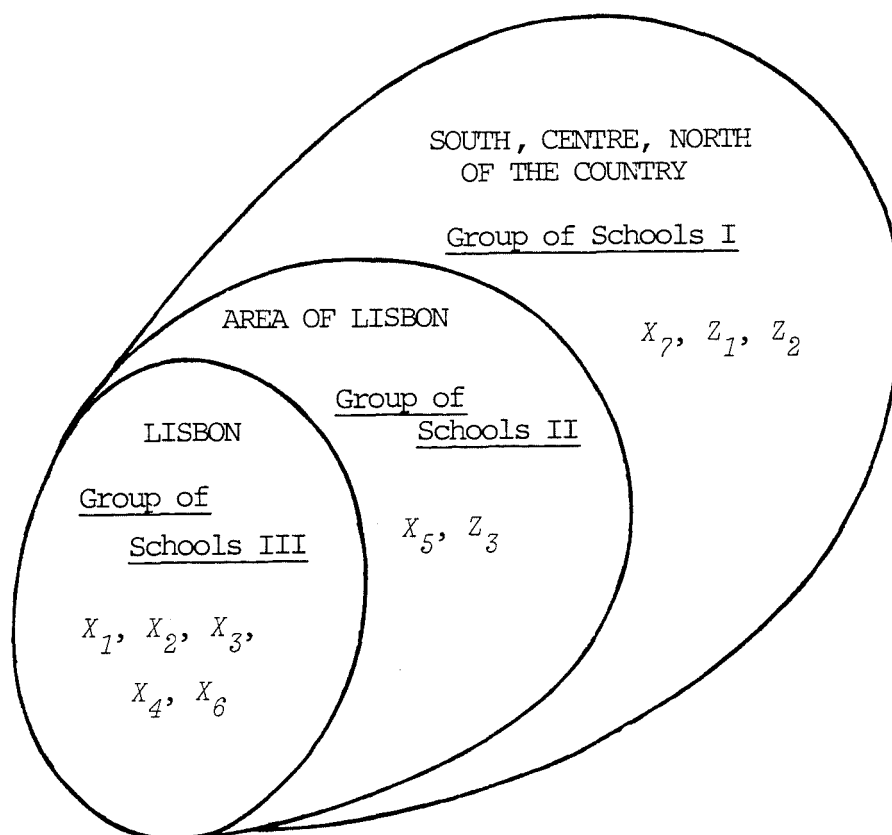


Figure 6.9 - *Groups of teachers/schools according to increasing degree of gender differential achievement*

is more complicated. We know that teacher X_7 who teaches outside Lisbon and who maintains a high level of conceptual demand²⁹ produced one of the highest levels of differential gender achievement. This is also the case, although more attenuated, of teacher Z_2 . This points to the crucial interrelation between specific geographical location and a specific pedagogic practice and leads to an important inference: a teacher with a high level of conceptual demand may well exacerbate gender differences in achievement in science in working-class schools, no matter how competent that teacher is in bringing the whole of his/her pupils to attain the level he/she has set (as in the case of teacher

X₇).

Why should some lower-working class homes be 'special' as opposed to other working-class homes? It may well be that in the former parents have contact with middle class people. Perhaps their practices are affected not only through their place of work but also through the area in which they live and the organizations to which they are affiliated (e.g. trade unions, political parties, religious institutions). It may be in such families that the pedagogic context, support for, and interest in the school's practices affect the motivations, aspirations *and* pedagogic competence of the children. Such a familial context whilst not erasing class differences in achievement³⁰ may well assist in reducing differential gender achievement. Here we might have a case of a reduction in the influence of ideologies and practices of patriarchy which we believe occurs in the metropolis i.e. Lisbon.

Why should lower-working class girls be able to overcome some of their difficulties when they attend a middle class school (assuming that there are differential conditions at home)? It may well be that differences between boys and girls are reduced in a middle-class school where the culture of the school, school class and peer groups models are favourable to a reduction in differential gender achievement.

Why do boys of that section of the middle class immediately below the upper-middle class perform better than girls in *U* competencies? Unfortunately, it is not possible to infer from the educational level³¹ of their parents the reasons for this gender differentiation in achievement of the pupils. J. Holland³² has found that middle-class parents who are located in the field of production relative to those who are located in the field of symbolic control are likely to have children who believe in strong gender differentiation. We are not able

to test this finding directly from our data as it would require a further treatment of the data which we were unable to carry out. However it may be that the influence of education is stronger on parents in category 7 (parents with a higher degree) for both parents are likely to have achieved a higher degree and therefore are more likely to encourage and support boys and girls equally.

The above could explain why differential achievement is greater in *U* than in *A* competencies. *U* competencies require high levels of abstraction and their attainment at school may well have some basis in an orientation towards these competencies together with a pedagogic practice directed toward their acquisition in the first agency of pedagogical transmission, i.e. the family. Therefore, it is likely that the achievement in *U* competencies will be more influenced by different patterns of socialization in the family. When these patterns are different for boys and girls then differential achievement linked to gender will be evident, precisely because the school usually maintains and even reinforces such patterns.

The fact that differential achievement in *U* competencies is more marked in the upper school than in the middle school is the opposite of what we should expect given the fact that a higher process of selection has taken place at this stage of the school life. It is possible that the level of conceptual demand in the upper school is set too high and we should remember that, in our sample, teachers of the upper school were on the whole more conceptual demanding than teachers of the middle school.³³ This may well account for the greater differential achievement in the upper than in the middle school.

3.2. We shall now try to integrate the discrete features which we have shown to affect differential gender achievement. We have two inter-related factors operating within the

family and two factors operating in the school . In the family there is a complex inter-relation between class and patriarchy as this affects the socialising practices within the family with respect to their consequences for the school achievement of the pupils. In the first place the lower the social class the more likely that the socialisation within the family follows gender specific practices which favour the boys' achievement in science. Further where the school is *outside* Lisbon this effect is likely to be more strongly marked in the family.

Within the school, the level of conceptual demand of the teacher may well contribute to differential achievement in association with differential competencies acquired in the family. Thus we should expect a greater degree of social class linked differential gender achievement *in general* in the upper school than in the middle school because the level of conceptual demand is greater in the former than in the latter. We should also expect that in the middle school teachers who make a high level of conceptual demand upon a predominantly working-class school class are also likely to increase differential gender achievement.

Thus within the working-class those factors which reduce class and patriarchy influences upon the socialising practices (geographical/cultural location of the family and/or extra-familial relations) are likely to reduce differential gender achievement where the school culture and school class factors are favourable. In the case of the higher social class groups it would seem that the crucial factor would appear to be the extent of patriarchal influences upon the socialising practices. Thus the higher social class group relative to the group below is associated with the absence of gender differentiation whereas the latter is associated with its presence.

Finally, differential achievement is likely to be much more marked in the case of *U* competencies than in the case

of *A* competencies because *U* competencies are more likely to be those which produce differences in acquisition under *conditions of contemporary pedagogic practice*. We have shown that in general *A* competencies should be acquired by all pupils.³⁴ In as much as the *evaluation* of *U* competencies produces a range of achievements approximating to a Gaussian curve it is likely that those pupils who are positioned on the left of this curve are likely to be those coming from families where orientation towards the more context independent principles required for *U* competencies is less pronounced, and as a consequence, supporting pedagogic practices in the family towards their acquisition are less likely to be available.

To conclude this section we should point out that a different type of question is left open: why do girls have a higher level of general achievement in Portugal (i.e. achievement in all school subjects taken together) whereas in sciences there is some underachievement (when the whole of our sample is considered)? It may be that the small differential achievement in sciences in favour of boys is compensated by a differential achievement in other school subjects, so much in favour of girls, that girls have a higher level of general achievement. Only further research can give some answer to this question.

4. CHANGES IN TEACHER'S PEDAGOGIC PRACTICE AND DIFFERENTIAL GENDER ACHIEVEMENT

The reader will remember that earlier in this thesis we reported the results of an attempt to find patterns of achievement in *A* and *U* competencies by concentrating on selected objectives of the teaching which were given special treatment. The two teachers involved in this special study were teachers X_3 and X_7 .³⁵

We have here an excellent opportunity to test the effects of this special pedagogic programme carried out by teachers X_3 and X_7 . Our previous analysis has revealed a relation between the achievement of pupils and their gender; working-class girls performing less well than boys in working class schools. We now could examine the pupils in the classes of the two teachers to see whether differential achievement on selected objectives is the same or different from achievement in the whole sample of objectives.

We shall put forward the following hypothesis: "Lower working-class girls perform better on selected objectives than they perform on the whole sample of objectives, i.e. differential achievement between boys and girls of the lower working-class in working class schools will be smaller".

Our grounds for this hypothesis are that working-class pupils by virtue of their family background (irrespective of whether the pupils themselves choose to learn or not) are less prepared to cope with the pacing of the pedagogic practice and so are less able to meet the requirements of the sequencing rules and the criteria they entail. This may affect girls more than boys. Since the special treatment given to the teaching of selected objectives corresponds to greater explicitness of criteria and of sequencing rules and to a weakening of pacing³⁶ the achievements of working-class girls may have improved.

4.1. PROCEDURE

To test the above hypothesis we carried out a procedure which can be summarized as follows:

- (a) We looked at the extremes of the curves (i.e. achievement $< 25\%$ and $> 75\%$, levels 1 and 4 respectively) and we compared the percentage of girls and boys who achieved these marks on selected objectives

with the whole sample of objectives. In order to do this we had to obtain the data for these selected objectives separated according to gender.

- (b) We concentrated our analysis on the achievement $\geq 75\%$ for *A* competencies (pass grade $\geq 75\%$) and $< 25\%$ for *U* competencies (failure grade $< 25\%$). These scores were selected because the majority of pupils scores for *A* will be concentrated in level 4 ($\geq 75\%$) whereas in the case of *U* competencies there will be a relatively larger number concentrated in level 1 ($< 25\%$). The above distribution will not be found in the first test for *A* competencies as the pupils are at the beginning of their learning process.
- (c) We assessed the relative position of boys and girls by the ratio of percentages of pupils in each of the two categories for a given mark.
- (d) The *B/G* ratio was used in *A* competencies because a higher percentage of boys with an achievement $\geq 75\%$ compared to girls was expected.
- (e) The *G/B* ratio was used in *U* competencies because a higher percentage of girls with an achievement $< 25\%$ compared to boys was expected.
- (f) We concentrated on teacher X_7 's data since of the two teachers who had carried out the particular study she was in a working-class school and her classes showed a higher differential achievement according to gender.
- (g) We concentrated on the pupils' achievement in the third term.

4.2. FINDINGS

The table in Figure 6.10 shows the ratios between third term's percentage of boys and girls for the whole sample of objectives of teacher X_7 .

| | |
|-------------------------------|-------------------------------|
| A COMPETENCIES | U COMPETENCIES |
| <i>Pass Grade</i> $\geq 75\%$ | <i>Failure Grade</i> $< 25\%$ |
| $B/G = 1.43$ | $G/B = 13.56$ |

Figure 6.10 - *Ratio between boys' and girls' achievement in A and U competencies of teacher X_7 's pupils: whole sample of objectives*

The tables in Figures 6.11 and 6.12 show B/G and G/B ratios for selected objectives of teacher X_7 . We present only some of the objectives taken as an example. However it should be noted that the patterns of ratios is similar for all selected objectives. These tables should be read in relation to the respective tables³⁷ referred to in Chapter three in order to understand the objectives we are analysing. We should bear in mind that the first column for each objective of A competencies (4, 13, 1, 14) corresponds to the diagnostic test when no teaching-learning had yet taken place.

4.3. INTERPRETATION

If we compare the B/G ratio in A competencies for the whole sample (Figure 6.10) to the same ratio for selected objectives (Figure 6.11) we can see that the ratio is in general smaller in the latter with the exception, as we expected, of the first testing period (diagnostic test). This means that the girls' achievement is better for

| YEARS | 7th | | | | | | | | 8th | | | | | | | | |
|------------------|-----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| OBJECTIVES | 2nd | | | | 4th | | | | 1st | | | | 4th | | | | |
| TESTING ORDER | 4 | 5 | 6 | 7* | 8* | 13 | 14* | 15* | 1 | 2 | 3 | 4* | 5* | 14 | 15 | 16* | 17* |
| <i>B/G Ratio</i> | .7 | .6 | 1.0 | 1.0 | 1.0 | 1.5 | 1.3 | 1.3 | 2.2 | 1.0 | 1.1 | 1.2 | 1.0 | 2.0 | 1.3 | 1.1 | 1.1 |

* Third term's tests

Figure 6.11 - Ratio between boys' and girls' achievement in A competencies (pass grade \geq 75%) of teacher X₇'s pupils: selected objectives

| YEARS | 7th | | | | | | | | | | 8th | | | | | | | | | |
|------------------|-------------|-----|-----|-----|-----|-----------------------|-----|------|------|-----|-----|-----|-----|-----|-----|------------------|-----|-----|-----|-----|
| OBJECTIVES | 5th a) + b) | | | | | 6th a) + b) + c) + d) | | | | | 6th | | | | | 7th a) + b) + c) | | | | |
| TESTING ORDER | 46 | 47 | 48 | 49* | 50* | 51 | 52 | 53 | 54* | 55* | 22 | 23 | 24* | 25* | 26* | 35 | 36 | 37 | 38* | 39* |
| <i>G/B Ratio</i> | 1.3 | 1.6 | 2.3 | 1.1 | 2.2 | 1.6 | 3.6 | 1.87 | 12.4 | 1.1 | 0.5 | 1.0 | 1.4 | 1.5 | 1.3 | 1.2 | 0.8 | 1.4 | 1.8 | 3.6 |

* Third term's tests

Figure 6.12 - Ratio between girls' and boys' achievement in U competencies (failure grade < 25%) of teacher X₇'s pupils: selected objectives

selected objectives than for the whole sample of objectives which constitute *A* competencies, i.e. after the teaching process has taken place, *differential achievement between boys and girls is reduced*. It also means that before the teaching process differential achievement is in general greater.

If we compare the *G/B* ratio in *U* competencies for the whole sample of objectives (Figure 6.10) to the ratio for selected objectives (Figure 6.12) we can see that the latter ratio is *much* smaller. This means that girls do much better on selected objectives than they do on the whole sample of objectives which constitute *U* competencies i.e. *differential achievement between boys and girls shows a very substantial decrease*. Further the marked reduction in differential achievement of *U* competencies is such that it approaches the pattern of differential achievement found for *A* competencies.

This allows us to say that our hypothesis is supported. We can now draw the following conclusion:

Lower-working class girls attending working class schools who have in general poorer achievement than boys of the same social class show a very marked improvement approaching the boys' achievement when there is explicit criteria, explicit sequencing rules and a weakening of pacing in the transmission-acquisition process. Patterns of differential gender achievement are changed to a point where they might well disappear if the changes become a regular feature of the teaching practice.

This conclusion is of extreme importance for it points to solutions for underachievement in school with respect to the relative underachievement of girls.

We would like to point out that our data shows that the greater relative improvement occurred in those competencies which are necessary for the higher level

understanding of the sciences, *U* competencies. When teacher X_7 maintained her level of conceptual demand *but changed her pedagogic practice* in the teaching of selected objectives the gender differential was greatly reduced.

For the sake of completeness we must add that we also examined the data of teacher X_3 who, as we have seen, is in a middle class school and whose pupils showed differential achievement in favour of girls in her middle school classes. We found that here the *boys* improve compared to girls, i.e. differential achievement was very much attenuated with boys approaching the girls' achievement.³⁸ Although the number of pupils is small, this suggests the general hypothesis that whenever a *differential achievement between two groups of pupils is found the disadvantaged group gains from explicitness of criteria and sequencing rules and a weakening of pacing*. We shall return to this issue later in the thesis when we shall be examining differential achievement in relation to social class.

5. CONCLUSION

5.1. In a previous chapter we described the analysis of the data using a stepwise regression. We saw that for the whole sample there was no relation between gender and achievement. It was only when the stepwise regression was applied to sub-samples corresponding to each teacher's pupils that a clear relation appeared for some teachers.

In this chapter we followed a method of analysis where we supplemented correlations (on which the stepwise regression analysis was based) with crosstabulation of variables. We were then able to make clearer the pattern of differential achievement and its possible explanations. Our study of special teaching for selected objectives pointed to a possible means of reducing differential gender achievement.

First our analysis was carried out at the level of the whole sample and correlation coefficients were used to trace a relation between gender and achievement. We reached the conclusion that there is no relation between gender and achievement. When an additional method of analysis was used, i.e. when the relation between gender and achievement was investigated by the crosstabulation of these two variables, we found some indication of a relation between gender and achievement. The two contradictory conclusions raised a number of questions which we felt we had to explore before accepting the conclusion that there was no relation between gender and achievement.

The whole sample was then divided in sub-samples according to each teacher's pupils. Our intention here was to create a number of sub-samples which would allow us to infer a pattern of similarity and difference between the classes of the various teachers. This enabled us to go much further. In fact we were able to reach conclusions 3, 4, 5, 6, 7, i.e. we were able to have a clearer insight into the relationship between the two variables gender and achievement through the influence of a third variable, social class.

5.2. We have tried in this chapter to find possible relations between gender and achievement, the patterns they follow and the reasons for their existence. Our analysis of a special teaching programme pointed to a possible solution.

If we consider the initial problem of the thesis, the evidence contained in this chapter provides us with some answers. On the basis of our findings we reached some important conclusions.

First, there is a differential achievement in sciences between boys and girls which is class based; upper-middle

class boys and girls perform equally and lower-working class boys perform better than girls especially in U competencies but only when they both attend working class schools. Girls' achievement is strongly linked to social class whereas boys' achievement has a weaker and less well defined linkage to it. Different learning conditions in the first agency of pedagogical transmission, i.e. the family, may be partly responsible for this differential achievement. Boys and girls of the lower-working class who attend a middle-class school and/or who live in the metropolis may experience less gender specific forms of socialisation in their families relative to the boys and girls who attend a working-class school especially if it is located in the country. Further a teacher with a high level of conceptual demand sharpens the division between boys and girls. From this point of view differential competence acquired at home is maintained or reinforced by the school. It is also possible that working-class boys and girls who attend a middle-class school and/or who live in the metropolis are influenced by the general culture of the school and by gender models in their school class.

Second, lower-working class girls attending a working class school show a very marked improvement approaching boys' achievement when there is greater explicitness of criteria and sequencing rules and a weakening of pacing in the transmission-acquisition process; and that this improvement is greater in U competencies. It seems that whenever a differential achievement between two groups of pupils is found the disadvantaged group gains from a greater explicitness of criteria and sequencing rules and a weakening of pacing.

If the above conclusions are now focussed on the initial problem of the thesis we can say that:

The underachievement of lower-working class girls attending working-class schools accounts for a small part

of the general under-achievement of many children in science classes; and their under-achievement in U competencies accounts for a relatively greater proportion of the general under-achievement.

A possible way to reduce the lower-working class girls' under-achievement is to make explicit criteria and sequencing rules and to weaken pacing in the transmission-acquisition process. Here we have clear evidence of the effect of the teacher's pedagogical practice on reducing differential gender achievement. Different conditions of teaching are required if we are to generalise a different pedagogic practice. Under present conditions it is unlikely that teachers can achieve in all objectives what our special programme teachers achieved in the case of the selected objectives.

If we consider that significant differential achievement occurs in *U* competencies and that *U* competencies are those which require a high level of abstraction, we can understand how different school courses can create different degrees of differential achievement. We can say that the greater the conceptual demand of a course and therefore of its level of abstraction under present conditions, *the greater the differential achievement between lower-working class boys and girls attending working-class schools.* This of course should not lead us to conclude that we must devise courses with a low level of conceptual demand, where factual knowledge only is stressed, in order to reduce differential achievement.

6. NOTES AND REFERENCES

1. H.M.I., 1980.
2. A. Kelly (ed.), 1981.
3. See *Girls into Science and Technology: The First Two Years*, 1982.
4. See also *Initial GIST Survey: Results and Implications*, 1981.
5. See Comber and Keeves, 1973.
6. See T. Yamane, 1973.
7. See I.N.E., 1982:

In the last two years of secondary school (when a choice has to be made) statistics of 1978-79 show that 63.7% of the girls (girls represented 54.9% of the total school population at this stage) were enrolled in one of the four areas of study in which mathematics is one of the subjects. Of these 63.7%, 45.3% were in one of the two areas of study in which biological sciences, physics and chemistry plus a vocational scientific subject (approximately one third of the timetable is allocated to this last) are studied. Considering the total of pupils in those four scientific areas, 52.8% are boys and 47.2% are girls. In the university numbers decreased, some girls had given up studies and many of them had followed medium level courses (e.g. kindergarten and primary school teaching, nursing). Thus statistics of 1979-1980 show for example that 37.3% of the women in the university followed science courses and 19.8% Economics and Social Sciences (girls represented 43.8% of the total university population). When we consider the total of students in those courses, 37.1% are women in the former and 42.3% in the latter; women outnumbered men in courses like medicine and pure sciences.

