THE INDIVIDUALISED LEARNING OF

PHYSICS IN SECONDARY SCHOOL CLASSROOMS

by

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the Ph.D degree, University of Surrey, 1979.
Summary:

Individualised Learning has attracted the attention of curriculum developers, psychologists and educationalists during the last two decades. These studies have looked at different aspects of it. However individualised learning as it is practised in secondary school classrooms, has been one of the less widely investigated manifestations. The study presented in this thesis was concerned with the identification of different elements which characterise individualised learning in Physics classrooms.

The combination of classroom environment and individualised learning material represents a highly complex situation which requires a broad approach in investigation. Bearing in mind the exploratory nature of the research presented here, it would not have been appropriate to test pre-established models or ideas. The research approach used led to a greater degree of understanding of classrooms using individualised learning, rather than to the validation of pre-established hypothesis. Although these classrooms are affected by both internal and external factors the ones which were taken into consideration in this study were those that appeared to influence the occupants' day-to-day behaviour.

The overall aim was to study individualised learning in operation, to discover the changes which have taken place in teachers' and students' behaviour as observed in practice. This research has found that:

a) According to the teachers there is no unique way of defining a particular approach to individualised learning. The variety of interpretation led to a variety of practice which did not depend on the quality of the material used but rather on the personal qualities and beliefs of the teacher.

b) Teachers described changes in their behavioural role in the classroom in four areas: preparation, control, interaction and motivation. These factors have taken on a new importance in the classroom.
c) Greater student participation in the classroom activities has introduced a new social order, where the "resource status" of each participant is a fundamental factor in interactions.

d) Teachers and students expressed opinions of the lab work that showed that experiments included in individualised learning should mainly be used to reinforce knowledge learned rather than to introduce new concepts. Furthermore, they agreed that students should be trained to take the best advantage of the experimental situation.

By considering the aspects mentioned above, it was possible to suggest some guidelines for the training of Physics teachers in the use of individualised learning.
ACKNOWLEDGEMENT

I would like to acknowledge the generous co-operation of all the teachers and students who made it possible to carry out this research and particularly to the A.P.P.I.L. Team.

My thanks are due to Dr. John Gilbert for his encouragement and supervision of this research and to all the Staff and Colleagues at the I.E.T. with whom I have had many useful discussions.

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CHAPTER I

Statement and outline of the research

1.1 Introduction

1.2 Purpose and scope of the research

1.3 Outline of the Thesis
1.1 Introduction

For some decades teachers have recognised the importance of individualised learning. They have realised that the physical, intellectual, emotional and social differences, so evident among their students, call for different approaches to teaching. They have found ways themselves to vary the pace, content, objectives and kind of activities undertaken in their courses. They have also been able to allow different students to do different things, in different ways and at different times within the classroom environment. In Great Britain, with the development of the enquiry-based curriculum in the sixties, and with the emergence of the mixed-ability group at the beginning of the seventies, individualised learning materials began to be developed and used. As a result of this, different approaches to individualised learning are now available. Some take the form of ready-made packages devised by teams of teachers and/or curriculum specialists (e.g. Project Highland and Islands (Roebuck, et. al 1974), The Resource for Learning Development Unit (Foster 1976), Working with Science (Wild and Gilbert 1977), Advanced Physics Project for Independent Learning (A.P.P.I.L. 1978)). Some have been developed by classroom teachers' activities on their own initiation and by "trial and error" methods (e.g. Independent Learning in Science (Green, 1974), Devon Independent Learning (Healy 1977), and CAMOL Independent Learning (Brown 1976).

No study has apparently yet been made of Physics Classrooms using individualised learning material with the aims of taking a closer look at the approach in its widest social and educational context.

1.2 Purpose and scope of the research

Any changes or innovations in the classroom imply changes in the organization and conduct of classes. In the case of individualised learning, where the new skills that the teacher has to develop in order to cope with the new approach, have not
been formulated in a sufficiently precise way, it is difficult to produce guidance without visualising first the new model of the classroom situation. In addition to this, it should be borne in mind that other aspects of classroom life could influence the new way of teaching, so that the same action at different times and in different contexts might acquire different meanings for the participants.

This research was concerned with the identification and study of the factors that change when an individualised learning approach to teaching and learning is introduced in Physics classrooms.

The general aim of this research could be stated as:

"To study individualised learning classrooms in order to identify the different factors operating and to produce guidelines for the training of teachers in the use of such materials."

As the research work was being developed, specific objectives emerged. These were to:

- Study the different interpretations given to the idea of individualised learning
- Identify new activities that the teachers have to perform
- Study students' perception of the teacher
- Study dyadic interactions, between teacher and student and between students.
- Study the role of laboratory-work

The students and teachers who took part in this study were using several different approaches to individualised learning in Physics or integrated science. In addition to the A.P.P.I.L.
schools (schools using materials from the Advanced Physics Project for Independent Learning) which were the basis for this research, the following schools were also involved in different aspects of it: R.F.L.D.U. schools (schools using material from the Resources for Learning Development Unit), Methodist College in Belfast (using CAMOL Independent Learning material), Beanfoy School in London (using worksheets developed by the Head of Physics) and Swindon School in Swindon (using worksheets developed by individual teachers).