8. See I. Romão, 1978, pp. 22, 26, 29, 62-4.
9. See J. Holland, 1982, a research project of the SRU-University of London Institution of Education, comparing girls' and boys' performance in Britain and France.

10. D. Lavin, 1965, pp. 128-131.
11. Third term's achievement, the result of two tests given to pupils over that term, is the only one considered here because it is the most relevant to this study as it indicates the actual level eventually attained by pupils.
12. See Figures VIII.1 and VIII.2 in Appendix VIII.
13. See Chapter five on Quantitative analysis of sociological variables and achievement.
14. See summary statistics for each teacher in Appendix VIII (Figures VIII.3 and VIII.4) and quantitative analysis of sociological variables and achievement in Chapter five. See also Chapter four on Teacher's pedagogic practice.
15. See Chapter four on Teacher's pedagogic practice.
16. *Ibid.* 13.
17. *Ibid.* 13.
18. *Ibid.* 13.
19. For a better understanding it is useful to look at the whole distribution of the sample in each teacher's summary statistics in Figures VIII.3 and VIII.4 in Appendix VIII.
20. *Ibid.* 15.
21. See Chapter seven on social class and achievement.
22. *Ibid.* 15. See also Appendix IV.
23. *Ibid.* 15.
24. It should not be forgotten that when teachers are divided there is still a mixture of social classes in the school classes.
25. This is not to say that employment opportunities are equal for men and women scientists in Portugal. Although both men and women have similar chances to get a job, women scientists concentrate in work areas like teaching whereas men concentrate on industry. But such inequality does not seem to affect girls' achievement in science nor the girls following of science careers; in fact a very high proportion of girls choose such careers (see INE, 1982 and also

- note 7 above).
26. We should remember that in middle class schools half of the population are working class children.
 27. Teacher Z_4 should be part of this group, but, as we have seen, no differential achievement occurs in her pupils; as we said before it is very likely that girls have experienced a more intense family directed process of selection than boys.
 28. We should remember that although teacher X_5 's school is in Lisbon, her pupils came mostly from the suburbs of Lisbon. See characteristics of school X_D in Appendix I.
 29. *Ibid.* 15.
 30. *Ibid.* 21.
 31. *Ibid.* 18, to see the educational level of parents in this group of parents' educational qualifications (categories 5 and 6).
 32. See J. Holland, 1983.
 33. *Ibid.* 15.
 34. See Chapter three on Patterns of achievement in different types of competencies.
 35. *Ibid.* 34.
 36. *Ibid.* 34.
 37. *Ibid.* 34, Figure 3.5 and Appendix VI, Figure VI.1.
 38. The following tables summarise data for teacher X_3 :

| A COMPETENCIES <i>Pass Grade \geq 75%</i> | U COMPETENCIES <i>Failure Grade $<$ 25%</i> |
|---|--|
| $G/B = 1.26$ | $B/G = 18.19$ |

Ratio between boys' and girls' achievement in A and U competencies of teacher X_3 ' pupils (middle school): whole sample of objectives

| COMPETENCIES | A | | | | | | | U | | |
|------------------|-----------------|-----|----|-----------------|-----|-----------------|-----|-----------------|------|-----|
| YEARS | 7 th | | | | | | | 7 th | | |
| OBJECTIVES | 1 st | | | 2 nd | | 3 rd | | 4 th | | |
| TESTING ORDER | 2 | 3* | 4* | 6 | 7* | 9 | 10* | 29 | 30 | 31 |
| <i>G/B Ratio</i> | .9 | 1.1 | .7 | 1.3 | 1.1 | 1.0 | 1.0 | 4.1 | 4.1* | .5* |

* Third term's tests
Results of diagnostic test are not presented

Ratio between boys' and girls' achievement in A competencies (pass grade \geq 75%) and U competencies (failure grade $<$ 25%) of teacher X₃'s pupils (middle school): selected objectives

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CHAPTER SEVEN

SOCIAL CLASS AND ACHIEVEMENT

1. INTRODUCTION

The relationship between social class and achievement is at the centre of the initial hypotheses of the thesis. It was therefore crucial for this study to make a careful analysis of that relationship.

The stepwise regression¹ analysis revealed a relation between differential achievement of pupils and social class (as indexed by father's and mother's academic qualifications and occupations) but we were unable to understand the subtleties of the relationship and its underlying pattern of differences and discrepancies.

In this chapter we shall trace in some detail the complex relations between social class and the differential pattern of pupils' achievements of *A* and *U* competencies in different schools and sections of school, in different locations and with different teachers. Our approach to this analysis will be similar to the approach we have followed in previous chapters. We shall present the analysis in the order in which we carried it out. The reader will then be able to see the development of our analysis from the most gross general level to the more delicate levels suggested by the hypotheses we formulated in our attempt to create a path through the interaction of the variables.

We shall begin with the analysis of the relationship between social class and achievement using father's educational qualification as the indicator of social class. This analysis will broaden to include an attempt to explain differences in differential achievement according to social class through the mediation of other variables. We shall then proceed with an analysis based on mother's qualification and father's and mother's occupations which will be compared with the analysis made for only father's educational qualification. This will be followed by the description of a special teaching programme as this affected pupils' achievement. In our

conclusion we will present the main findings of the chapter.

2. ANALYSIS BASED ON FATHER'S EDUCATIONAL QUALIFICATION

2.1. CHOICE OF INDEX OF SOCIAL CLASS

Our indices of social class position of the family are in terms of the education and occupations of the parents. We did not produce a compound index for both parents as we wanted to explore the differential relation to pupils' achievements of each parent's level of education and occupational function. Further there is good reason that a woman's educational level and occupation arises out of a different inter-play of contexts, attitudes and opportunities than the educational level and occupational function of a man. We decided to choose educational level as our crucial class indicator because we were able to construct here an ordinal scale of levels of education which formed a hierarchy of achievement and, as a consequence, the correlational values and stepwise regression based upon them, are the result of a regular hierarchy of increasing values. This was not the case for the scale of occupations. Further in Portugal there are few studies which permit us to create a scale of increasing status of occupational groups. Secondly, the scale we constructed deliberately differentiated groups of occupations which on theoretical grounds we believed would have a special relation to pupil achievement.² As a consequence our occupational scale does not yield a smooth interval scale of increasing hierarchical position and so our correlations are affected by this irregular hierarchy. Finally, educational level, in general, has higher correlations with pupils' achievement than occupational level (Figure 7.18).

Although in the main there is a high correlation between mother's and father's educational level and occupation (see general matrices of correlations)³ for the above reasons we decided to base our analysis upon educational level as our indicator of class position.

Finally we chose father's educational level in preference to that of mother's for the following reasons:

- (a) The correlation with achievement is in general higher, as can be seen in the table of Figure 7.18.
- (b) The relationship between father's qualification and achievement shows more regular patterns than the relation between mother's qualification and achievement.⁴
- (c) Although there is a difference in level between mother's and father's educational qualifications, this difference is consistent across the levels (Figure 6.6).
- (d) Father's and mother's educational qualifications are highly correlated as can be seen in the general matrices of correlations.⁵

2.2. DATA ORGANIZATION AND COMPARISONS

2.1.1. Crosstabulation of father's educational qualification and pupil's achievement are here presented in histograms.⁶ The percentage, in relation to the total number of each of the different social groups, is indicated in each bar. The mean score is indicated in brackets at the top of each bar. A * sign at the top of each bar indicates that the number of pupils is less than 5 in the cell which produced that bar; a number < 5 is not considered significant.⁷

Secondly, if we are examining a category within the educational scale (row of cells) where the total number of pupils is less than or equal to five then we drop the respective row from our analysis, i.e. we assume that no pupils exist in this category.

2.1.2. Our comparisons are as follows:

Within each one of the two groups, middle and upper school, a comparison between the achievement of children of different social groups is made for either *A* or *U* competencies. Comparisons across competencies and across the two sections of the school are also made. Our interpretations are based upon correlations between father's educational qualification and achievement supplemented by the following data from the crosstabulations:

- (a) Mean scores
- (b) Pass grades (achievement higher than 50%, levels 3 and 4). Failure grades (achievement lower than 50%) can be inferred from the pass grades.
- (c) Failure grades < 25% (level 1) and pass grades \geq 75% (level 4). This enables us to distinguish pupils who have either an exceptionally low or an exceptionally high achievement.

2.3. FIRST STAGE

We began with a *hypothesis* which can be stated as follows: "Differential achievement is more marked in the case of *U* competencies between children of different social groups; working class having the lowest performance and upper-middle class having the highest performance". This hypothesis is of course a sub-hypothesis of the broad hypotheses with which this study began.⁸ We also

hypothesized that differential achievement is greater in the middle than in the upper school, as a result of the process of selection which has already taken place in the upper school.

2.3.1. Findings

The table in Figure 7.1 summarizes the correlation values between father's educational qualification and achievement in *A* and *U* competencies for both middle and upper school.

| SECTIONS OF THE SCHOOL | COMPETENCIES | |
|------------------------------|--------------------|------------|
| | <i>Acquisition</i> | <i>Use</i> |
| <i>Middle School</i> | .07 | .10 |
| <i>Upper School</i> | .25 | .31 |

Figure 7.1 - *Correlation between father's educational qualification and achievement*

The histograms in Figure 7.2 show the values of the relationship between father's educational qualification and achievement in both the middle and the upper school and in both *A* and *U* competencies as given by the crosstabulation between the two variables.

2.3.2. Interpretation

Correlation coefficients always have a positive value and are higher in *U* than in *A* competencies both in the

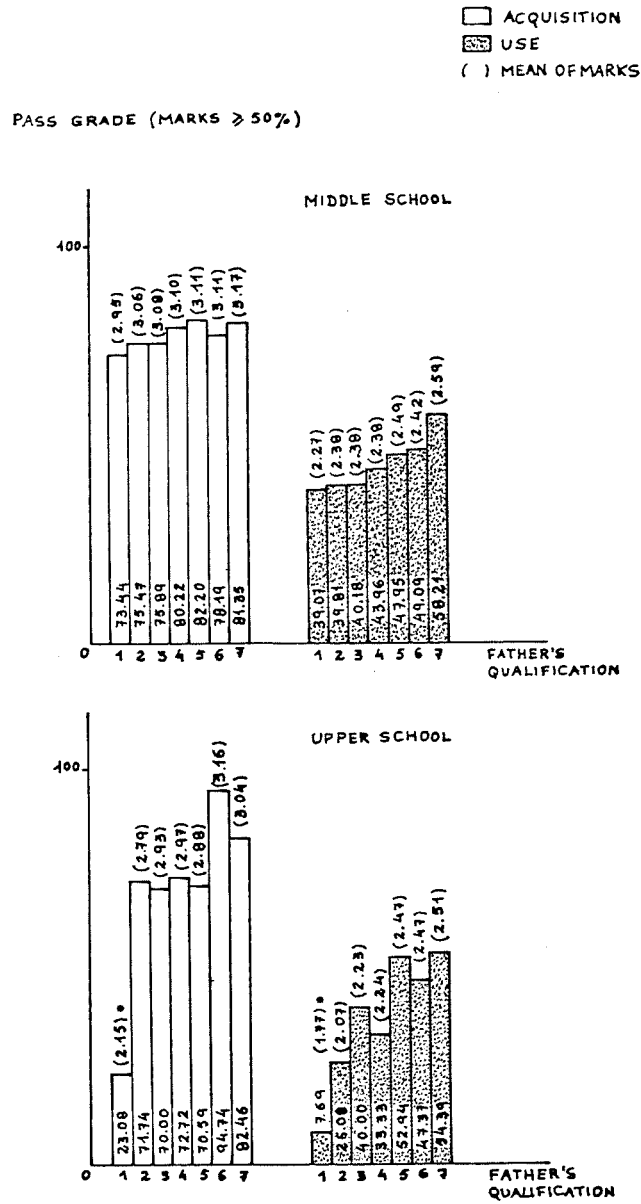


Figure 7.2 - Relation between father's educational qualification and achievement: All sample, Middle and Upper School

PASS GRADE \geq 75%

FAILURE GRADE $<$ 75%

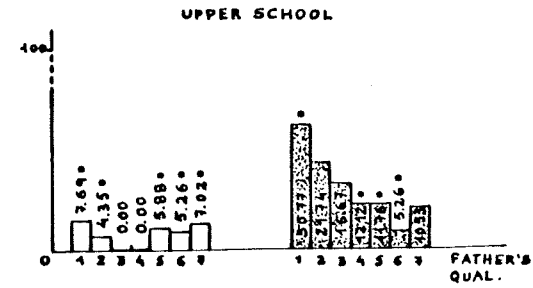
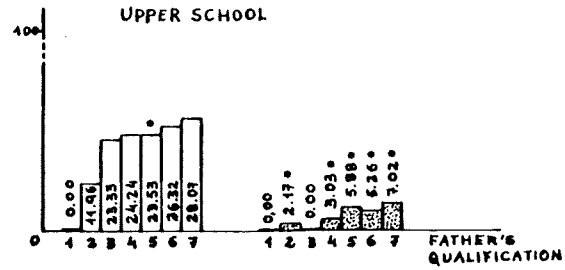
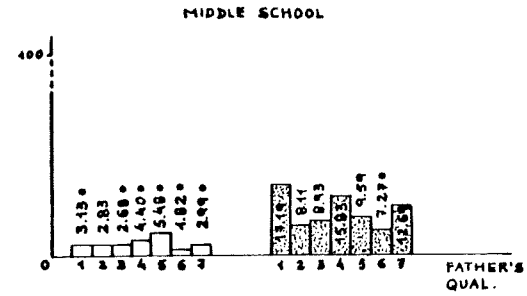
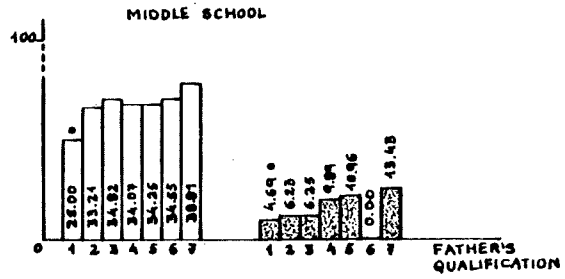


Figure 7.2 (cont.)

middle and the upper school. They are higher in the upper than in the middle school for both *A* and *U* competencies. This could mean that middle class children perform better than working class children and that such a difference is more marked in the upper than in the middle school and in *U* than in *A* competencies. Considering, however, that correlation coefficients are low in the middle school (to the point that they can be considered statistically not significant) and that they are not significantly higher in *U* than in *A* competencies (especially in the middle school) we can conclude: *There is differential achievement between children of different social groups in the upper school, but no significant differential achievement exists in the middle school; furthermore, there is no significant difference between A and U competencies either in the middle or in the upper school (Conclusion 1).*

Crosstabulation graphed in Figure 7.2 shows that:

Middle School - There is no significant difference in *A* competencies although middle class children are slightly better: mean marks and percentage of pass grades are slightly higher for middle class children, although the percentage of pupils achieving pass grades $> 75\%$ is higher for middle-class pupils the percentage of failure grades $< 25\%$ is virtually equal for all social groups. However some class differences appear in the case of *U* competencies. We can see some grading of increased competence as we pass from the bottom to the top of the social class scale. The mean marks, percentage of pass grades, pass grades $> 75\%$ are all higher for the highest social classes although the percentage of failure grades $< 25\%$ is similar across the social classes.

Upper School - There is a difference in *A* competencies in the different social groups, especially between 1-2 and other groups: mean marks, percentage of pass grades and

percentage of pass grades $\geq 75\%$ are better for groups 3-7, although the percentage of failure grades $< 25\%$ is quite similar. In *U* competencies there is a quite marked grading of increased competence from the bottom to the top of the social scale: mean marks, percentage of pass grades $\geq 75\%$ are all higher for the highest social groups and percentage of failure grades $< 25\%$ is lower also for the highest social groups.

Based on this evidence we can conclude: *although not very marked, there is a differential pattern of achievement in the middle school between children of different social groups; the highest social groups seem to be better especially in U competencies. In the upper school the differential class pattern of achievement is more clearly marked especially in U competencies (conclusion 2).*

Our final conclusion of this initial analysis depends upon which conclusion we accept as having greater validity. Thus if we take conclusion 1 based upon statistical significance of correlation our initial hypothesis has little support, however if we take conclusion 2 there is a greater measure of support for the hypothesis. Even in this case, however, there is no great class difference between *A* and *U* competencies even in the upper school where the differential achievement of pupils is greater than in the middle school.

However we should note that the number of middle class children with pass grades $\geq 75\%$ is much higher than that of working class children especially in *U* competencies. This is a fact of the greatest importance particularly in the upper school because university entrance selection has required very high marks (particularly the most prestigious degrees like medicine, engineering, etc.), and as a consequence middle-class children are favoured.

2.4. SECOND STAGE

On the basis of the above two partially contradictory conclusions we decided that we would use a strong criterion of support for our hypothesis and as a consequence we accepted conclusions 1, i.e. that our hypothesis was not confirmed. We were puzzled, however, not only because of the discrepancy found between the middle and upper sections of the secondary school, but also because of the small differential achievement even in *U* competencies found in the middle school. In fact if differential achievement is class regulated it should be more marked in the middle than in the upper school and more marked for *U* than for *A* competencies. We did find differential achievement, but it was clearly marked only in the upper school where *both A* and *U* competencies were affected.

Based on the fact that teachers differ so much in their pedagogical practice⁹ and the findings of the stepwise regression analysis which gave the teacher as the most important variable in explaining differential achievement in the middle school¹⁰ we put forward a new *hypothesis*: "The small differential achievement between different social groups in the middle school, and the small difference between achievement in *A* and *U* competencies is due to great differences between teachers' pedagogical practice and these differences conceal the relationships between father's educational qualification and achievement *when the sample is treated as a whole*". The fact that the upper school teachers in our sample were more similar in their pedagogical practice than the middle school teachers¹¹ could explain why differential achievement was more evident in that section of the secondary school.

In order to investigate this revised hypothesis we need to treat each teacher's classes of pupils as a separate case; for only then can we investigate the effect each teacher's pedagogic practice¹² has on pupil achievement.

2.4.1. Findings

The table in Figure 7.3 summarizes the correlation values between father's educational qualification and achievement in *A* and *U* competencies in the middle and the upper schools when the unit of the sample is a teacher.

| SECTIONS OF SCHOOL & TEACHERS | | COMPETENCIES | | <i>Acquisition</i> | <i>Use</i> |
|-------------------------------------|-------|--------------|--|--------------------|------------|
| | | | | | |
| <i>Middle School</i> | X_2 | (2) | | .18 | .21 |
| | X_4 | (4) | | .09 | .16 |
| | X_5 | (5) | | .04 | .21 |
| | X_6 | (6) | | .09 | -.05 |
| | X_7 | (7) | | .09 | .24 |
| | Z_1 | (8) | | .09 | .06 |
| | Z_3 | (10) | | .00 | .02 |
| | Z_4 | (11) | | -.05 | .13 |
| <i>Upper School</i> | X_3 | (3) | | .03 | .15 |
| | Z_2 | (9) | | .33 | .38 |

Figure 7.3 - *Correlation between Father's educational qualification and achievement: Pupils separated by teachers*

Histograms in Figures 7.4 and 7.5 show the relationship between father's educational qualification and achievement in *A* and *U* competencies in the middle (Figure 7.4) and the upper school (Figure 7.5) when pupils are separated by teachers.

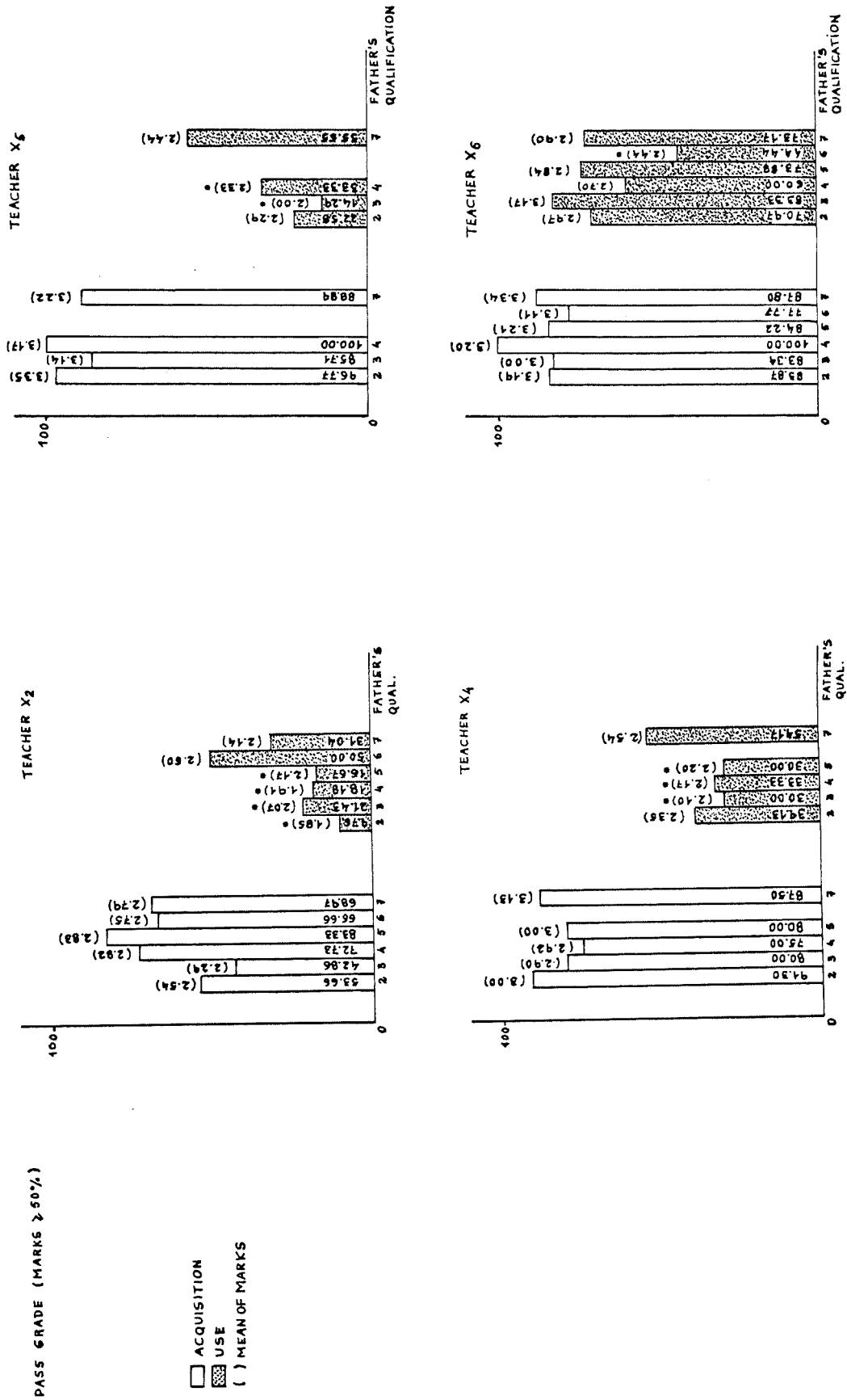


Figure 7.4 - Relation between father's educational qualification and achievement: Middle school separated by teachers

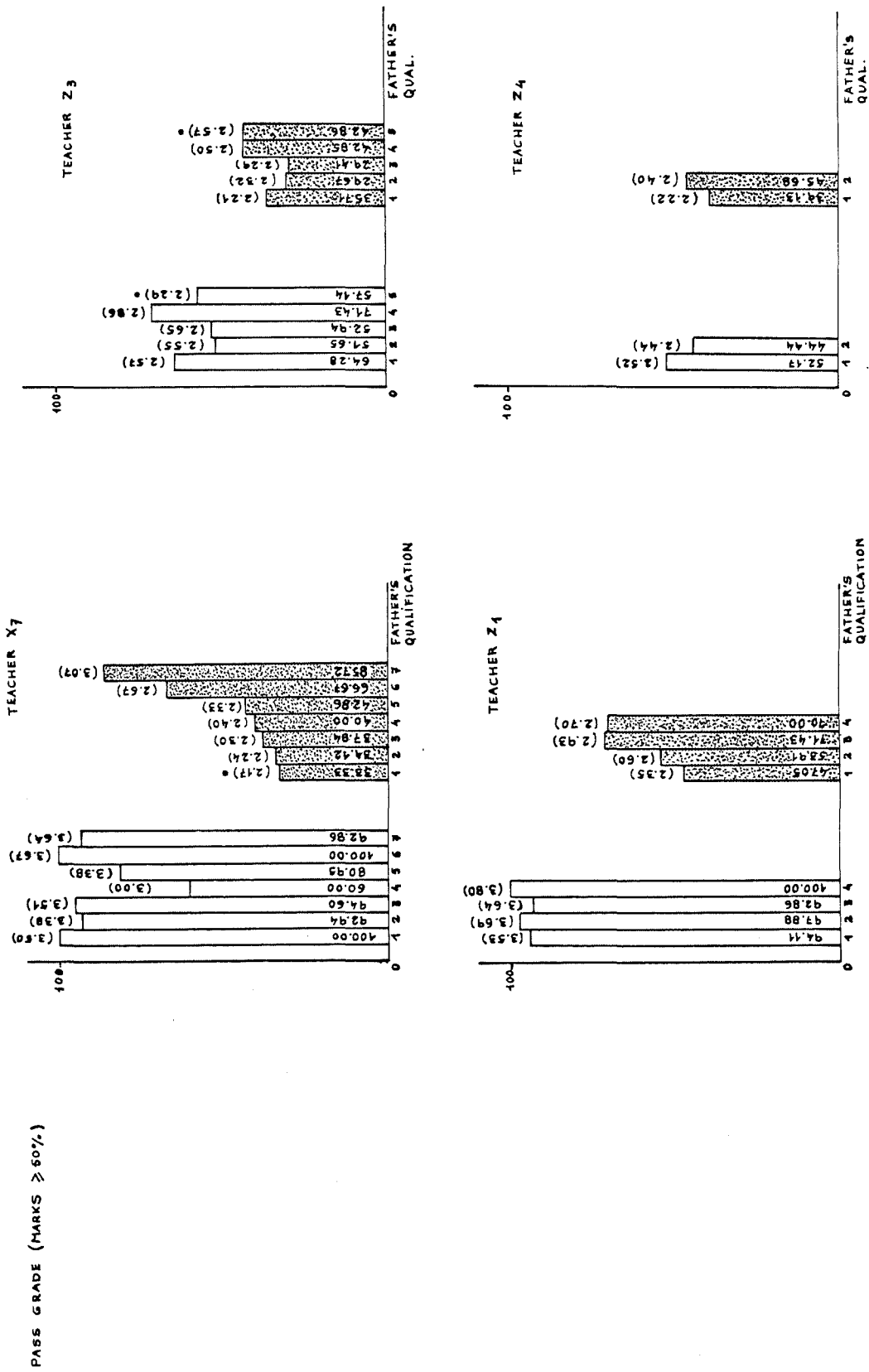


Figure 7.4 (cont.)

PASS GRADE (MARKS \geq 60%)

PASS GRADE > 75%

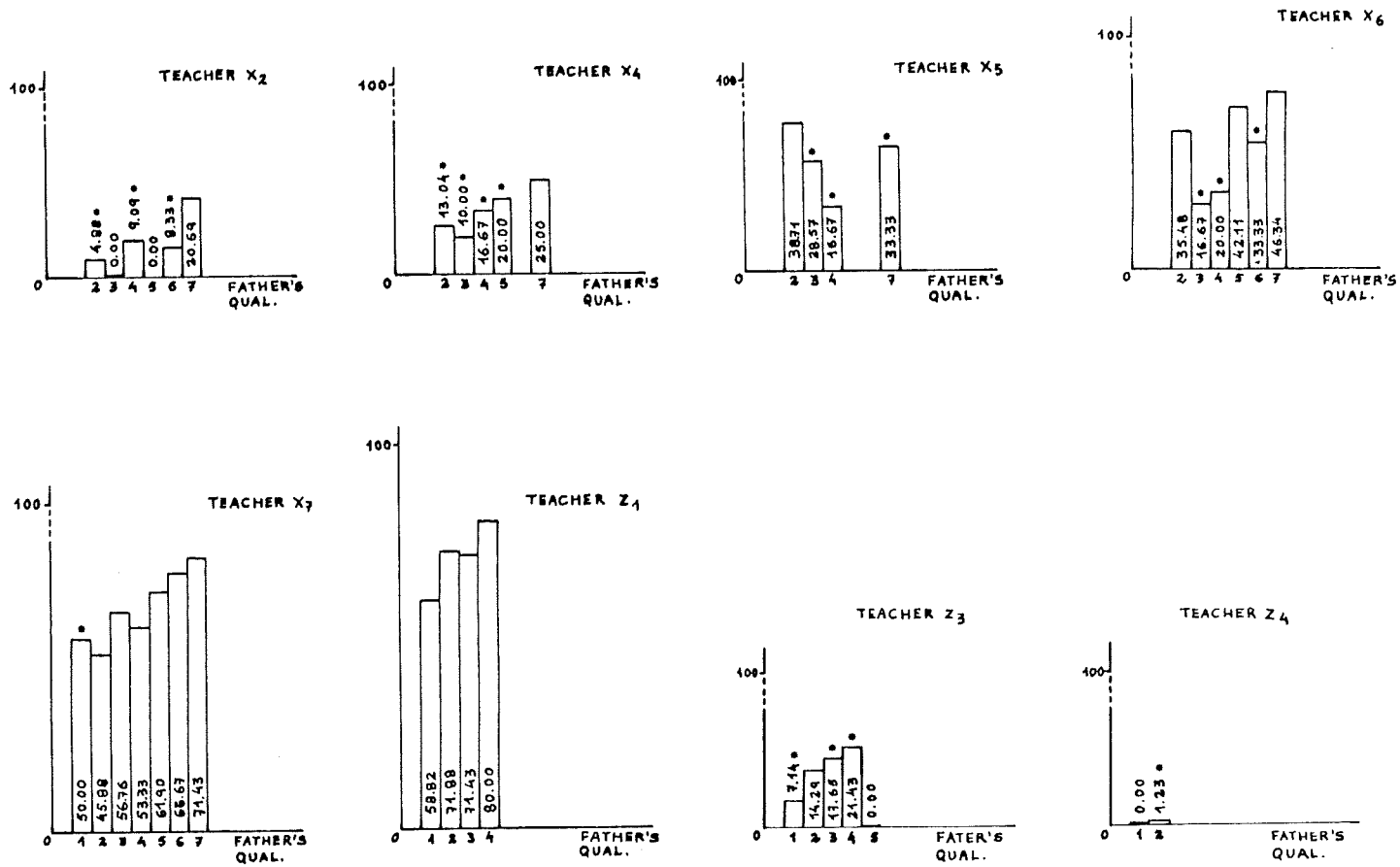
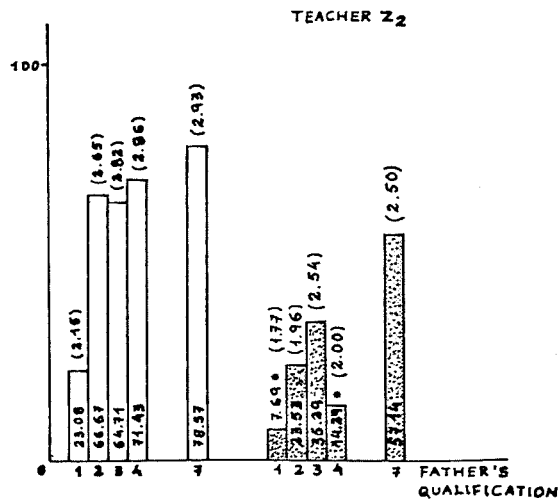
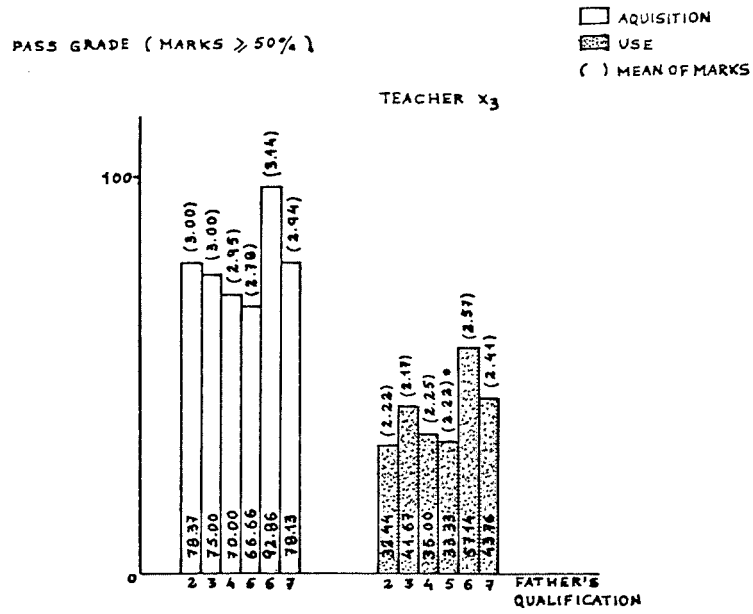


Figure 7.4 (cont.)



PASS GRADE $\geq 75\%$

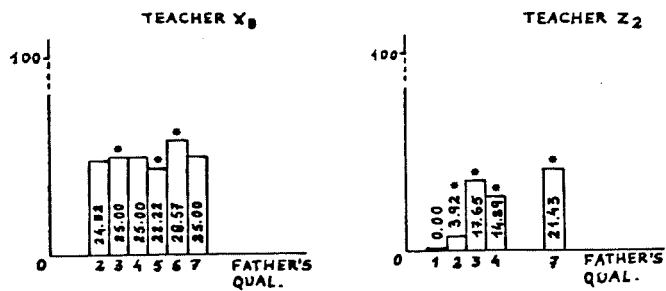


Figure 7.5 - Relation between father's educational qualification and achievement: Upper school separated by teachers

In this analysis we had to discard teachers X_1 , X_3 in middle school and teacher X_1 in upper school because of the small number of pupils and the great variation in their father's educational qualification. These two facts together made the data unsuitable for comparison.

For this analysis we graphed for A competencies pass marks $\geq 50\%$ and pass marks $\geq 75\%$ and for U competencies we graphed only the general pass marks $\geq 50\%$. We were forced to ignore failure marks $< 25\%$ for both A and U competencies and pass marks $\geq 75\%$ for U competencies because the number of pupils in each cell for virtually all categories and all teachers was below five.

2.4.2. Interpretation

In the middle school, the correlations are low for A competencies in the case of teachers X_5, Z_3, Z_4 and for U competencies in the case of teachers X_6, Z_3 . Note teacher Z_3 has low correlation for both A and U competencies. In the upper school, there is a low correlation in the case of teacher X_3 for A competencies. On the other hand some other correlations are relatively high. In the middle school for A competencies teacher X_2 and for U competencies teachers X_2, X_5, X_7 . Note teacher X_2 has high correlations for both A and U competencies. In the upper school teacher Z_2 has high correlations for both A and U competencies. These high values are all statistically significant.

We can conclude that *in some cases both in the middle school and in the upper school there is a class regulated pattern of achievement especially for U competencies where the highest social groups perform best (conclusion 3)*. We reached the same conclusion on the basis of the stepwise regression analysis when the unit was the classes of a teacher.¹³

On the basis of the crosstabulations graphed in Figures 7.4 and 7.5 we can see that *there is a definite pattern of differential achievement between different social groups very well marked for many teachers and especially for U competencies, where the highest social groups are always the best; there is a similar pattern for A competencies if we consider pass grades $\geq 75\%$ (conclusion 4).*

Although the correlations are statistically significant, we find this is only the case for a small number of teachers and so we would be reluctant to say that this evidence is supportive of our hypothesis. However, the histograms (Figures 7.4 and 7.5) permit a more delicate analysis and here we can see that our initial hypothesis is supported: *There is differential achievement more marked for U competencies between children of different social groups, working-class having the lowest performance and upper middle-class having the highest; this pattern of differential achievement is in general similar in the middle and the upper school (conclusion 5).*

This last point faults our initial hypothesis for we had hypothesized that differential achievement should be *higher* in the middle than in the upper school. The relatively higher level of teacher demand in the upper school probably accounts for the similarity between middle and upper school. It may well be that it is this very high level of teacher demand that is responsible for the lower working-class children's (especially those whose parents cannot read or write) failure in the upper school.

Finally, we should stress that, as we hypothesized, the small differential achievement between different social groups in the middle school and the small difference between achievement in A and U competencies we found, was a consequence of treating the sample as a whole and this concealed the true relationships. When each teacher's classes of

pupils are analysed separately we can see the social class regulation of achievement. However, this *does not show that it is the teacher herself who causes that effect*. In fact we should not forget that when we separated the sample by teachers, we simultaneously separated it by other variables such as type and area of school, gender and social composition of the classrooms, percentage of pupils repeating.

We should note that because the sub-samples of teacher/ classes necessarily contain a small number of pupils and because father's educational qualification is measured by a scale of seven points the probability of finding statistical significance is not high. We have found that some relations are indeed significant. But our major interest here is in finding *patterns* of differences and similarities between sub-samples rather than in the isolated significance of one sub-sample.¹⁴

2.5. SOCIAL CLASS AND ACHIEVEMENT AS MEDIATED BY OTHER VARIABLES

At this point we have to look for explanations of the differences we encountered between each teacher's pupils. In fact although we found a pattern of differential achievement according to social class as indexed by father's educational qualification for most teachers, such differential achievement is not equal for all teachers and for a few teachers is absent, as in the case, for example, of teachers X_6, Z_1, Z_3 . On the other hand, we find that a highly *pedagogically* competent teacher, X_7 ,¹⁵ produces a class of pupils which exhibits a pattern of class regulated differential achievement. Thus such differential achievement is difficult to attribute wholly to the lack of pedagogic competence of the teacher and it may well be in part a function of the high level performances required by *U* competencies which perhaps working-class children are less likely to acquire under particular pedagogic regimes.

However our conclusion (conclusion 5) leaves some discrepant cases and differences between sub-samples of pupils to be explained. Many hypotheses can be put forward to explain these discrepancies and we are now going to explore the likeliest ones on the basis of the data we possess. First we shall deal with each hypothesis separately; then we shall examine them together.

2.5.1. The mediation of gender

As we have seen before,¹⁶ differential achievement is related to gender: lower working-class girls attending working class schools, especially in *U* competencies, perform worse than boys of the same social class. We have also seen that when the sample is divided in two groups, boys and girls, the relationship between social class and differential achievement is much more marked and well defined for girls than for boys. Thus there are gender differences *within* social class position which affect girls' achievement within the working-class.

From this point of view we might think that that part of the comparative underachievement of the lowest social groups in working-class schools is more due to the underachievement of *girls* than to the underachievement of boys. Further, if in such schools *boys* outnumber girls differential achievement related to social class should be less evident. If *girls* outnumber boys differential achievement related to social class should be more evident, i.e. whenever the lower working-class is fundamentally represented by girls differential achievement will tend to be greater. The more the lower working-class predominates in the school population the more that effect should be important.

Let us then look at the gender composition of each teacher's sample of pupils. Percentages are shown in table of Figure 7.6; these should be viewed in relation to the

characterization of each school's social composition which is summarized in Figure 7.12 (paragraph 2.5.3). As in our previous analysis,¹⁷ a qualitative scale of the schools' social composition is indicated by brackets following the number of each teacher.

| TEACHERS AND SCHOOLS | | GENDER | | |
|-------------------------|-------|-------------|--------------|-------|
| | | Boys (%) | Girls (%) | |
| Middle School | X_2 | (M) | 56.64 | 43.36 |
| | X_4 | (M) | 39.29 | 60.71 |
| | X_5 | (W+) | 42.86 | 57.14 |
| | X_6 | (M) | 42.74 | 57.26 |
| | X_7 | (W+) | 39.04 | 60.96 |
| | Z_1 | (W) | 73.56 | 26.44 |
| | Z_3 | (W) | 54.90 | 45.10 |
| | Z_4 | (W) | 37.17 | 62.83 |
| Upper School | X_3 | (M) | 44.35 | 55.65 |
| | Z_2 | (W+) | 38.18 | 61.82 |

Figure 7.6 - Percentage of boys and girls
in each teacher's sample of pupils

If we now concentrate on the analysis of the working class schools we shall be able to see that those where girls outnumber boys (teacher X_5, X_7, Z_4, Z_2) are those where great differential achievement related to social class occurs. Schools where boys outnumber girls (teachers Z_1, Z_3) have small differential achievement. The differential achievement associated with teacher Z_4 cannot be explained by this gender effect because, as we have seen,¹⁸ no relationship exists between gender and achievement for this teacher.

If we look at the values in the table of Figure 7.12 (paragraph 2.5.3) where the social composition of each teacher's sample is indexed, we can see that *the effect described above is most marked for teachers Z_1 and even for Z_3, Z_2 who have an extremely high percentage of the lower-working class population in their classes.*

2.5.2. The mediation of repetition

2.5.2.1. We have already seen¹⁹ that repeaters and non-repeaters have different levels of achievement: non-repeaters are in general better than repeaters especially in the case of *U* competencies and in the upper school. This can be seen very clearly in the analysis of the values presented in the tables of Figures 7.7 and 7.8.

Category 1 corresponds to category 1 and category 2 corresponds to categories 2, 3, 4, 5 in the first 1-5 scale established for repetition.²⁰ Therefore category 1 refers to pupils who have never repeated a year in their school lives and category 2 corresponds to pupils who have repeated one or more years in the past and/or in the present, i.e. the year in which they are now.