The study has been limited to some areas which emerged, during the initial phases, as being the most salient. This decision should not be taken to mean that these areas were the only ones of importance. Indeed there are others, but the ones chosen seemed to influence participants' day-to-day classroom behaviour to the most marked extent.

1.3 Outline of the Thesis

The classroom life is a unity which cannot easily be broken into segments. Each factor studied was affected by the others in the continuum of the teaching and learning process. Each of four chapters (IV, V, VII, VIII) presents an analysis of one aspect which is very closely related to the others, and one chapter (VI) brings all the elements together to form a composite picture of five classrooms.

Chapter II presents an account of how the idea of individualised learning emerged in the U.S.A. and in this country and a discussion is given on the different attempts made to unify the ideas. It also presents a review of previous work done on the different factors studied here. As the literature on the different roles that the teachers are supposed to play is usually presented in the form of a contrast to traditional teaching so a review of the teacher's role in both kinds of classroom is included. Studies done on interactions in science classrooms are presented and two studies about dyadic interaction in such classrooms using individualised learning, are discussed. The laboratory work and its importance in Physics
education is also discussed.

The relationship between the approach used in the research and the methods and techniques used are presented and discussed in chapter III. The central focus of the research was the understanding of classrooms where individualised learning had been adopted. As no simple method is sufficient for studies such as this, it was necessary to employ a range of methods and techniques which are described also in chapter III.

Chapter IV discusses the problems of the terminology used around the idea of individualised learning. The teachers' perception of the different terms suggested some characteristics for each term. These were based on their own experiences and their aims in teaching.

Chapter V looks at the changes in classroom activities that teachers have undertaken. The teachers' perception of the activities performed in individualised learning suggested four areas of change. This, plus the study of students' perception of the teacher, are presented and discussed.

Chapter VI brings teacher and students together in the classroom. Five case studies of classrooms using A.P.P.I.L. material are presented. I examine the way the student and teachers work with the material and the factors which influenced these classrooms.

An analysis of the one-to-one interaction in the classroom is presented in chapter VII. The teacher and student interactions were studied following Hargreaves' model of interaction (Hargreaves 1972). A model of the elements which influenced the initiation of interaction is discussed and the student-student interactions are analysed by comparing a "who speaks to whom" matrix with the student's perception of the group.

Chapter VIII deals with one of the most debatable elements
in Physics Education, "The role of the Laboratory Work". Two approaches to individualised learning were selected to study teachers' and students' opinions on the role of the laboratory work. In spite of the era of curriculum development in which we have been immersed for the last two decades, teachers and students were agreed in saying that the concern of laboratory work is with the subject to be learned (Physics) rather than with the approach used to learn it.

As it is hoped that the outcome of this research will be directly used by teachers, the thesis concludes with a chapter where a discussion of all the elements in a Physics classroom using individualised learning material is presented and some guidelines for the training of teachers are suggested. (Chapter IX) This aims to bridge the gap between the findings in curriculum research and the usability of these findings at classroom level.
CHAPTER II

Literature Review

2.1 Introduction

2.2 The development of individualised learning

2.3 Attempts to unify the idea of individualised learning

2.4 The role of the teacher
   4.1 The role of the teacher in traditional classrooms
   4.2 The role of the teacher in individualised learning classrooms

2.5 Interactions in the classroom

2.6 Laboratory work in teaching Physics
   6.1 Reasons for using laboratory work
   6.2 Types of lab. work
   6.3 The lab. work in individualised learning

2.7 Conclusions
2.1 Introduction

The different schools of Psychology have stressed for many years, the roles of individual differences in learning. In this country, these individual differences have been used and are still being used, for streaming and selection in secondary schools. The organizational changes introduced recently in some schools have brought changes in classroom populations. The difference in attainment between the so called "top group" and "bottom group" within a classroom is becoming larger. This fact has led to a different emphasis in the interpretation of the effect of individual differences in learning. The need to pay close attention to these differences in the classroom has become essential. Individualised learning is the name collectively given to the different approaches used in classrooms to meet their need. This chapter reviews previous work done in this area.

2.2 The development of individualised learning

Early attempts to introduce individualised learning originated in the United States of America under the influence of Dewey and Thorndike's ideas of education. The social-economic problems associated with the unexpectedly high proportion of drop-outs and grade retentions found in secondary schools (Fox and DeVault 1978) were also influential.

In the 1920's, Dewey used "individual differences" as a measure of appreciation of individuality, i.e. emphasizing students' choice and involvement in the development of classroom projects (Snelbecker 1974). Thorndike used "individual difference" to emphasize that the variability of students has an important implication in educational practice, i.e. that equalizing the teaching in the classroom seems to increase differences among the students (Claser 1967).