Use

| MARKS REPETITION | 1 (%) | 2 (%) | 3 (%) | 4 (%) | Mean |
|---------------------|----------|----------|----------|----------|------|
| 1 | 6.68 | 44.04 | 37.91 | 11.37 | 2.54 |
| 2 | 12.87 | 50.30 | 34.26 | 2.57 | 2.27 |

CONT (Overleaf)

Acquisition

| MARKS REPETITION | MARKS | | | | Mean |
|---------------------|----------|----------|----------|----------|------|
| | 1 (%) | 2 (%) | 3 (%) | 4 (%) | |
| 1 | 2.53 | 16.06 | 42.78 | 38.63 | 3.18 |
| 2 | 3.76 | 22.67 | 44.75 | 28.51 | 2.98 |

Figure 7.7 - *Relation between repetition and achievement: middle school*

Use

| MARKS REPETITION | MARKS | | | | Mean |
|---------------------|----------|----------|----------|----------|------|
| | 1 (%) | 2 (%) | 3 (%) | 4 (%) | |
| 1 | 11.18 | 43.53 | 40.59 | 4.71 | 2.39 |
| 2 | 21.98 | 54.95 | 21.98 | 1.10 | 2.02 |

Acquisition

| MARKS REPETITION | MARKS | | | | Mean |
|---------------------|----------|----------|----------|----------|------|
| | 1 (%) | 2 (%) | 3 (%) | 4 (%) | |
| 1 | 2.94 | 17.06 | 53.53 | 26.47 | 3.04 |
| 2 | 4.40 | 32.97 | 56.04 | 6.59 | 2.65 |

Figure 7.8 - *Relation between repetition and achievement: upper school*

2.5.2.2. Let us now find whether or not the relation between repetition and achievement is influenced by a third variable, social class. We shall divide the two samples of repeaters and non-repeaters into four groups according to father's educational qualification.

- 1st group - f.e.q. 1-2
 2nd group - f.e.q. 3-4
 3rd group - f.e.q. 5-6
 4th group - f.e.q. 7

It should be noted that in this analysis we are combining teachers and therefore a certain blurring of relations is to be expected, especially in the middle school where the variance between teachers is relatively greater than in the upper school.²¹

The tables in Figures 7.9 and 7.10 summarize the results for achievement in relation to these four groups for both *A* and *U* competencies within the middle (Figure 7.9) and upper (Figure 7.10) schools. We are focussing upon pass grades $\geq 50\%$ only, so as to reduce the exposition and because it is sufficient for the purpose of this analysis. Accordingly we are not graphing these data as we have done in other cases. The figures refer to percentages of children who have marks $\geq 50\%$ within a given category.

| REPETITION FATHER'S QUALIFICATION | Acquisition | | Use | |
|---|-------------------|---------------|-------------------|---------------|
| | Non-Repeaters (%) | Repeaters (%) | Non-Repeaters (%) | Repeaters (%) |
| 1 | 79.76 | 72.05 | 48.99 | 36.02 |
| 2 | 81.42 | 73.33 | 46.90 | 35.56 |
| 3 | 83.15 | 74.36 | 55.06 | 33.33 |
| 4 | 81.90 | 79.31 | 57.75 | 62.06 |

Figure 7.9 - *Relation between repetition and achievement: middle school separated by father's educational qualification*

| REPETITION FATHER'S QUALIFICATION | Acquisition | | Use | |
|---|-------------------|---------------|-------------------|---------------|
| | Non-Repeaters (%) | Repeaters (%) | Non-Repeaters (%) | Repeaters (%) |
| 1 | 69.49 | 60.87 | 30.51 | 15.22 |
| 2 | 74.47 | 62.50 | 42.55 | 18.75 |
| 3 | 95.83 | 58.33 | 58.33 | 33.33 |
| 4 | 92.50 | 58.82 | 62.50 | 35.29 |

Figure 7.10 - *Relation between repetition and achievement: upper school separated by father's educational qualification*

From the above tables we can draw the following conclusions:

- (a) *U competencies in the middle school* - there is a strong social class effect upon the achievement of repeaters; among non-repeaters the social class effect on differential achievement is very much smaller.
- (b) *U competencies in the upper school* - there is a strong social class effect upon achievement for both repeaters and non-repeaters.
- (c) *A competencies in the middle school* - there is a very small social class effect upon achievement in repeaters and no class effect upon achievement in non-repeaters.
- (d) *A competencies in the upper school* - there is no class effect upon the achievement in repeaters; there is a clear class effect upon achievement in non-repeaters.

And with respect to differences between repeaters and non-repeaters of different social classes:

- (a) *U competencies in the middle school* - repeaters of upper-middle class are as good as non-repeaters; in all other social groups repeaters are worse.

- (b) *U* competencies in the upper school - repeaters of all social groups are much worse than non-repeaters with a more marked difference than in the middle school (in the groups where the difference existed).
- (c) *A* competencies in the middle school - repeaters of upper middle-class are as good as non-repeaters; in all other social groups repeaters are slightly worse.
- (d) *A* competencies in the upper school - repeaters are always worse than non-repeaters but the difference is more marked for the two highest social groups.

From the above two general conclusions can be drawn:

- (1) Non-repeaters are in general better than repeaters, especially in the case of *U* competencies; a conclusion we had reached before. From this it follows that the more repeaters in a sample the higher the underachievement of that sample. As repeaters are related to social class (in our sample for example the mean of the academic qualification of the fathers of non-repeaters is 3.77 whereas the mean of repeaters is 2.64) such underachievement related to repetition is again a function of social class.
- (2) Repetition seems to be a more efficient procedure for improving achievement especially in *U* competencies in the middle than in the upper school.

However, the most relevant conclusion with respect to the relation between social class background and achievement of pupils is the following:

- (3) For *U* competencies the pattern of differential achievement between different social groups is strongly marked for *repeaters* both in the middle and the upper school and for *non-repeaters* in the upper school.

However, for *A* competencies the class effect is strongly marked only for non-repeaters in the upper school.

2.5.2.3. These findings are strong support for the hypothesis that there is a relation between social class, repetition and differential achievement. This hypothesis holds only for the middle-school. In the upper-school non-repetition affects differential achievement and here only in the case of *A* competencies.

The relative underachievement of the lowest social groups in the middle school is more due to the underachievement of *repeaters* than to the underachievement of non-repeaters. If non-repeaters outnumber repeaters differential achievement related to social class will be less marked; however, if repeaters outnumber non-repeaters, differential achievement related to social class will be more marked, i.e., whenever the lowest social groups are mainly represented by repeaters differential achievement will tend to be greatest. The more the lowest social groups predominate in the school population the more that effect will be evident.

Let us now analyse the percentage of repeaters and non-repeaters in each teacher's sample of pupils. Percentages are shown in table of Figure 7.11. These should be viewed in relation to the characterisation of the social composition of each teacher's pupils which is summarized in Figure 7.12 (paragraph 2.5.3.). A qualitative scale of the schools social composition is indicated (in brackets following the teacher).

In order for there to be an inter-relation between social class, repetition and achievement then the school classes must contain representatives from *both* middle-class and working-class. Teachers Z_1, Z_3, Z_4 do not have the full social class range represented among their pupils and as a

| TEACHERS AND SCHOOLS | | REPEATERS | <i>Non-repeaters</i> (%) | <i>Repeaters</i> (%) |
|-------------------------|-------|-----------|-----------------------------|-------------------------|
| | | | | |
| <i>Middle School</i> | X_2 | (M) | 89.38 | 10.62 |
| | X_4 | (M) | 66.67 | 33.33 |
| | X_5 | (W+) | 20.63 | 79.37 |
| | X_6 | (M) | 82.91 | 17.09 |
| | X_7 | (W+) | 58.82 | 41.18 |
| | Z_1 | (W) | 35.06 | 64.94 |
| | Z_3 | (W) | 41.18 | 58.82 |
| | Z_4 | (W) | 7.08 | 92.92 |
| <i>Upper School</i> | X_3 | (M) | 64.52 | 35.48 |
| | Z_2 | (W+) | 60.00 | 40.00 |

Figure 7.11 - *Percentage of non-repeaters and repeaters in each teacher's sample of pupils*

consequence the social class, repetition/achievement relation does not hold for these teachers. On the basis of our argument we would expect the class-repetition achievement effect to be most strongly marked for teachers X_7 and especially X_5 because they have a social hierarchy among their pupils and *both* a high percentage of repeaters and a high proportion of low social class pupils. The class-repetition achievement should be least marked in the case of teachers X_2 , X_4 , X_6 because they have a low percentage of repeaters and a high proportion of middle-class pupils.

The above means that *part of the differential achievement in relation to social class of teachers X_5 , X_7 may be*

attributed to the relation between repetition and social class background. The differential achievement of the pupils in the classes of teachers X_2, X_4, X_6 cannot be attributed to the relation between social class and repetition.

In the upper school the differential achievement in relation to social class cannot be attributed to the relation between repetition and social class background. Here it is the percentage of non-repeaters which may account for part of the differential achievement in relation to social class but only in 4 competencies.

2.5.3. The mediation of the teacher's pedagogical practice

As we have seen before,²² the teacher's pedagogical practice is strongly influenced by the social composition of the school: teachers in schools with a low social composition tend to lower their level of conceptual demand and therefore the level of abstraction elicited by their courses tends to be low.

From this we can deduce that the focus of transmission will be more directed to the pupils of the social class which predominates in the school. In such circumstances, where a relation exists between social class and achievement (as we have found), a working class child in a working class school will tend to show higher achievement when compared to a middle class child than if he/she were in a middle class school. *Therefore differential achievement between different social groups will tend to be greater in middle class schools.*

Let us then analyse the social composition of each teacher's sample of pupils. This is summarized in the table of Figure 7.12 which shows the mean fathers' educational qualification and the percentage of pupils with f.e.q. 1

and f.e.q. 2 (lower working-class) and f.e.q. 7 (upper middle-class).

| TEACHERS | | FATHER'S QUALIFICATION | Mean | 1 (%) | 2 (%) | 7 (%) |
|--------------|-------|------------------------|-------|-------|-------|-------|
| | | Middle School | X_2 | | 4.19 | 0.00 |
| X_4 | | | 4.34 | 1.20 | 27.71 | 27.71 |
| X_5 | | | 3.33 | 3.28 | 50.82 | 11.48 |
| X_6 | | | 4.76 | .85 | 26.50 | 35.04 |
| X_7 | | | 3.21 | 3.23 | 45.70 | 6.99 |
| Z_1 | | | 2.21 | 9.77 | 73.56 | .57 |
| Z_3 | | | 2.55 | 9.33 | 60.67 | 1.33 |
| Z_4 | | | 1.95 | 20.54 | 72.32 | 0.00 |
| Upper School | X_3 | | 4.34 | 0.00 | 30.33 | 24.59 |
| | Z_2 | | 2.97 | 12.04 | 47.22 | 11.11 |

Figure 7.12 - Summary of the social composition of each teacher's sample as given by f.e.q.

The figures in the table show that the focus of transmission is likely to be more directed to the middle class pupil with teachers X_2, X_4, X_6, X_3 and more directed to the working class pupil with teachers Z_1, Z_3, Z_4 . It is possible that teachers X_5, X_7, Z_2 hold the tension between these two extremes. However, it is very likely that because of the pedagogic attributes of these teachers (X_5, X_7 are

'strict' and Z_2 is not 'benevolent')²³ the focus of their transmission is likely to be directed towards the middle-class pupils.

The above appears to indicate that *part of the differential achievement in relation to social class of teachers $X_2, X_4, X_5, X_7, X_3, Z_2$ can be due to the influence of this factor.* It is of course true that such an influence will only be noticed in schools where a social class hierarchy exists among the pupils, as indeed it is the case in the schools where these teachers work.

We must stress that the differential achievement between social groups due to the effect described above is *directly* related to the teacher's pedagogical practice but is *indirectly related* to the social class composition of the school.

The above appears to indicate that there is a complex inter-action between social class, differential achievement, social composition of the school class and focus or orientation of the teacher's pedagogic practice.²⁴

According to our conclusions teachers with a high degree of conceptual demand will tend to sharpen the division between different groups of pupils. Thus *part of the differential achievement between social groups may be due to the influence of this factor affecting teachers X_2, X_3, X_7 and even X_5 who were all found to be in the category of high conceptual demand.* This may also be the case for teachers X_1, X_4, Z_2 who although not demanding are not generous either.

We know that teachers X_6, Z_1, Z_3, Z_4 do not make a high degree of conceptual demand and thus this factor cannot account for the performances of their pupils. However we do know that teachers X_6, Z_1, Z_4 evaluate A competencies as U competencies and it may well be that this incorrect

recognition blurs the relation of differential achievement to the social class background of the pupil. For it is precisely in the matter of *U* competencies that the class effect upon differential achievement is relatively greater. If teachers define *A* competencies as *U* competencies then performances of pupils will show less the effect of social background.

We should also consider that the competence of the teacher to bring all her pupils (or the majority) up to a given level of achievement may well reduce the social class effect upon differential achievement. We should here recall one of the conclusions of our analysis of the teachers' pedagogic practice where we noticed that teachers X_3, X_7 showed a high competence in bringing their pupils to a given level of achievement. This may well explain why differential achievement among the pupils of teacher X_3 who was teaching in a middle-class school is relatively less marked, and that the differential achievement in the working-class school in which teacher X_7 was teaching may well have been greater had that teacher less of this rare competence.

2.5.4. We have now considered a number of hypotheses and carried out a series of analyses to explore the reasons for our discrepant cases and for differences in achievement in the sub-samples of pupils.

On the basis of these analyses we have some understanding how the mutual influence of various variables can blur and even conceal the effect of each other and the relationship between achievement and social class. It is because of these mutual influences that the pattern of differential achievement is not clearer.

We shall now try to show the inter-relationships among the intervening variables we have analysed. What we shall do is to show the distribution of the three intervening

variables (teacher's pedagogic practice, gender, repetition) and the teachers who, according to our previous analysis, are likely to produce either a higher or a lower differential achievement according to the social class composition of their pupils. These inter-relationships among the intervening variables are shown in the two diagrams of Figures 7.13 and 7.14.

The analysis of the diagrams should reveal those factors which can explain differences in differential achievement associated with different teachers according to the social background of their pupils.

High differential achievement (Figure 7.13):

- X_2 - Teacher's pedagogical practice
- X_3 - Teacher's pedagogical practice
- X_4 - Teacher's pedagogical practice
- X_5 - Teacher's pedagogical practice, gender, repetition
- X_7 - Teacher's pedagogical practice, gender, repetition
- Z_2 - Teacher's pedagogical practice, gender.

Low differential achievement (Figure 7.14):

- X_6 - Teacher's pedagogical practice
- Z_1 - Teacher's pedagogical practice, gender, repetition
- Z_3 - Teacher's pedagogical practice, gender, repetition
- Z_4 - Teacher's pedagogical practice, repetition

The picture seems clear in the case of teachers X_2, X_4, X_3 where the differences in differential achievement (higher for teacher X_2) may be due to their respective different pedagogical practices. The difference between teachers Z_2 and X_5, X_7 may also be due to differences in pedagogical practice. The similarity between teachers X_5, X_7 is likely to be due to the different mutual influence of the variables.

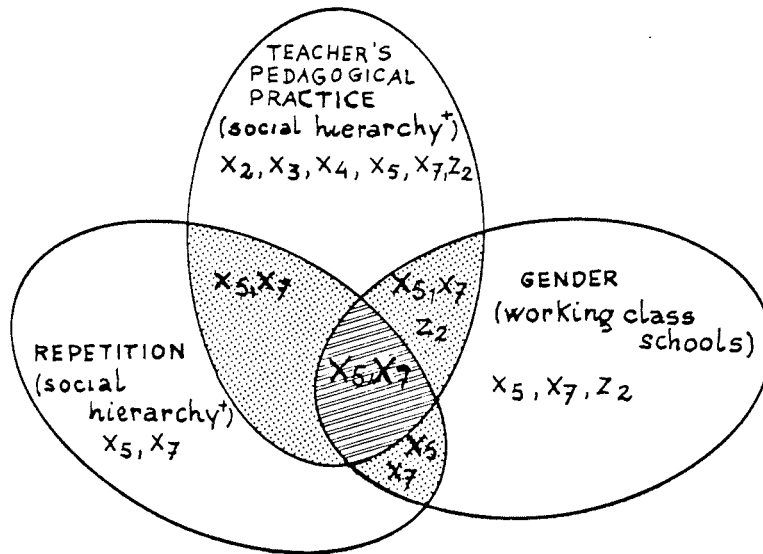


Figure 7.13 - *Interrelationships between variables likely to produce a higher differential achievement with social class*

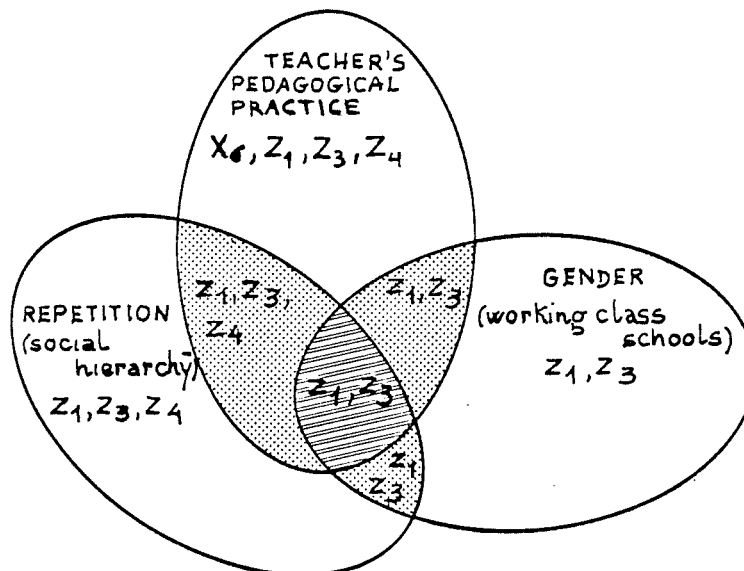


Figure 7.14 - *Interrelationships between variables likely to produce low differential achievement with social class*

On the other hand the *tiny or non-existent differential achievement in the case of teachers Z_1, Z_3* is likely to be due to their pedagogical practice, the higher number of boys in relation to girls, and the lack of influence of repetition because of the absence of social hierarchy. It is likely to be exclusively due to the pedagogical practice in the case of teacher X_6 .²⁵

The above shows that in accounting for social class effects upon *differences in differential achievement both the influences of family and teacher/school factors must be considered*. Some variables are more closely associated with the influence of the family (gender, repetition), some are more closely associated with the influence of the teacher/school (level of conceptual demand, competence to bring pupils up to a given level) but *all* relate to *both* the family and the teacher/school. However *the crucial variable which produces differences in differential achievement appears to be, from this analysis of our data, the teacher*. Where there is minimal differential achievement this is not because the teachers are effective in bringing *all* children to develop competencies of a high level but on the contrary the teachers are restricting *all* children to a common achievement of a lower level of scientific performance.

3. ANALYSIS BASED ON OTHER SOCIAL CLASS INDICES

We carried out our main analysis of social class and achievement, taking father's educational qualification as an index of social class. What we shall do now is to examine the effect of our other three variables, mother's educational qualification and father's and mother's occupation, in order to see whether we have missed an important relation. Clearly *space* forbids the possibility of repeating a detailed analysis like the analysis we have just carried out. We shall present here a summarised description of the total analysis we did indeed carry out.

3.1. MOTHER'S EDUCATIONAL QUALIFICATION

Let us analyse the relation between mother's educational qualification and achievement and see if the pattern is similar to the one found for father's educational qualification. The table in Figure 7.15 summarizes the results for both *A* and *U* competencies within the middle and the upper school. In order to save space we are focussing upon pass grades $\geq 50\%$ and we shall not graph the data but only present them in table form. The figures refer to percentages of children who have marks $\geq 50\%$ within a given category.

| SCHOOL & COMPETENCIES | | MOTHER'S QUALIFICATION | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|-----------------------|----------|------------------------|--|-------|-------|-------|-------|-------|-------|-------|
| | | | | % | % | % | % | % | % | % |
| <i>Middle School</i> | <i>A</i> | | | 77.95 | 75.73 | 75.35 | 79.73 | 80.89 | 86.36 | 86.67 |
| | <i>U</i> | | | 44.09 | 39.74 | 41.10 | 45.95 | 56.18 | 50.00 | 56.66 |
| <i>Upper School</i> | <i>A</i> | | | 38.10 | 68.64 | 84.00 | 81.42 | 81.48 | 83.33 | 90.32 |
| | <i>U</i> | | | 19.05 | 29.66 | 44.00 | 42.42 | 40.74 | 83.33 | 58.07 |

Figure 7.15 - Relation between mother's educational qualification and achievement: Middle and Upper School

The figures in the table show that the general conclusion (conclusion 5), which we reached when father's educational qualification was the social class index, is also valid when considering mother's qualification. A comparison of both measures suggests that within category 1, mother's educational level is more important than the father's in producing higher achievement either in *A* or *U* competencies in the upper school. However, the evidence presented in the following paragraph (3.2) suggests that the importance of the mother

over the father in the lower working-class (category 1) is more associated with occupational level than with the educational qualification. In fact in this category we cannot speak of educational qualification since these parents are reported illiterate. The mother's educational level appears to be more important than the father's for category 3 for *A* and category 6 for *U* competencies both in the upper school. In all other cases *father's educational qualification is either similar to or more important than mother's in accounting for higher achievement.*

3.2. FATHER'S AND MOTHER'S OCCUPATIONS

3.2.1. Findings

The tables in Figures 7.16 and 7.17 summarise the results for achievement in relation to father's occupation (Figure 7.16) and mother's occupation (Figure 7.17)²⁶ in both *A* and *U* competencies and within the middle and the upper school. We are again focussing only on pass grades $\geq 50\%$, so as to shorten the exposition. The figures refer to percentages of children who have marks $\geq 50\%$ within a given category.

3.2.2. Interpretation

We must bear in mind that the figures in the tables overleaf are certainly concealing the effect of other variables (teacher's pedagogic practice, gender, repeaters, social composition of the school classes). As a consequence the social class effect is probably more marked than it appears especially in the case of the middle school.

Analysis of the figures in the tables should thus be made (especially in the middle school) considering the differences between social groups in terms of their *relative* value and not in terms of their absolute value. In the

| SCHOOL & COMPETENCIES | | FATHER'S OCCUPATION | | | | | | | | | | | |
|-----------------------|----------|---------------------|--------|--------|--------|--------|--------|--------|--------|--------|---------|---------|---------|
| | | 1 % | 2 % | 3 % | 4 % | 5 % | 6 % | 7 % | 8 % | 9 % | 10 % | 11 % | 12 % |
| <i>Middle School</i> | <i>A</i> | - | 76.56 | 79.07 | - | 75.40 | 78.69 | 70.69 | 78.89 | - | 79.77 | 91.67 | 81.26 |
| | <i>U</i> | - | 45.32 | 42.64 | - | 36.13 | 40.17 | 37.93 | 45.56 | - | 51.19 | 66.66 | 55.11 |
| <i>Upper School</i> | <i>A</i> | - | 50.00 | 51.72 | - | 60.00 | 81.48 | 68.18 | 78.13 | - | 86.11 | 100.00 | 80.00 |
| | <i>U</i> | - | 31.25 | 20.69 | - | 20.00 | 44.44 | 27.27 | 40.63 | - | 41.67 | 57.14 | 50.00 |

Figure 7.16 - Relation between father's occupation and achievement: Middle and Upper School

| SCHOOL & COMPETENCIES | | MOTHER'S OCCUPATION | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|-----------------------|----------|---------------------|--|-------|-------|-------|-------|-------|-------|-------|-------|--------|-------|-------|-------|
| | | | | % | % | % | % | % | % | % | % | % | % | % | % |
| <i>Middle School</i> | <i>A</i> | | | 77.69 | 65.21 | 79.52 | 83.34 | 69.56 | 77.50 | 72.86 | 78.38 | 79.16 | 76.47 | 90.63 | 80.95 |
| | <i>U</i> | | | 42.90 | 41.31 | 39.75 | 35.42 | 43.48 | 47.50 | 31.43 | 46.85 | 50.00 | 58.83 | 59.38 | 61.90 |
| <i>Upper School</i> | <i>A</i> | | | 66.67 | 66.67 | 61.53 | 85.72 | 85.72 | 77.78 | 70.00 | 87.50 | 100.00 | 75.00 | 94.74 | 75.00 |
| | <i>U</i> | | | 31.37 | 33.33 | 26.93 | 28.57 | 28.57 | 40.74 | 35.00 | 56.25 | 55.55 | 37.50 | 68.42 | 37.50 |

Figure 7.17 - Relation between mother's occupation and achievement: Middle and Upper School

analysis we shall consider the 1-9 scale instead of the 1-12 scale,²⁷ i.e. category 3 joined to category 4, 8 to 9 and 10 to 11, because categories 4, 9, 11 are in fact sub-categories which were set to be the object of a particular analysis to follow.

The interpretation of the values presented in the tables shows that:

Middle School

A competencies:

If we compare first of all the relation between father's and mother's occupation to *A* competencies there are few differences of any importance.

U competencies:

Here we can see that the pattern of similarity is maintained. For both parents the break in the series appears to start at category 10 + 11 where this category and 12 are associated with a highest percentage of passes. If we look at the categories associated with the lowest percentage of passes then for both mother and father it is occupational category 7 which has nearly the lowest association with passes (mother 31,43%, father 37.93%). Occupational category 5 has the lowest association with father's occupation (36.13%). In general, however, the distributions are very similar.

Upper School

A competencies:

If we compare first of all the association of passes in *A* competencies with mother's and father's occupations we can notice that there is some association with father's occupation and the percentage of passes (~ 50% for categories 2,3; ~ 60% for categories 5,7; ~ 80% for categories 6,8,12; ~ 90% for category 10 + 11). However, there is a different

association between mother's occupation and passes in *A* competencies. Further for all categories up to category 5 there is a much higher association between mother's occupational level and *A* competency achievement than for father's occupational level. Category 10 + 11 shows for both mother and father a high association with passes. In general for four occupational categories the mother's occupational level is associated with a higher percentage of passes in *A* competencies than the father's occupational level. It would seem then that success in *A* competencies in the upper school is more associated with *mother's occupational level*, especially for the lower occupational levels.

U competencies:

There is some suggestion of an association between achievement in *U* competencies and both father's and mother's occupational level: categories 1,2,3 + 4,5,7 with the lowest association of passes and 6,8 having a higher association with categories 10 + 11 and 12 for fathers and 10 + 11 for mothers having the highest association with achievement in *U* competencies. On the whole distributions for mothers and fathers are very similar except for category 8 + 9 where mother's occupation has a stronger association with *U* competency achievement than father's.

From the analysis some conclusions can be drawn:

- (a) Category 5 (skilled and qualified manual workers, etc.) is not better than categories 2 and 3 + 4 (unskilled manual workers and service workers), as might have been expected. If father's occupation is considered, category 2 is even considerably better than category 5.
- (b) Category 3 + 4 (service workers) is worse than category 2 (unskilled manual workers).

- (c) The heterogeneous category 1 (housewives) is always placed among the six (1-7) lowest categories, even the lowest in a few cases.
- (d) Category 6 (non-manual employees, etc.) is in general better than the categories below (housewives, manual and service workers, skilled and qualified manual workers, etc.).
- (e) Category 7 (small proprietors, managers in small enterprises, etc.) is worse than category 6 (non-manual employees, etc.) and placed among the four (1-5) lowest categories.
- (f) Category 8 + 9 (supervisors of non-manual employees, technicians of an intermediate grade, primary school teachers, etc.) marks a division in achievement in relation to categories below except category 6 (non-manual employees, etc.) to which it is sometimes quite similar.
- (g) Category 10 + 11 (lower grade of self-employed and salaried professionals, medium proprietors, secondary school teachers, etc.) is in general better than category 8 + 9 and either similar to category 12 (higher grade of self-employed and salaried professionals, large proprietors, etc.) or even better than it.

The above conclusions are in general more marked for *U* than for *A* competencies and for the upper than the middle school. Both these findings confirm the previous ones(2.).

The first consequence of these conclusions is that we *should change the occupational scale if we want it to reflect a grading of achievement from the lowest to the highest.* Such a scale would then be:

3 + 4, 5, 2, 1, 7, 6, 8 + 9, 12, 10 + 11

We would suggest that the reason why category 2 is ahead of categories 3 + 4, 5 is not because children from it perform better in real terms *but because they have undergone a higher process of selection* and therefore most of these pupils are not in school at the stage which is the object of our study. Further, the fact that there are comparatively more repeaters in 2 than in 3 + 4, 5 shows that in general these pupils have a lower performance. The higher achievement they show in relation to other groups is precisely because they were repeating the year.

Category 1 is understandably not in the lowest position because of the very fact that it is a heterogeneous category. It is mother's educational qualification and the educational qualification and occupation of their husbands which determine the position of housewives.

The fact that category 7 is behind category 6 may well be due to these parents being employed in types of manual work for part or the whole of their lives. Thus the basis for placing this category in front of category 6 - the importance of organizing for oneself an independent occupational life (self-employed) - may be unwarranted. This finding points to the *importance of the cultural over the economic in the parents' situation as far as children's achievement is concerned*. Group 7 should therefore be joined to the preceding categories of the scale which include people performing manual work. Category 10 + 11 is in front of category 12 because of the influence of its sub-category 11; this is evident from the values in the tables (we shall deal with this aspect in paragraph 3.3). Although *the grading of achievement is not the one we expected according to our occupational scale, a grading still exists and the broad conclusion of the analysis based on parents' occupations confirms the conclusion we reached for father's educational qualification (conclusion 5), and therefore that conclusion gains a higher level of generality*.

On the basis of the above we can draw a line between two main occupational groups according to children's achievement:

Manual - 2, 3 + 4, 5, 7
 Non-manual - 6, 8 + 9, 10 + 11, 12

Such a grouping is valid for either father's or mother's occupation.

Finally we should note that on comparing father's and mother's associations we are able to see that, in terms of producing higher achievement, *mother's occupation* appears to be more important than father's in the working class - groups 2, 3 + 4, 5 - in *A* competencies and only in the upper school. It is possible that the mother's importance in the middle school is masked by the intervening variables we have previously analysed. It may be that working-class mothers relative to fathers create for their children both motivation and aspiration *and* a pedagogic practice supporting the development of *A* competencies. From this point of view they do all they are able to do.

3.3. ANALYSIS OF DISCRETE OCCUPATIONAL GROUPS

We separated some particular occupational groups as sub-categories of main categories because we intended to make an analysis of these discrete groups. These are sub-categories 4, 9, 11 which are part respectively of categories 3, 8, 10. Group 4 includes domestic helpers and maids, hairdressers, etc., group 9 primary and kindergarten teachers and group 11 secondary school teachers.

The *hypotheses* which were at the basis of this separation are:

- (a) Within a given occupational category, working class children whose mothers are in close contact with

middle class people will do better at school than those who do not have such contact.

- (b) Within the occupational category of which they are part, children of kindergarten and primary teachers or children of secondary school teachers will do better at school.

We cannot make an analysis of the three sub-samples of pupils according to teachers, because of the small number of pupils in each one of these three sub-categories. The analysis, therefore, has to include the whole sample of teachers, with the inevitable shortcomings such a compounding entails.

The data can be seen in the tables of the previous paragraph (Figures 7.16 and 7.17). There are no fathers in sub-categories 4 and 9.

Let us now compare sub-category 4 to 3, sub-category 9 to 8 and sub-category 11 to 10.

Middle School

- (1) Sub-category 4 is associated with similar levels of achievement to category 3.
- (2) Sub-category 9 is associated with similar levels of achievement to category 8.
- (3) Sub-category 11 for fathers is associated with higher levels of achievement than category 10 for both *A* and *U* competencies. For mothers it is associated only for *A* competencies.

Upper School

- (1) Sub-category 4 is associated with a much higher level of success than category 3 only in *A* competencies.

- (2) Sub-category 9 is associated with a higher level of success than category 8 only in *A* competencies.
- (3) Sub-category 11 is associated with a higher level of success than category 10 for both *A* and *U* competencies.

Our hypotheses are partially confirmed and have a good deal of support in the upper school. It is very possible that the partial lack of support for our hypotheses is the result of the complex inter-action between variables, gender, repetition, school location and teachers which lie behind any pupil score.

On the basis of the above we can draw the following conclusions:

- (a) The children of mothers in lower service functions with contact with middle-class mothers are likely to do better at school in *A* competencies than those of mothers who do not have such contact.
- (b) A child of a kindergarten or a primary school teacher is likely to have a higher achievement in *A* competencies than a child of parents of the same educational and socio-economic level.
- (c) A child of a secondary school teacher has, in general, a higher level of achievement in secondary school than a child of parents of the same educational and socio-economic level. In fact he/she has even a higher level of achievement than a child of parents with the highest cultural and socio-economic status. This differential achievement is more marked for *U* competencies.

These conclusions lead to the following suggestions:

- (a) It may well be that the contact of working-class mothers in lower service functions with middle-class mothers raises the significance of education for these mothers, and may facilitate the taking over of

attitudes and motivations which in turn have implications for their children's attitudes, motivations and interest in education. It is as if such contact changes the social and psychological context in which the school is placed but does not change the pedagogic focus of the *practice* of the mother and so there is no effect on the acquisition of *U* competencies. The school maintains or reinforces the presence or absence of the competence to which the pupil is oriented in the family. On the other hand it could be that mothers who choose occupational functions which bring them into close communicative contact with middle-class women may themselves be in some important ways different from their working-class peers in their attitude and orientation to education.

- (b) Those mothers who are kindergarten and primary school teachers appear not to have a different pedagogic practice from those of the same educational and socio-economic level and so there is no differential effect on the development of *U* competencies. Such pedagogic practice appears to be quite different from that of secondary school teachers. However, they may raise in their children motivations, aspirations and interest in education which affects their development of *A* competencies. Perhaps a crucial feature here is the desire for, and expectation of, social mobility for their children held by these kindergarten/primary school teachers.
- (c) 'The school at home', which secondary school teachers' children enjoy, works very efficiently. And it works efficiently not only because parents in general (especially mothers) *efficiently* help their children with their homework, but because the whole pedagogic context and practice of school is present in the home. A child in such a home enjoys particularly exceptional learning conditions. There is no better example of a

situation in which the home is an extension of the school. Perhaps again a crucial feature here is the desire and expectation of social mobility for their children held by these teachers.

3.4. COMPARISON OF DIFFERENT SOCIAL CLASS INDICES

Finally we shall now compare differential achievement related to social class taking the four indices of social class.

On the basis of the analyses we have carried out we reached the conclusion that the father's educational qualification has a marked influence upon pupils' achievement. We reached similar conclusions for the other three indices of social class, i.e. mother's educational qualification and mother's and father's occupations. The conclusion (conclusion 5) gains a higher level of generality and therefore we can say that *there is differential achievement, more marked for U competencies, between children of different social groups, with working-class pupils having the lowest performance and upper-middle class pupils having the highest; this pattern of differential achievement is in general similar in the middle and in the upper school.*

Further, we saw that a comparison of the influences of the father's and mother's educational qualification upon pupils' achievement in both middle and upper school showed that *in general* they are either similar or the father's is more important than the mother's. The analyses also pointed to a greater influence of the educational level over the occupational level in producing higher achievement. Comparison of father's and mother's occupations showed that the *mother's occupation* appears to have a stronger effect than father's upon pupils' achievement in A competencies in the case of working-class pupils in the upper school. Further, children of working-class mothers who are employed in lower-service occupations which bring them into

cultural contact with middle-class women show reduced differential achievement in *A* competencies. There is also an increase in the achievement of *A* competencies in the upper school for children whose mothers are kindergarten or primary school teachers. There is higher achievement of both *A* and *U* competencies in both middle and upper school for children whose parents are secondary school teachers.

We can also compare the influences of the four indices of social class upon differential achievement by analysing the correlations between these variables and achievement in *A* and *U* competencies for both middle and upper school. The table in Figure 7.18 summarizes these correlations.

In making this analysis there is the inevitable problem, to which we have repeatedly referred, that the correlations, particularly in the middle school are affected by the blurring of relations between a group of variables and so, as a consequence, we should disregard the absolute values of these correlations and attend only to their relative values. However, even if we do this the effects cannot be ignored. It may be useful to present the relationship between social class and achievement in this form because it gives the reader a short summary of the influence of the four social class variables, provided the reader bears in mind the shortcomings entailed in the figures in the table.

If we attend *only* to the relative values of correlations rather than to their absolute values we will see that the conclusion above continues to hold. Further we can see that mother's and father's education seems to be more important than occupation and the father appears in general to be more closely associated with pupils' achievement. All influences are in general more marked for *U* competencies.

| SOCIAL CLASS INDICES SECTIONS OF THE SCHOOL | <i>Acquisition</i> | | | | <i>Use</i> | | | |
|--|----------------------|---------------|-------------------|---------------|----------------------|---------------|-------------------|---------------|
| | <i>Qualification</i> | | <i>Occupation</i> | | <i>Qualification</i> | | <i>Occupation</i> | |
| | <i>Father</i> | <i>Mother</i> | <i>Father</i> | <i>Mother</i> | <i>Father</i> | <i>Mother</i> | <i>Father</i> | <i>Mother</i> |
| <i>Middle School</i> | .07 | .05 | .02 | .00 | .10 | .09 | .08 | .05 |
| <i>Upper School</i> | .25 | .27 | .27 | .25 | .31 | .26 | .27 | .20 |

Figure 7.18 - Correlation between social class and achievement taking four different indices of social class

The analysis confirms our choice of father's education as the best indicator of class background. The *father's cultural level as represented by education appears to be the major influence within the family especially and perhaps solely for the achievement of U competencies*. The relative influence of mother and father is difficult to determine from our data as it may vary with the class position of the father and the pattern of education and occupation in any one family.

4. CHANGES IN TEACHER'S PEDAGOGIC PRACTICE AND SOCIAL CLASS DIFFERENTIAL ACHIEVEMENT

The reader will remember that earlier in this thesis we reported the results of an attempt to find patterns of achievement in *A* and *U* competencies by concentrating on selected objectives of the teaching which were given special treatment. The two teachers involved in this special study were teachers X_3 and X_7 .²⁸

We have here a further opportunity to test the effects of this special pedagogic programme carried out by teachers X_3 and X_7 . Our analysis has revealed a relation between the achievement of pupils and their family background as indicated especially by the father's educational qualification. We have the opportunity of examining the pupils in the classes of the two teachers to see whether differential achievement on selected objectives is the same or different from achievement in the whole sample of objectives.

We shall put forward the following hypothesis: "Lower working-class children perform better on selected objectives than they perform on the whole sample of objectives, i.e. differential achievement between lower working-class children and middle class children (taken as reference) is smaller".

Our grounds for this hypothesis are that working class pupils by virtue of their family background, irrespective of whether the pupils themselves choose to learn or not, are less prepared to cope with the *pacing* of the pedagogic practice and so are less able to meet the requirements of the sequencing rules and the criteria they entail. Since the special treatment given to the selected objectives corresponds to making explicit criteria and sequencing rules and to weakening pacing²⁹ working class pupils may have improved their learning.

4.1. PROCEDURE

To test the above hypothesis we carried out a procedure which can be summarised as follows:

- (a) We took father's educational qualification as a measure of the social composition of the whole sample. We considered two social groups within our father's educational qualification 1-7 scale; one group corresponded to the lower working-class and another corresponded to the middle class:

1st group - f.e.q. 1-2: lower working-class

2nd group - f.e.q. 5-7: middle class

To consider only the upper middle-class (category 7) would be of little significance given the small number of pupils in teacher X_7 's sample (see (g) below).

- (b) We noted the achievement of these two groups. We looked at the extremes of the curves (i.e. achievement < 25% and \geq 75%, levels 1 and 4 respectively) and we compared the percentage of children of the two social groups who had these marks in the selected objectives and in the whole sample of objectives. In order to do this we had to obtain the data for these selected objectives separated according to father's educational

qualification.

- (c) We concentrated our analysis on the achievement $\geq 75\%$ for *A* competencies (pass grade $\geq 75\%$) and $< 25\%$ for *U* competencies (failure grade $< 25\%$) where in general there are higher numbers of pupils and the values would be more significant. This distribution clearly will not be found in the first test (diagnostic test) for *A* competencies.
- (d) We assessed the relative position of lower working-class and middle class children by the ratio of percentages of pupils in the above two categories for a given mark.
- (e) The 2nd/1st group ratio was used in *A* competencies because a higher percentage of middle class children with an achievement $\geq 75\%$ compared to lower working-class children should be expected.
- (f) The 1st/2nd group ratio was used in *U* competencies because a higher percentage of lower working-class children with an achievement $< 25\%$ compared to middle class children should be expected.
- (g) We concentrated on teacher X_7 's data since, out of the two teachers who had carried out the particular study, her classes showed higher differential achievement according to social class.
- (h) We concentrated on the pupils' achievement in the third term to simplify the analysis.

4.2. DATA

The table in Figure 7.19 shows the ratios between third term's percentages of lower working-class children and middle class children for the whole sample of

objectives of teacher X_7 :

| A COMPETENCIES (Pass Grade $\geq 75\%$) | U COMPETENCIES (Failure Grade $< 25\%$) |
|---|---|
| 2nd/1st = 1.43 | 1st/2nd = 1.61 |

Figure 7.19 - Ratio between l.w.c. and m.c. children's achievement in A and U competencies of teacher X_7 's pupils: whole sample of objectives

The tables in Figures 7.20 and 7.21 show 2nd/1st and 1st/2nd ratios for selected objectives of teacher X_7 . We present only some objectives as an example; it should be noted that the pattern of ratios is similar for all of them. These tables should be read in connection with the respective tables³⁰ in Chapter 3 so that one can understand the objectives. We should also bear in mind that the first column for each objective of A competencies (4, 13, 1, 14) corresponds to the diagnostic test when no teaching-learning had yet taken place.

4.3. INTERPRETATION

If we compare the 2nd/1st ratio in A competencies for the whole sample (Figure 7.19) to the same ratio for selected objectives (Figure 7.20) we can see that that ratio is in general smaller in the latter with the exception of the first testing period (diagnostic test); in fact it is smaller to the point of being below 1 in many cases. This means that lower working-class children do better on selected objectives than they do on the whole sample of A competency objectives, i.e. *differential achievement between lower working-class children and*

| YEARS | 7th | | | | | | | | | 8th | | | | | | | |
|---------------|-----|-----|-----|-----|-----|------|-----|------|-----|-----|------|------|------|------|------|------|------|
| OBJECTIVES | 2nd | | | | | 4th | | | | 1st | | | | | 4th | | |
| TESTING ORDER | 4 | 5 | 6 | 7* | 8* | 13 | 14* | 15* | 1 | 2 | 3 | 4* | 5* | 14 | 15 | 16* | 17* |
| 2nd/1st Ratio | | .97 | .72 | .80 | .88 | 1.73 | .96 | 1.13 | .78 | .97 | 2.25 | 1.42 | 1.08 | 2.34 | 1.19 | 1.48 | 1.25 |

* Third term's tests

Figure 7.20 - Ratio between l.w.c. and m.c. children's achievement in A competencies (pass grade \geq 75%) of teacher X₇'s pupils: selected objectives

| YEARS | 7th | | | | | | | | | | 8th | | | | | | | | | |
|---------------|-------------|------|------|------|------|-----------------------|------|------|------|------|-----|------|------|-----|------|------------------|-----|------|------|------|
| OBJECTIVES | 5th a) + b) | | | | | 6th a) + b) + c) + d) | | | | | 6th | | | | | 7th a) + b) + c) | | | | |
| TESTING ORDER | 46 | 47 | 48 | 49* | 50* | 51 | 52 | 53 | 54* | 55* | 22 | 23 | 24* | 25* | 26* | 35 | 36 | 37 | 38* | 39* |
| 1st/2nd Ratio | 1.74 | 1.76 | 2.01 | 1.47 | 2.22 | 1.34 | 1.00 | 1.57 | 1.70 | 1.77 | .92 | 1.54 | 1.95 | .88 | 1.10 | 1.39 | .83 | 1.35 | 1.03 | 1.41 |

* Third term's tests

Figure 7.21 - Ratio between l.w.c. and m.c. children's achievement in U competencies (failure grade $<$ 25%) of teacher X₇'s pupils: selected objectives

middle class children suffers a decrease to the point where they become equal after the teaching process has taken place. It also means that before the teaching process differential achievement is in general greater.

If we compare the 1st/2nd ratio in *U* competencies for the whole sample (Figure 7.19) to the same ratio for selected objectives (Figure 7.21) we can see that that ratio is on average smaller in the latter. This means that lower working-class children do better on selected objectives than they do on the whole sample of *U* competency objectives, i.e. *differential achievement between lower working-class children and middle class children decreases*. However that decrease is smaller than the decrease noticed for *A* competencies and much smaller than the decrease noticed for girls' and boys' differential achievement.³¹

Our hypothesis was on the whole supported. We can then draw the following conclusion:

Lower working-class children who have in general poorer achievement than middle class children show a marked improvement approaching the middle class children in A competencies and show some improvement in U competencies, when criteria and sequencing rules are made explicit and when there is a weakening of pacing in the transmission-acquisition process.

The suggestion we made before when we were dealing with differential achievement related to gender³² now gains greater support: *Whenever a differential achievement between two groups of pupils is found, the disadvantaged group gains from making criteria and sequencing rules explicit and weakening pacing*. However, the pattern of improvement seems to be different in gender-differential achievement and social class-differential achievement. In fact although for *A* competencies the pattern of improvement of the disadvantaged group seems similar, for *U* competencies it is

substantially different: differential achievement between boys and girls is very much decreased whereas differential achievement between lower working-class children and middle class children shows only a slight decrease. This means that within the lower working-class, girls greatly benefit from a strengthening of criteria and weakening of pacing to the point where they approach boys of the same social class, but neither boys nor girls of the lower working-class show the same degree of improvement when compared to middle class children; i.e. the explicitness of criteria and sequencing rules and the weakening of pacing is not enough to make differential achievement between social classes disappear. This is as far as we can go with the data we have obtained, although we can speculate and say that a still greater accentuation of criteria and sequencing rules and weakening of pacing may attenuate social class differential achievement.

5. CONCLUSION

5.1. In a previous chapter we described the analysis of the data using a stepwise regression. We saw how, through stepwise regression analysis applied to the whole sample, a significant relation between social class and achievement could only be found in the upper school. It was only when the stepwise regression was applied to sub-samples corresponding to *each* teacher's pupils that a relation appeared between social class background and pupil's achievement for some teachers' classes. In this chapter we followed a method of analysis similar to the one we followed when we were examining relations between gender and achievement.³³ We complemented correlation figures (on which the stepwise regression analysis was based) with crosstabulation between variables. We were then able to see more clearly the pattern of differential achievement and its possible explanations. Further, our analysis of the achievement of selected objectives on the part of lower working-class pupils in

the special teaching programme suggested a possible pedagogic strategy for the reduction in the differential achievement of disadvantaged groups.

Initially the analysis was kept at the level of the whole sample and correlation coefficients were used to examine the relation between social class and achievement. However, the conclusion we reached raised a number of questions which we felt we had to explore before accepting the conclusion that the relation between social class and achievement was limited only to the upper school. When an additional method of analysis was used, i.e. when the relation between social class and achievement was expressed through the crosstabulation of these two variables, we found some indication of a relation between social class and achievement. The whole sample was then divided in sub-samples according to each teacher's pupils. The intention here was to generate a range of sub-samples of teacher/classes where we could explore patterns of similarities and differences with respect to the social class composition of each teacher/classes and the levels of achievement of the pupils. This analysis revealed that for some teachers/classes there was indeed a relation between social class and achievement especially for *U* competencies. However it also revealed a number of teachers/classes where there was no relation. It was at this stage that we carried out a more delicate analysis. Our previous analyses suggested that teacher's pedagogic practice, gender and repetition all related to the achievement of pupils. We then examined the extent to which the class effect was mediated through these variables.

5.2. We have attempted to unveil possible relations between social class and achievement, the patterns they follow and to suggest solutions to overcome differential achievement. If we consider the initial problem of the thesis, the evidence contained in this chapter gives some

answers and substantial support for the broad hypotheses we initially put forward.

On the basis of our analysis we reached important conclusions.

First, *there is differential achievement, more marked in U competencies, between children of different social groups, working class having the lowest performance and upper middle-class having the highest; the pattern of differential achievement is in general similar in the middle and the upper school.* Although the process of selection in the upper school should have narrowed the class effect upon differential achievement it is also the case that the level of conceptual demand made by teachers has increased and so the class differential is maintained. This conclusion is valid whatever index of social class (from the four we have considered) is taken. Differences in differential achievement between sub-samples of teacher/classes of pupils are due to the influence of *both* the family and the teacher-school factors. Differential achievement may well have been greater had a significant number of lower working-class children not left school at the stage which is the object of our study.³⁴

Second, *parents' educational qualification is in general a more important factor in influencing differential achievement than occupation in either the middle or the upper school and for A or U competencies. In general father's characteristics are more important than mother's.* This suggests that the cultural aspect has more weight than the socio-economic in influencing differential achievement at school. It also suggests that the father's cultural level has more weight than the mother's. However we must point out that mother's occupation appears to have a stronger effect than father's upon pupils' achievement in A competencies particularly in the case of working-class pupils in the upper school. Further, the occupational

position of the parents appears to have great importance in some cases. In fact, there appears to be a reduction in differential achievement of A competencies for those working-class pupils whose mothers are employed in lower service occupations which bring them into cultural contact with middle-class women. There is also an increase in differential achievement of *both* A and U competencies and in both middle and upper school favouring pupils whose mothers and fathers are secondary school teachers.

Third, *lower working-class children who generally have poorer achievement than middle class children show a marked improvement approaching the middle class children in A competencies and show some improvement in U competencies, when criteria and sequencing rules are made explicit and pacing is weakened in the transmission-acquisition process.* The suggestion we made when analysing gender differential achievement³⁵ now gains greater support: *whenever a differential achievement between two groups of pupils is found the disadvantaged group gains from making explicit criteria and sequencing rules and weakening pacing.*

If the above conclusions are now brought together to bear upon the initial problem of the thesis we would say that:

The underachievement of working class children accounts for part of the general underachievement of many children in science classes; and their under-achievement in U competencies accounts for a relatively greater proportion of the general under-achievement.

A possible solution to diminish working class under-achievement, under the present pedagogic regime, is to make explicit criteria and sequencing rules and weaken pacing in the transmission-acquisition process.

If we consider, as we did before,³⁶ that it is in *U* competencies that the significant differential achievement occurs and that *U* competencies are those which require a high level of abstraction, we can understand how different courses can produce different degrees of differential achievement. We can say that, under the present pedagogic regime, *the greater the conceptual demand of a course and, therefore, of its level of abstraction, the greater the differential achievement between working class and middle class children.* This of course should not lead us to conclude that we must devise courses with a low level of conceptual demand, where only factual knowledge is stressed, in order to reduce differential achievement. A competencies are useful essentially because they are a prerequisite for the acquisition of *U* competencies and these are the ones which make learning at school valuable. We shall return to this point later in the final chapter.

In the final chapter we shall attempt to embody the above conclusions in a theoretical framework.

6. NOTES AND REFERENCES

1. See Chapter five on Quantitative analysis of sociological variables and achievement.
2. See Chapter two on Introduction to the empirical study.
3. See matrices of correlations for all teachers in Appendix VIII, Figures VIII.3 and VIII.4.
4. *Ibid.* 3.
5. *Ibid.* 3.
6. *Ibid.* 2, to understand the meaning of each category of the 1-7 scale for father's educational qualification.
7. See T. Yamane, 1973.
8. See Chapter one.
9. See Chapter four on Teacher's pedagogical practice.
10. *Ibid.* 1.

11. *Ibid.* 9.
12. *Ibid.* 9.
13. *Ibid.* 1.
14. *Ibid.* 1.
15. *Ibid.* 9.
16. See Chapter six on Gender and Achievement.
17. *Ibid.* 16.
18. *Ibid.* 16.
19. *Ibid.* 1.
20. *Ibid.* 2, to understand the meaning of each category of the 1-5 scale for repetition.
21. *Ibid.* 9.
22. *Ibid.* 9.
23. *Ibid.* 9.
24. *Ibid.* 9.
25. Surprisingly we find that teacher Z_4 who has a restricted social composition in her school classes appears in the diagram as having low differential achievement with respect to the social class background of her pupils. However, we have seen that despite this there is differential achievement in her classes associated with social class and she is a teacher who makes a low level of conceptual demand. We have a contradiction. However, on closer examination we find that although there is a restricted social class composition among her pupils limited to categories 1 and 2 of the parents' educational scale, there is a high percentage of pupils drawn from social class 1 where the parents are reported illiterate. Therefore there is hierarchy *within* the lower working-class between a family background where there is a measure of reported literacy and a family background where there is reported illiteracy. Thus the differential achievement of teacher Z_4 may be partially the result of a hierarchy *within* the lowest social class group which is a necessary condition for a relation between social class, repetition and differential achievement to emerge.

26. *Ibid.* 2, to understand the full meaning of each category of the 1-12 scale for parents' occupations. To ease the analysis we present here a summary of the scale:

1. Housewives
2. Unskilled manual workers. Self-employed workers in agriculture and street vendors.
3. Service workers: lower and intermediate grades, without supervisory functions.
4. (Cont. of category 3) Domestic helpers, etc.
5. Skilled and qualified manual workers with and without supervisory functions. Unskilled supervisory workers. Controllers and inspectors: lowest grades. Armed and police forces: lowest ranks.
6. Nonmanual employees in administration and commerce. Nurses without supervisory functions. Technicians: lower grade. Armed and police forces: low ranks.
7. Small proprietors. Managers in small enterprises. Supervisors of manual employees: higher grade. Self-employed workers in manufacturing, commerce.
8. Supervisors of non-manual employees in administration and commerce. Lower management. Nurses with supervisory function. Technicians: intermediate grade. Armed and police forces: intermediate-lower ranks.
9. (Cont. of category 8) Primary and Kindergarten teachers.
10. Self-employed and salaried professionals: lower grade. Medium proprietors. Managers of medium enterprises. Technicians: higher grade. Armed and police forces: intermediate higher ranks.
11. (Cont. of category 10) Preparatory and secondary school teachers.
12. Self-employed and salaried professionals: higher grade. Large proprietors. Administrators and

officials: higher grade. Industrial managers in large enterprises. Armed and police forces: highest ranks.

27. *Ibid.* 26.
28. See Chapter three on Patterns of Achievement in different types of competencies.
29. *Ibid.* 28.
30. *Ibid.* 28.
31. *Ibid.* 16.
32. *Ibid.* 16.
33. *Ibid.* 16.
34. See, for example, M. Silva and I. Tamen, 1981, appendix with statistics. The number of pupils in the secondary school relative to the primary and preparatory schools drops dramatically except in the case of the Lisbon area and for the two largest cities Lisbon and Porto, where the numbers in both secondary and primary levels are similar. The reduction in numbers varies with the areas but in some cases (like the area where our teachers Z_1 and Z_4 teach) the reduction is very great. We should point out, although our national statistics are not designed to show this, that lower working-class children are likely to be the early leavers.
35. *Ibid.* 16.
36. *Ibid.* 16.

7. BIBLIOGRAPHY

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CHAPTER EIGHT

CONCLUSION

Major Findings, Discussion and
Policy Implications

1. INTRODUCTION

This thesis started with a broad problem arising out of the current underachievement in the science classrooms of secondary schools in Portugal. The questions we addressed were related to the division between two groups of children with respect to achievement in sciences; a group constituted by those children who have high levels of success and another group constituted by those who show high levels of failure. Before we started our research reported in the thesis we had been led to believe that the introduction of new methods and new contents in science education was at least partially accountable for this sharp division between two groups of children. Modern contents and methods in science teaching seemed to have pushed the 'brightest' children to a greater development of higher competencies and although this kind of teaching fulfilled its goals it appeared to do less for the 'less bright' children who seemed to us to have fallen behind.

We initially believed that this failure was caused by the high level of conceptual demand entailed in the modern science teaching and based on Bernstein's work¹ we were led to believe that the working-class children who tended to be failures at school, failed within its present pedagogic regime because of the high level of abstraction entailed in modern science courses. As a pretest of these hypotheses we carried out an elementary analysis of the data of a class we had taught in a subject which made a high level of conceptual demand.² This analysis showed that middle-class children performed equally well in competencies requiring a low level of abstraction and in those requiring a high level of abstraction. It seemed, therefore, that there were no special difficulties for middle-class children to learn that part of the text which required high level abstract competencies. For working-class and lower middle-class children the picture was quite different. They, in general, performed worse than middle-class children but the difference was particularly marked in *U* competencies. Working-class children

therefore seemed to show a particular difficulty in learning that part of the text which required a high level of abstraction.

Based on Bernstein's work and on the pilot investigation, we devised a detailed empirical study in which we tried to unveil possible relations between social class and achievement in different types of competencies in the sciences. We aimed at understanding the complex of interrelations we felt existed behind children's underachievement in the sciences, and possibly in other school subjects. We extended the research to include the consideration of a number of other sociological factors besides the direct indicators of nominal social class, (father and mother's educational qualifications and occupations).

We believed that social class not only affected the orientations and procedures children initially brought to the school but also affected the conceptual focus of the teacher.

We will make an attempt in this final chapter to summarize the main findings highlighting the points which we consider crucial. We will then relate these findings to the initial problem and hypotheses and we will point out where we think explanations and solutions were achieved. We will proceed to the development of a sociological model arising out of Bernstein's theory of cultural reproduction which we will use to interpret our findings.³ Finally, we will discuss the implications for policy in science education.

We would like to stress that in this chapter we will keep *separate* our findings in our empirical research from our theoretical considerations. The reader, therefore, should take this into account and consider the first part of the chapter as the direct result of our empirical research and the last part as a further theoretical elaboration.

2. CONCLUSIONS OF THE EMPIRICAL STUDY

The empirical study we have described in the previous chapters identified specific variables as important factors in influencing achievement in science education. These variables are related to *both* the family and the school. The family variables are social class and gender, and the school variables are teacher and type and area of school.

2.1. INFLUENCE OF SOCIAL CLASS ON SCIENCE ACHIEVEMENT

The evidence gathered in the research shows the influence of social class upon pupils' achievement in the sciences. The major conclusion is that there is differential achievement, more marked in *U* competencies, between children of different social groups, lower working-class having the lowest and upper middle-class having the highest performance. This pattern of differential achievement is in general similar in the middle and the upper school. This conclusion is valid for any of the four social class indices we created, i.e. father's and mother's occupational and educational levels. However, parents' educational qualification is in general a more important factor in influencing differential achievement than occupation in either the middle or the upper school and for *A* or *U* competencies. In general father's characteristics are more important than mother's. This suggests that the cultural aspect has more weight than the socio-economic in influencing differential achievement at school. It could suggest that the father's cultural level has more weight than the mother's. However, it may be that the index of parents' educational level is more reliable and valid a measure. We should also bear in mind that father's occupational level affects the pedagogic context of the family in numerous direct and indirect ways. Father's occupation affects the material resources available and their form. It also affects the social networks of support and power a family can activate.

The evidence suggests that lower-working class mothers whose occupation places them in contact with middle-class women have a positive influence upon the improvement of their children's achievement. However this improvement only takes place in *A* competencies. This suggests that these mothers are sensitive to the importance of providing their children with the necessary pedagogic conditions but perhaps they are less able to provide the orientation towards the *U* pedagogic competencies required by the school. The occupational group which has a marked influence in improving the relative achievement of their children is the group of secondary school teachers. This can be explained by the relative weak classification between school and family with respect to the pedagogic practices developed in both sites of acquisition. For these parents the home is in the school and the school is in the home.

It is important to note that the greatest differential achievement occurs at the top end of the marks scale: there are very few lower working-class children placed in this position whereas there is a high percentage of upper-middle class children placed in this position. This tendency is more marked in the upper school.

The evidence obtained in our study showed that differential achievement associated with social class in the whole school population is masked by various factors originating in both the family and teacher-school relations. The complex inter-actions of these factors, under particular combinations, will make more or less clear social class differential achievement. This we will discuss in the following paragraphs. It is important to point out that the degree of differential achievement found would have been greater had a significant number of lower working-class children (especially from rural areas) not left school at the stage which was the object of our study. This fact explains how the progressive raising of the school leaving age has led to higher differential achievement. On the basis of our findings we would predict that the more children are kept

at school (*with no change in curriculum and pedagogic practice*) the higher the differential achievement as the influence of the selection process will be less pronounced.

On the basis of our findings we would say that social class differential achievement is a composite of two simultaneous phenomena which have occurred in the past few years in Portugal: the greater number of children attending school and the higher level of conceptual demand. In fact the evidence we found showed that it is in *U* competencies that the greater differential achievement occurs. This indicates that working-class children do not show particular difficulties in learning that part of the text which requires from them an understanding of elementary rules of procedure but they show real difficulty in that part of the text which requires a high level of abstraction and application. Hence the higher differential achievement is a consequence of the higher level of conceptual demand *realised through the current teaching practice*.

The evidence obtained in the research does not give support for the resistance thesis⁴ in its explanation of failure of working-class children at school. If working-class children do not want to learn or resist learning then their failure would be equal in all types of competencies required by the school which, as we have seen, is not the case. Further, we believe that both working-class children and their parents in Portugal believe in the value of the school and it is the compounded failure at school that makes pupils end by rejecting school.

2.2. INFLUENCE OF GENDER ON SCIENCE ACHIEVEMENT

The evidence obtained in the study we carried out shows that there is some relation between gender and achievement at school. The major conclusion is that differential achievement in sciences between boys and girls is *class based*. Upper middle-class boys and girls perform equally.

Lower working-class boys perform better than girls especially in *U* competencies *only* when they both attend working-class schools. Girls' achievement is strongly associated with social class whereas boys' achievement has a weaker and less well defined association with social class.

The evidence in Portugal rules out the general influence of teachers and school as important sources of pressures and expectations affecting girls' underachievement. It also rules out the influence of IQ/gender links. The evidence suggests that gender differential achievement in Portugal is related to different patterns of masculine and feminine held in the family, and therefore points to the family as the major factor producing girls' relative underachievement in the sciences. The stronger the differential patterns of masculine and feminine in the family the greater the differential achievement. In the case of Portugal it seems that these different patterns are stronger in the country, they are weaker when approaching the metropolis and disappear in the metropolis itself. It seems, therefore, that in Lisbon different patterns of masculine and feminine with respect to different pedagogic practices and orientations in the family are reduced even in the lower working-class. It may be that middle-class girls provide models for the working-class girls in a school class which, in itself, does not emphasise gender based discriminations.

Gender differential achievement, as any other (class) differential achievement, between groups of pupils can be sharpened by the influence of teacher/school factors as we will discuss in the following paragraph. We have argued that the absence of findings linking achievement to gender in Portugal may well be a function of less delicate analyses than those carried out in this thesis.

2.3. INFLUENCE OF TEACHERS' PEDAGOGIC PRACTICE AND THE SCHOOL CONTEXT

The evidence obtained in the study of the teacher's pedagogic practice together with the information obtained in the central part of the research (the relation between sociological factors and achievement) permits important conclusions with respect to the influence of teachers' pedagogic practice upon differential achievement between groups of children and confirms our initial hypothesis.

First, the evidence shows that teachers differ greatly in the level of conceptual demand they make of their pupils. They also differ greatly in their ability to enable pupils to attain a given level (the level they set for their courses). Both of these two competencies of the teacher influence pupils' differential achievement. The greater the competence of the teacher in setting a course with a high level of conceptual demand *and* in bringing the pupils to attain that level *the sharper the division between groups of children with respect to their achievement*. This is so because their ability to bring pupils to attain a high level of conceptual demand is selectively focussed upon *some* pupils rather than upon all pupils. This itself arises out of the context of teaching conditions as we will discuss later.

Furthermore, young teachers and teachers in the country and/or working-class schools tend to lack the competences mentioned above and as a consequence differential achievement between groups of children (gender, social class) tends to be less as their general level of achievement is depressed. It is considered that young teachers who, in general, are less effective in these competences will become more and more effective if they teach in middle-class schools and will become *less and less effective* if they teach in a working-class school and/or a school in the country. It is difficult to know whether these teachers have low expectations of their pupils and so modify their conceptual demands or whether the pupils fail to meet high demands and so the

teachers accordingly lower their demands or both. Further we do not know whether the pupils do not fulfill the expectations of the teachers because they are no longer interested in school and/or because the teachers have not developed an effective pedagogic practice and settle for a low level of demand which makes life 'comfortable' for both teachers and taught.

What seems certain is that the pedagogic practice of the teacher is strongly related to the school context where he/she teaches. It is that social context which makes teachers develop courses with a low or high level of abstraction to match what they consider (consciously or unconsciously) to be attributes of the school population they teach. A working-class school and/or a school in the country acts selectively on the conceptual level of the teaching so as to produce a reduced conceptual demand and *focus* of the pedagogic practice. This means that the achievement of some groups of pupils is dependent upon the context in which they are taught and/or the experience of the teacher. Although a superficial analysis may indicate that all pupils are equally affected by the lower level of teaching as all receive this kind of teaching, it is the working-class group of children which is most affected. They are the children who are less likely to develop competencies of a relatively high level of abstraction, because *both* sites of acquisition (family and school) are less likely to provide them with the opportunity to develop these kind of competencies. For middle-class children the family will help them to a lesser or greater extent in the development of relatively high level abstract pedagogic competencies, whether or not the school carries out this function.

What was said above makes clear that when marked differential achievement between groups of children (social class, gender) does not exist at school in our study, it is *not* because all children are achieving a high conceptual level of scientific understanding, but because they are *all* being provided with a low conceptual focus. From the point

of view of knowledge *acquired at school* they are all attaining this low level. In these cases the working-class child is restricted to a low level because he/she has not been given the chance of acquiring higher levels at school. We would argue that teachers who make a very low level of conceptual demand have failed to understand the sociological implications of the transmission-acquisition process they are promoting.

Through our analyses we were able to understand the role of the teacher/school in concealing the true relationships between sociological factors and achievement. When the teacher variable is controlled these relationships appear with all their importance.

If we consider all the quantitative and qualitative assessments of the teacher's pedagogic practice we have made we would suggest that the level of abstraction required by a course is directly related to the *social context of the school*, whereas the competence to enable pupils to attain a *given* level in both types of competencies (*A, U*) is directly related to what is commonly understood as teacher competence. Both, level of abstraction and competence to bring pupils to a given level, are evidently influenced by the social context of the school and the so-called common competence of the teacher.

Thus if we consider the teacher's pedagogic competence, teachers may be well trained in the design of a curriculum which entails the necessary level of demand and they may have a sound basis in educational psychology and new teaching methods to enable them to transmit effectively the competences to *many* of their pupils but, *under the present teaching conditions* in Portugal, these competencies of a teacher *sharpen* the division between two groups of children. It is only when the teacher is aware of the role of the sociological context of teaching that he/she may be able to take steps to correct the depressing effect of that context upon the focus of conceptual demand. Such sociological

knowledge is at least a necessary condition for the raising of the level of achievement of working-class children.

In an exploratory study on the teaching of selected objectives, we saw that when a teacher maintained the level of conceptual demand but introduced changes in her pedagogic practice there was a decrease in differential achievement between groups of children. The evidence we obtained shows that lower working-class girls attending a working-class school show a very marked improvement approaching boys' achievement where the criteria and sequencing rules of the transmission were made more explicit and when there was a weakening of pacing. This improvement is very marked in *U* competencies. The evidence also showed a similar pattern with lower working-class and middle-class children although in this case the improvement was somewhat less. This suggests that *whenever there are two groups of children differing in achievement the disadvantaged group gains with these changes in the teacher's pedagogic practice.*

This clearly raises the question of teaching conditions because what the teachers in our special programme did for a few selected objectives cannot be carried out for all objectives under present teaching conditions. Thus, *both* different teaching conditions and effective teachers are *indispensable* for the improvement of science education in general and for improvements in achievement of working-class children in particular. It is important to point out that these different teaching conditions are essentially related to factors like time available, number of children per class, which permits a reduced pacing and so creates the opportunity to make criteria and sequencing rules more explicit. Although we did not find any clear relation between good facilities and equipment and improved achievement of working-class children, certainly good facilities are important for better science education. Improved facilities *are not the direct crucial* factor in maintaining a teaching which develops high level competencies. They are, however, an indirect crucial factor, because of the depressing effect on teacher from whom more is demanded

when good facilities are not present.

Finally it is important to point out that the teachers in our study who were the most able to design a course with a high level of conceptual demand and to enable their pupils, including their working-class pupils,⁵ to attain that level are those who have a pedagogic practice characterised by an explicit structure. This structure is based on the clear definition of competencies to be developed and of the scientific contents to be learned, the setting of appropriate strategies to attain them and the assessment of the defined objectives.⁶ The grading of teachers' competence we designed⁷ follows roughly a grading of more structured to less structured teaching. This seems to suggest that an explicit framing of selection, sequencing and criteria, *especially where the framing of the rules of conduct between teacher/pupils is relaxed*, is likely to produce higher achievement in pupils under the present pedagogic regime.

3. THE LEVEL OF DEMAND OF SCIENCE COURSES

3.1. DIFFERENTIAL ACHIEVEMENT AND CONCEPTUAL DEMAND

We saw that a teacher who makes a high level of conceptual demand tends to sharpen the division between groups of children, i.e. in terms of school achievement the disadvantaged group is *relatively* more disadvantaged when the level of demand is higher. However, this group is, in absolute terms, less disadvantaged. The diagram in Figure 8.1 will make the reasoning clearer.

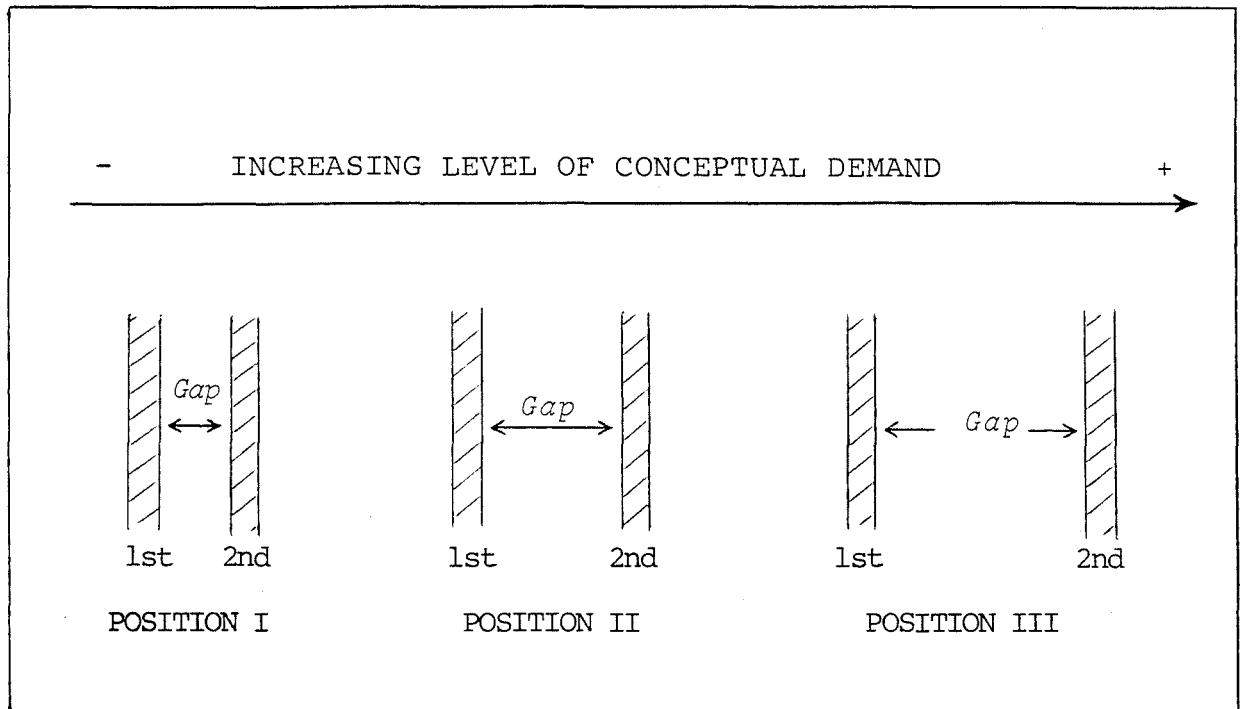


Figure 8.1. - *Relation between level of conceptual demand and differential achievement*

By first group and second group we mean the disadvantaged group and the advantaged group of children, be they in terms of social class or gender. Thus pupils of the first group will be the lower working-class children and those of the second group will be the upper middle-class children. Or within the working-class the first group can be represented by girls and the second by boys.

If we now analyse the diagram we see that the gap between two groups of children increases with increases in the level of conceptual demand. It is clear that although a larger gap exists in position III, pupils of all social classes are better in that position than they are in Position I, i.e. *both* groups have attained a higher level of competence in position III than in positions I and II.⁸ It is important to point out that in terms of school assessment pupils in positions I, II, III taught by different teachers may find themselves with marks of similar orders although a higher spread of marks is to be found in position II and III and as a consequence a higher differential achievement will occur. This fact has led us to

believe that the introduction of science courses with a higher level of conceptual demand has produced more disadvantage for the disadvantaged children. In the light of our findings we understand that this is not necessarily true. There is in fact *a sharper division between two groups of children, but even working-class children are better equipped* in position III than they are in positions I and II. What increases is the differential achievement between working-class and upper middle-class children. This means that the introduction of modern science courses is placing upper middle-class children relative to working-class children in a stronger position than before with respect to the possession of a knowledge of a high level of abstraction. We will explore this aspect later on.

We should now remember that, according to our findings, the teachers who make a higher level of conceptual demand and at the same time show the competence to enable pupils to attain that level and therefore who place pupils in position III, are those teachers who have a better *curriculum vitae* in terms of extra-official qualifications, experience in teacher training and curriculum development, knowledge of the psychology of education and new methods of science teaching. They are the teachers who develop a more structured teaching. This clearly points to the importance of *effective* teacher training. An effective teacher training as it has been conceived so far allows teachers to learn how to set a course with a high level of conceptual demand and how to enable their pupils to attain high level competencies by developing adequate teaching strategies. However, the evidence suggests that it is only when teachers are sensitive to the sociological aspects of their practice that they can prevent the social context of the school having a depressing effect upon their teaching placing their pupils in position I. Further it is the awareness of these sociological aspects that will make teachers realise the gap they are likely to produce between groups of children, whenever the conceptual demand is kept at a high level and their practice unchanged. The teachers' awareness of these two

points is at least a necessary condition towards improvement of science education.

3.2. REDUCTION OF DIFFERENTIAL ACHIEVEMENT

We have also seen that when a change occurred in the teaching characterized by an explicitness of sequencing rules and criteria and a weakening of pacing the disadvantaged group improves and approaches the achievement of the advantaged group. This means that *without* lowering the level of conceptual demand the gap to which we have been referring decreased, and position III of the diagram in Figure 8.1 will have changed according to the diagram in Figure 8.2.

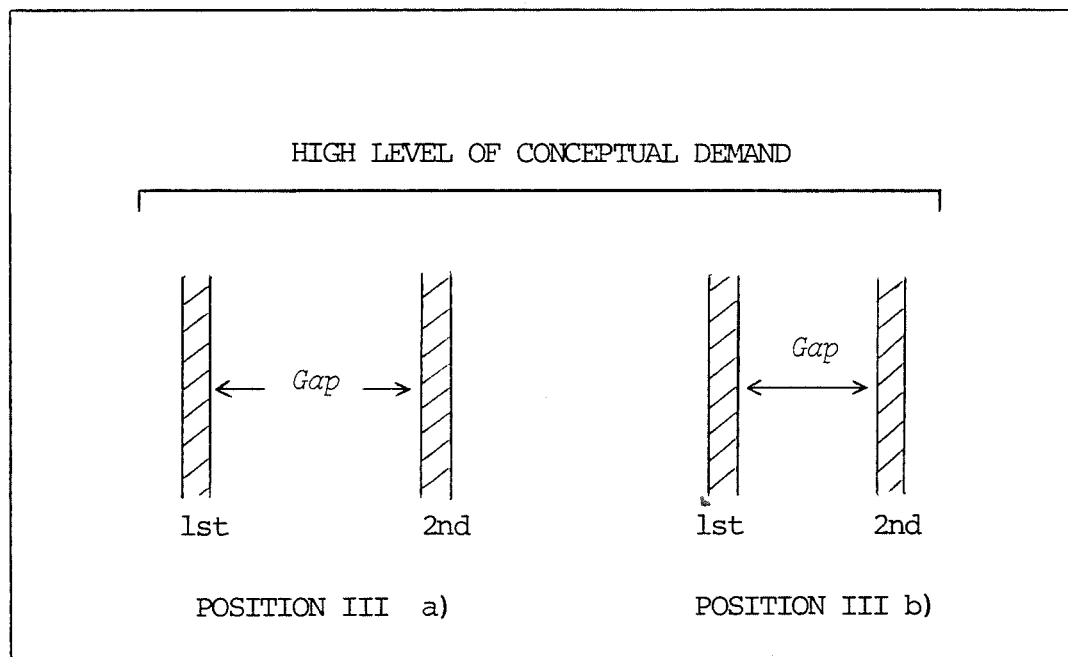


Figure 8.2. - *Influence of teachers' pedagogic practice in the decreasing of differential achievement*

This clearly points to the major influence of the teacher's pedagogic practice in the reduction of differential achievement. Such reduction was possible because the teachers involved in the teaching of selected objectives, which entailed a change in the pedagogic practice, were highly trained, experienced teachers with a developed understanding of science teaching methods. This knowledge enabled them to find effective ways of making the sequencing rules and the criteria more explicit and transferable. We would argue that a refinement of the techniques used by these teachers, with the simultaneous sociological awareness to which we have referred, would lead to even smaller differential achievement between groups of children, be they in terms of social class, gender or others.

In these circumstances and on the basis of our study, we would suggest that a high level of conceptual demand *with* a simultaneous small differential achievement is possible if teachers are equipped with the methodology of the subject, and the knowledge of the social context of learning. This is a necessary condition for developing an effective teacher training. However, teaching conditions would also have to change because what the two teachers were able to produce in the case of selected objectives is clearly not possible for the total objectives of a science course under the present teaching conditions. Put in extreme terms, we would say that position III a) is possible to attain with good teacher training, position III b) is possible to attain with good teacher training *and* good teaching conditions. These teaching conditions would require *at least* more time available both for pupils and teachers. This points to an expensive pedagogy. However, it may well be more expensive ultimately to maintain the differential achievement between social groups or to lower the level of conceptual demand.

4. CONTRIBUTION OF THE FINDINGS TO THE INITIAL PROBLEM

If we now consider the initial problem of the thesis it is clear that the findings of our research have made

some contribution to its explanation. The broad hypotheses we initially put forward are on the whole supported.

First, we are able to say that the underachievement in sciences is related to social class. Social class is certainly a major factor in separating children in two groups in the science classroom; lower working-class show the lowest achievement and upper middle-class the highest. Second, if competencies required in the sciences are separated in two groups, those requiring a high level of abstraction and those requiring a lower level of abstraction, differential achievement is in fact, higher as hypothesised, in the former type of competency. Third, also as hypothesised, it is the high level of conceptual demand of modern science courses which have increased the difference between two groups of children in the science classroom in Portugal.⁹ Hence, where the conceptual level is low differential achievement between different social groups is reduced; where it is high the differential achievement is increased. Different courses, therefore, create different degrees of differential achievement: the greater the conceptual demand of a course and therefore of its level of abstraction, *the greater the differential achievement* between working-class and middle class children.

However, the picture is much more complex. In fact there are multiple interactions in the science classroom to produce a differential achievement, related to both the family and the school. On the basis of the analyses we carried out we would say that the differential achievement associated with social class is mediated through a number of variables namely gender, years of repetition and the teacher. The influence of gender is felt whenever different patterns of masculine and feminine leading to different practices and orientations prevail in the family. This is, in Portugal, linked with working-class families living in the country. The influence of repetition is felt whenever the working-class is more represented as it is in this

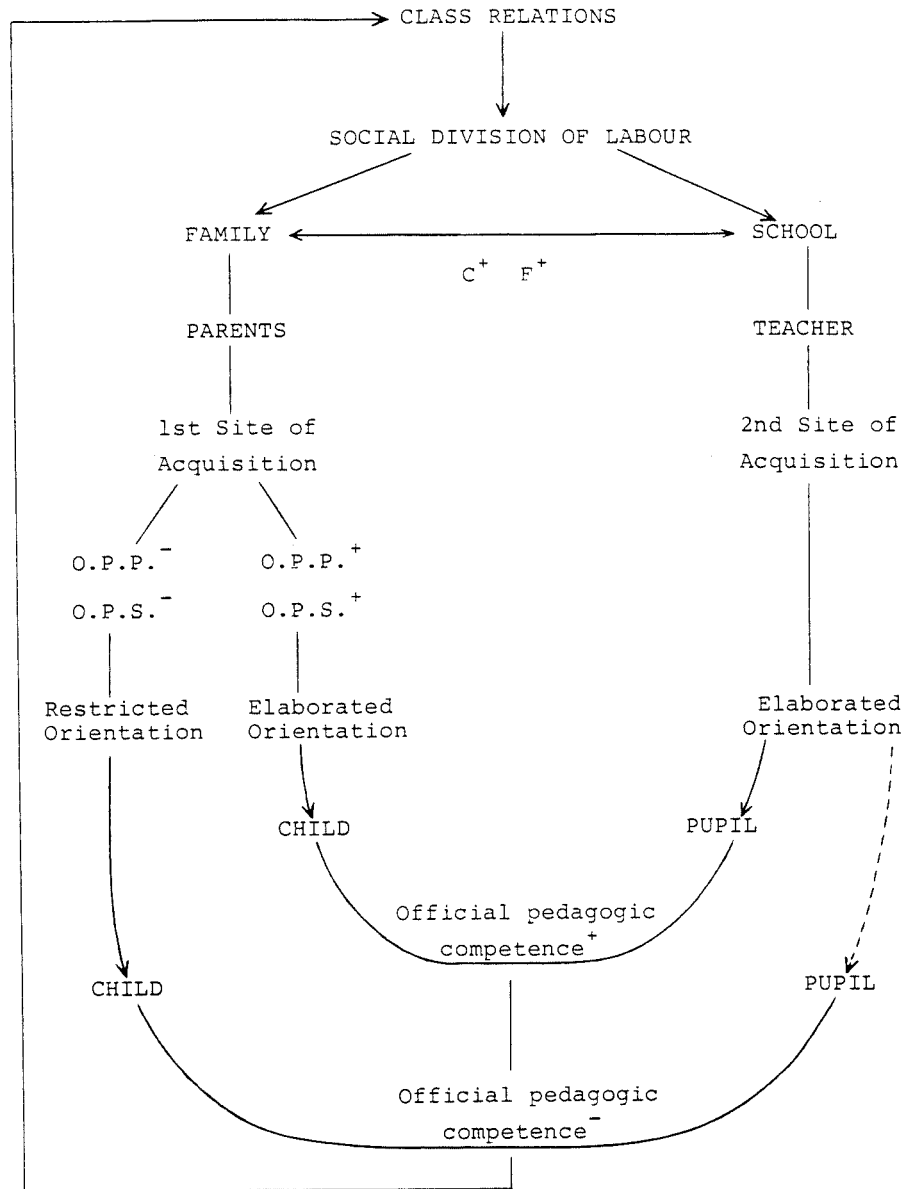
class that a high percentage of repetition occurs. The influence of teachers' pedagogic practice is very complex and depends on their attributes which are a function of both their training and the social context where they teach. In general this factor teacher/school maintains and even reinforces the competencies brought by the child into the school.

As we have seen the causes which lie behind differential achievement in the sciences are of a very complex nature but the causes which we have explored are directly or indirectly related to social class. This clearly gives more support to our initial hypotheses although the explanation is more complex than that pre-supposed by our original formulation of those hypotheses. To summarise we would say that *between social class and achievement in the sciences lies the invisible regulation of the social context of the school class which acts selectively upon the conceptual focus of the teacher and upon the ability of the teacher to enable pupils to attain required levels.*

5. INTRODUCTION OF A THEORETICAL MODEL

We shall now try to develop a theoretical model, drawing on Bernstein's work,¹⁰ which will allow us to offer a more general interpretation of our findings. The diagram of Figure 8.3 summarises the main relations in this model.

We have seen that pacing seems to be important for when it is reduced there is time available for explicating both the sequencing rules of learning and their criteria. This would seem to be necessary because the working-class children in our study, especially those in the country are less prepared in their homes to meet the rules and orientation of the transmission regulating the teaching practice. However, this may be only the surface features of a more basic problem. Where pacing is strong the cost



C F - Classification and Framing
 O.P.P. - Official pedagogic practice
 O.P.S. - Official pedagogic space
 + strong; - weak
 We have given only extreme positions; other variations are likely to be found

Figure 8.3 - Social Class and Pedagogic practice

of the pedagogic practice is cheaper than where it is weak. It is less expensive for, within a given time, certain children will be able to learn because they will be learning at home where the conditions both material and symbolic facilitate pedagogic acquisitions. In other words strong pacing followed by acquisition is only possible or is more likely, where the pupil is able to continue the process of acquisition at home. Indeed we would argue that strong pacing in the school demands a pedagogic context of acquisition in the home if successful acquisition is to take place. In this way the home is an economic subsidy to the cost of the transmission in the school. In other words a strongly paced transmission in the school requires a second site of pedagogic acquisition i.e. the home. The latter is a necessary condition for successful acquisition in the school.

Further if there is to be a second site of acquisition then it must be possible for the media of acquisition to pass from the school to the home so that appropriate learning can take place in the home. The medium which transfers learning at school to the home is the textbook. Here we can begin to see the importance of early reading.¹¹ For if the child reads early then she/he has access to the book and so to the textbook (or equivalent) which permits the creation in the family of a second site of acquisition.

This requirement is perhaps only a necessary condition it is not a sufficient condition for successful acquisition. The second site of acquisition, the home, must be capable of creating what we can call an official pedagogic space. Now the distinguishing features of this space depend upon the *context of acquisition in the school*. If the context of acquisition in the school requires silence, isolated learning, relatively context independent texts acquired in competitive relations with others there is good reason for believing that social class regulates the distribution of such contexts in the family.

We can distinguish families in terms of those who have imbedded in their practices a spatial arrangement which we could call an official pedagogic space, from those families who do not create such a space. Such an official pedagogic space in the home creates the context of acquisition of the school's pedagogic performances. For example if it is not possible to provide in the home a space for the child as *pupil*, that is a space where noise is excluded, where silence is possible, which is isolated, then acquisition is more difficult. In working-class homes in Portugal the material conditions for such a space are less likely to be found. Indeed the presence of such an isolated space for solitary learning could well be antithetic to the more communal and supportive practices often found in such homes, especially in the country in Portugal. Further the independence of children often valued in these homes is not so much based upon the independence in the *learning* encouraged by the school but *an independence of the parents* so that the child can leave the parents free *and* assist both in the home and as a wage earner.

Bernstein argues that the school requires an elaborated orientation to meanings where there is an indirect relation to a local material base. However the *realisation* of these meanings is regulated by the classification and framing procedures of the school.¹² Thus from this point of view the school requires of the pupil an orientation to its orders of meaning *and* an orientation to the contexts, contents and rhythms it creates for their realisation in a given pedagogic practice.

He argues that restricted orientations arise out of the forms of solidarity based upon a simple division of labour, whereas elaborated orientations are more likely to arise out of the forms of solidarity based upon a complex division of labour. From this point of view class relations broadly distribute elaborated and restricted orientations according to whether the conditions of work in which individuals find themselves approximate either to a simple

or complex division of labour. Bernstein points out that restricted orientations may be transformed by work itself through the activity of trade unions, political parties. Further *how* the school creates the contents, contexts and rhythms of elaborated orientations may well affect crucially those who acquire the modality of its elaborated codes.

If the school insulates itself strongly from the family, that is if there is a strong classification between the home and the school, then in the case of working-class families their practices, relations and orders of relevance and language variety are less likely to be seen as legitimate and encouraged by the school. In this case there is a double disadvantage entailed in the school's pedagogic practice. In the first place the orientation to elaborated meanings required by the school may not be encouraged in the family and in the second place the contexts, contents and rhythms of the school are not related to the contexts, contents and rhythms of the families *local* pedagogic practice.

It is true that a de-contextualising of knowledge and local practices acquired at home always, to some extent, occur at school to children of all social classes. The school selects, re-focusses and abstracts from the knowledge and practices the child brings to it and this de-contextualising process is followed *at the same time* by a re-contextualising of the child into the official pedagogic practice of the school. Given that this practice is much nearer to the middle-class because the official pedagogic practice of the school is imbedded in, and perhaps dominates, their local pedagogic practice then the twin processes of de-contextualising and re-contextualising will favour the middle-class child and place the working-class child under a crucial disadvantage. Thus it is likely in Portugal, especially in the country, that working-class families are less likely to incorporate in their local pedagogic practice the official pedagogic practice and the specialised space it requires.

The school constitutes an individual called pupil; the family an individual called child. Pupil and child overlap in the middle-class. They are more likely to be sharply separated in the Portuguese working-class and a double life, one at home and another different one at school may be created. There is in this case a strong classification between the two agencies of pedagogic transmission as boundaries and practices between them are sharp indeed. For the middle-class this classification is weaker.

The pedagogic competence of the individual is a result of a complex of interactions between the child who comes from the social institution called the family and the pupil who attends the social institution called school. Thus for the working-class child the official pedagogic competence will be less developed and for the middle-class child will be more developed. In fact, the school maintains and emphasises the competencies brought into it by the middle-class children and *by omission* also maintains and reinforces the competencies brought by working-class children. In other words little is changed by the school; on the contrary, differential reproduction is maintained and legitimised. In such conditions each child follows separate ways under the same roof of the comprehensive mixed classes and mixed sex school.

We have seen how there is little difference between the pupils with reference to the achievement of *A* competencies; the crucial differences arise out of differential acquisition of *U* competencies. Further we have seen how the pedagogic practice of the teachers in the country and working-class schools is selectively focussed upon *A* competencies. In a sense it may even be the case that working-class pupils are over-socialised into *A* competencies and under-socialised into *U* competencies by the school. We have argued that strong pacing makes the home a necessary second site of acquisition and that such a site together with appropriate pedagogic practices is much more likely to be found in the middle-class than in the working-class.

This model is liable to be challenged because it appears to entail a deficit approach: working-class children lack the competencies middle-class children possess. In fact, according to this model, working-class children as we have defined this group in this thesis, relative to middle-class children, are more likely to lack the pedagogic competence to achieve *U* competencies *with respect to the pedagogic regime of the school*. However, because the working-class children in our sample perform differently than the middle-class children it does not mean they do not have the same potential to acquire the modality of the elaborated code demanded by the school. Indeed it may well be that if the modality of the school's elaborated code was changed (its classification and framing strengths) so that the contexts, contents and rhythms of the school's pedagogic practice had greater relevance to the contexts, contents and rhythms of the children's family and community culture the acquisition of crucial *U* competencies would be facilitated.

Whilst it is indisputable that working-class children possess a valid competence and this competence should be respected and incorporated into the pedagogic practice of the school, it appears from our findings that working-class children do not have the same facility in acquiring the *U* competencies of science. The acquisition of these competencies, however, would not necessarily make the children middle-class in their cultural practice. Neither should the understanding of scientific concepts and principles, and the competence to use this knowledge in solving new problems and in understanding and criticising the world, be the preserve of a socially selected few. Scientific literacy is a necessary condition for equal access to the discourse *and* decisions of power. To defend the culture of the working-class does not entail that the children should be deprived of scientific literacy nor that such literacy entails the adoption of what are considered to be middle-class values and practices and the loss of their own values and practices.

We can use the general form of our model to analyse differential gender achievement in the acquisition of *U* competencies. We suggest that as in the total school population working-class pupils are disadvantaged as compared to middle-class pupils so *some* girls are disadvantaged compared to boys. These are the girls from families where different patterns of male and female behaviour are expected and which, in Portugal, occurs mainly in working-class families in the country. In Portugal, as we have said, the school its ethos and teachers do not have a bias against girls. We have argued that the difference in achievement arises from gender differences in the upbringing of the children so that boys and girls are socialised into different values, aspirations, practices and competencies. In Portugal this occurs mainly in the working-class in the country, where very strong patriarchal values and practices dominate the family, and it is in the country where differential gender achievements are to be found in our research. Clearly in societies where the school holds different expectations, attitudes for boys and for girls and where the curriculum offers the possibility of gender differentiated subjects, then we would expect a compounding of school and family influences to produce differential achievement in science.

If we had to sum up and point to the major issue raised by our argument it would be this. At the moment the curriculum and pedagogic practice in science education in Portuguese secondary schools through the direct and indirect effect of social class is producing a stratification of knowledge broadly parallel to the hierarchy of social class. On the whole working-class children particularly lower-working class are restricted to a level of understanding of science which denies to these pupils what is available to the middle-class children; the ability to understand, develop and apply the principles of science. We could consider that *A* competencies represent the vocabulary of science, whereas the *U* competencies represent the syntax. From this point of view working-class children are acquiring the vocabulary without the syntax. And this has many

implications. Working-class pupils are confined within a very limited conception of science, science as definitions, elementary procedural rules, rather than science as an imaginative exploration and explanation of the physical world. From this point of view they are likely to be cut off from the power of its discourse. We can say that from this perspective the school is institutionalising inequalities in the acquisition of the power of discourse. However, from another point of view, particularly, in developing societies such as Portugal, working-class pupils have unequal access not only to the power of discourse but also unequal access to the discourses of power and their dominant agencies and practices in society.

6. REFLECTIONS ON THE METHODS AND RESEARCH

The research we have carried out, for the reasons we gave in Chapter two, did not involve any observation of the teachers' classroom practice, nor were we able to talk to the parents of the children about their practices. We have made a number of inferences from our data about the teacher's pedagogic practice on the basis of quantitative and qualitative data which are basic to our explanations of differential achievement. Whilst we consider that our inferences are warranted it clearly is important to obtain a description of the actual classroom practice with reference to both the teachers and the pupils in selected classrooms in selected schools. The research we have carried out would help in focussing such a description.

We have developed a model to understand what we take to be the presence or absence of what we have called an official pedagogic space and an official pedagogic practice imbedded in the socialising practices of the family. It would be necessary to test the inferences we have made from this model by interviewing or better still giving actual descriptions based upon observations of selected families. We could distinguish within the working-class

families between those whose children were successful at science and those who were not and examine whether this difference was associated with differential use of official pedagogic practices and coding orientations. In the same way we have made inferences about the varying strength of patriarchy in order to account for differential gender achievement. It would be a matter of some importance to obtain direct information on this matter from the families. This issue could turn out to be more complex than we have indicated.

We must point out that the data we have obtained are limited to some fields of science teaching and the achievement of pupils. We do not know whether the patterns of differential achievement and their sources would hold for other science fields or for a group of subjects in the humanities. Is it the case, for example, that the selective focus of the teachers we have identified in our study finds its *equivalence* in other subjects of the curriculum. Whilst it is perhaps easier to identify this selective focus in science it may well be that the *level of analysis* of non-scientific subjects is capable of variation from a descriptive level to the principles upon which the description is based. It would seem to us to be important to widen the scope of this study in order to explore the extent to which the patterns we have found, especially with reference to the selective focus of the teacher, are specific to science or are more general.

Our findings suggested that a teaching with an explicit structure and where criteria and sequencing rules are made more explicit would improve learning. However, our study does not discuss in detail the most appropriate structure or the most appropriate ways of making the criteria and sequencing rules more explicit in the specific context of the science classroom. More research into classroom interaction is needed so that appropriate specific pedagogic practice can be designed, tested and established. However, *we would like to emphasise most strongly that the explicit framing suggested by our study does not (and should not) exclude the centrality of the*

pupils' experience and cultural context in the development of the pedagogic practice.

A matter of some importance is whether the patterns of differential achievement we have identified have their source in genetically determined differences in intelligence between social groups. This is a very complex question which has been the object of continuous controversy.¹³ From our data we can offer the following arguments. We have seen that pupils of the working-class achieve higher levels of competence in the development of abstract knowledge when they are taught by teachers who, at the same time, make a high level of conceptual demand and have a high competence to enable pupils to attain that level. This was true even when comparing only working-class schools. This shows that working-class children have not in general a genetically determined lower ability and that under well-structured and appropriate teaching they can achieve higher levels. Further, we have seen that gender differential achievement can be explained in terms of differences and similarities of gender socialising practices. It would seem reasonable to explain differential achievement associated with social class also in terms of differences and similarities of socialising practices associated with social class. Perhaps the most convincing evidence from our study is the evidence of the change in the achievement of working-class girls and also of working-class pupils in general consequent upon the special teaching programme.

If we are to continue to teach the present curriculum it would be of crucial importance to carry out a more extensive study of the effects of special teaching programmes along the lines of our programme but widening the range of objectives taught and building in the design controls on the selection of *contents* through which the objectives are achieved.

We should like to draw attention to the importance of generating a description which permits two levels of analysis. In our research if we had confined our analysis to the level of the whole sample then we would have failed to understand the dynamics of the problem. It was only when we shifted the level of the analysis to that of the teaching context of each teacher's classrooms that we were able to reveal the dynamics.

Finally, we should alert the reader to the limitations on the findings created by the constraints on our procedures of sampling discussed in chapter two.

7. POLICY IMPLICATIONS

We shall conclude our study with a brief discussion of some policy implications for science education in Portugal. Clearly it is beyond this thesis to enter at this stage into a broad discussion of the policy and practice of science education. What we shall do is to draw attention to the variation between teachers with respect to their conceptual focus and their competence to enable pupils to reach a given level of achievement, for this raises issues which we believe are much wider than the specific circumstances of any one school.

We have seen how teachers differ in their level of conceptual demand and in their competence to enable pupils to attain that level. It is a matter of interest to point out that this variety in the teachers' pedagogic practice takes place within the same general syllabuses designed by the Ministry of Education, and that these same general syllabuses can lead to such different grading of courses in different schools and with different teachers, as we saw in our analyses. Some might claim that these differences are a sign that teaching is responding to the needs of local communities. Indeed in order to accomplish

context-specific teaching practice, the above argument has been used for the abolition of national examinations in Portugal. However, this apparently wise measure defended by progressive teachers and educationalists may, according to our findings widen the gap between the kinds of teaching children receive in big cities and in working-class and/or country schools. This gap, if undiscovered, will legitimate selection procedures for entrance to further education, university and occupations. Furthermore, this gap which reflects great differences in the development of high level knowledge will reinforce by itself differences between social classes. Thus, a child who steps into a school disadvantaged may leave it still more disadvantaged.

In the last fifteen years in Portugal there was a change in the form of the centralised educational system. This system moved from a highly centralised controlled educational system characterised by national exams, an exclusive textbook approved by the Ministry of Education, the presence of a general system of inspection and the existence of head teachers appointed by the Ministry of Education to a system without national exams (with the exception of the exam before entrance to university), free choice of textbooks, absence of inspection and schools run by a body of elected teachers. The educational system is now highly controlled by the individual school and the role of the Ministry of Education is greatly reduced, its major function limited to the setting of school syllabuses usually only in terms of broad guidelines. Most of these changes have undoubtedly produced advantages to teaching and learning at school. However, the present *total* lack of control over the school has increased differences in learning between schools and has brought serious disadvantage for the already disadvantaged children. It should be noted that many of the changes, namely the abolition of national examinations, were expected to produce the opposite result. It is important to focus our attention not only on those teachers (and schools) whose

pedagogic practice produces a general low level of learning but also of equal importance to focus our attention on those teachers who have raised the level of demand to a point that their teaching entails the learning of concepts and details of a university level syllabus inappropriate for children at the secondary school level. The latter is more likely to occur in big cities and in middle-class schools, usually former 'liceus'. It is important to note that these are teachers who are very often requested by the Ministry of Education to design examination tests (whenever national exams still exist, e.g. the exam before entering the university). This means that after the years of primary, preparatory and secondary schooling during which teachers/schools (and pupils) followed their uncontrolled particular pedagogic practice there is an examination which, more than ever, is only suited for *some* pupils, i.e. the pupils of those teachers who design the test papers or of teachers with a similar pedagogic practice. It is true that these are teachers who write school textbooks but this does not necessarily function as a control, firstly, because the schools can select the textbooks they wish and, secondly, because teachers are free to re-contextualise textbooks according to their own perspectives.

These changes which in principle should be good have had the damaging effects we have broadly tried to indicate. Clearly the solution does not lie in going back to the previous system but *some kind of control should be investigated* in order to correct some of the disadvantages of the present system. In seeking for this control we may arrive at the conclusion that, under particular conditions, the national examination may be a less unjust form of control and a less damaging form of control, especially where such examinations are complemented by yearly school based assessment. We would like to point out that the changes we have referred to in the examination system were introduced step-by-step by successive governments of either left wing or right wing position. This necessarily leads us to think that consequences of such changes have been either misunderstood and/or

disregarded by both types of governments in power.

It may seem strange today that we are suggesting a greater measure of control from the centre in Portugal, in order to reduce unproductive variation between teachers which is a source of inequalities between social groups. There is another alternative. In order for teachers to be aware of the influence of the social context upon their teaching so that they can be reflexive to their own practices an infra-structure would need to be created so that teachers could monitor their own practices through collective discussion and evaluation. Further, from our very limited research it would seem that teachers require more support in developing appropriate teaching strategies.

In a sense what we are really suggesting is a greater understanding by the centre of some of the implications of present variation rather than a return to traditional dominance by the centre. In the same way we are suggesting the need for a greater understanding by teachers of the implications of their teaching contexts and a developed responsiveness by teachers to this understanding. Both these movements of centre and teachers could be facilitated by the creation of a new infra-structure of in-service teacher training which, itself, would have consequences for initial training.

Finally we must point out that because we have found evidence of class linked differential achievement in term tests this does not necessarily mean that high marks on these tests indicate that a scientific imagination has been acquired nor that low marks necessarily mean the absence of such an imagination. Indeed our thesis has not addressed the question of the assumptions, possibilities and constraints of the science curriculum as such. We have not addressed the issue of what science and for whom. To do this would require a thesis in its own right. However, we feel it is important to stress that our thesis has explored

differences in test results within a set of assumptions, possibilities and constraints of a given curriculum.

8. NOTES AND REFERENCES

1. See, for example, B. Bernstein, 1977 and 1982.
2. See analysis in Chapter one.
3. See B. Bernstein, 1982 and B. Bernstein elaborated in M. Diaz, 1983 first part.
4. See P. Willis, 1977.
5. This is evident by comparing the marks obtained by working-class pupils of different teachers and *taking into account the level of demand* of these teachers (see data in Chapter seven).
6. The kind of structure they follow can be appreciated through, for example, A. Domingos *et al.*, 1981 and 1983.
7. See Chapter four on Teacher's pedagogic practice.
8. This is evident when we compare the marks obtained by pupils of any given social class taught by different teachers and *controlling for the level of demand* of these teachers (see data in Chapter seven).
9. This is substantiated by the fact that, in our study, the comparison of teachers with different degrees of conceptual demand showed higher social class differential achievement for teachers with a higher level of conceptual demand.
10. *Ibid.* 1 and 3.
11. Clearly all pupils in the secondary school are in the formal sense literate. However, whether all pupils can make equal sense of science textbooks is another matter.
12. See B. Bernstein, 1973 chapter 11 and 1977 part II.
13. See, for example, A. Jensen, 1972 and J. Kamin, 1974.

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