The most clearly documented work on individualised learning during the first half of this century, was the Winnetka Plan and the Dalton Plan.
The Winnetka Plan was started by Frederic Burk in San Francisco State Normal School by 1912 (Fox and De Vault 1978). Initially it included a series of self-instructional textbooks in each of several subject areas. Later on this approach was implemented in Illinois where the curriculum was divided into two parts, namely, 1) common essentials, (i.e. reading, arithmetic, spelling and self-expression) in which pupils worked individually with workbooks and progressed as their ability permitted, and 2) group activities, in which pupils were encouraged to work in groups.

The Dalton Plan was originated by Helen Parkhurst in 1919 based on the ideas of Frederic Burk. It was used extensively in the high school at Dalton Massachusetts. According to Kimmins and Rennie (1932) three fundamental principles formed the basis of the plan:

a) Freedom:
The child was free to determine, to a large extent, when she/he could study any given topic.

b) Co-operation and interaction in group life:
This was implemented through the creation of subject laboratories.

c) Time responsibility:
Children were allowed to distribute the time allocated for a month's study.

The main common characteristics of these two attempts at individualised learning were:

1. They allowed the students to self-pace a coverage of the course.
2. A choice of activities was presented.

Both approaches to individualised learning were widely copied and rapidly spread around the world. In this country a Dalton Association was established with the aim of providing a forum for discussion about the use of the Plan (Taylor 1972), but despite this, the Dalton Plan disappeared from English schools. According to Taylor (1972) among the reasons for this were:
- The fact that schools needed special re-arrangement;
  "...all the classrooms had to be re-arranged as 'laboratories',
in all subjects assignments had to be written and the related
books and equipment provided, and so on". (pg. 137)

- The role conflict experienced by the teachers,
  "The Dalton Plan required a major change in the role of
the teacher who was now expected to move from the centre
of the stage". (pg. 137)

- The lack of central support in the production of material
  "The Dalton Plan failed to develop any central supporting
agency .... some few assignments were indeed published in
the early days by way of a sample, but the Dalton gospel
rested essentially on local inspiration". (pg. 138)

- The pressure of external exams,
  "....The Dalton Plan came to England at a time when
education was closely tied to external exams and, on
reflection, progress at school was measured in marks given
for written work". (pg. 139)

- The financial problems at the time,
  "Teachers trying to work Dalton methods with their heavy
reliance on printed resources, were hamstrung by severe
cuts in books and stationery allocations". (pg. 277)

- The insecurity of employment for the teachers
  "Doubtless, too, the insecurity of employment at such a
time encouraged a righteous orthodoxy in all but the bravest".
  (pg. 277)

In the late fifties, individualised learning re-appeared in
the United States of America as a consequence of three pressures:
1) The social-economic factors of: shortage of teachers, large classes, the need to improve the quality of instructions.

2) The new ideas and research on learning thus evolving: the hierarchical formulation of learning, e.g. Gagné, Bruner, Piaget, the behaviour modification orientation, e.g. Skinner

3) The availability of hardware (projectors, recorders, television, computers, etc) and the simplicity of their operation allowing the teacher to incorporate equipment in the classroom.

The major development of this new movement to individualised learning was Programmed Learning which was based on Skinner's Operant Conditioning Theory of Learning (Skinner 1961).

Programmed Learning materials have the following characteristics:

a) a set of terminal behaviours (behavioural objectives are set),
b) the subject-matter, process or skill to be learned is broken down into its elements,
c) the material is presented in a logical sequence of small steps,
d) the student receives immediate reinforcement,
e) the student works at his/her own rate and checks his/her own progress.

(Lysaught and Williams 1963)

Programmed Learning only provided help in solving some of the problems of teaching in secondary schools. It seems to have had major value for the learning of a particular skill, e.g. how to use an oscilloscope, how to use a slide rule, and for remedial and enrichment purposes (Gage and Berliner 1975). However a good deal of what, later on, became individualised learning, has its roots in programmed learning.

A large number of approaches to individualised learning in science started to be developed in the United States of America after the appearance of programmed learning; among them there were:
"Individually Prescribed Instruction" (I.P.I.). This was developed by Glaser, Bolvin and Lindvall with the co-operation of the University of Pittsburgh and the Baldwin-Whitehall Public School. It is an instructioned system based on a set of behavioural objectives correlated with diagnostic instruments and curriculum material - including programmed material, workbooks - and teaching techniques (Lindvall and Cox 1970).

"Program for Learning in Accordance with Needs". (P.L.A.N.) This was developed by thirteen school districts with the American Institute for Research and Westinghouse Learning Corporation. It consists of modules which include objectives associated with recommended learning activities and criterion test. It is further individualised by providing alternate teaching-learning strategies called Teaching-Learning Units. (Flanagan J. 1970).

(I.P.I. and P.L.A.N. were the first two national programmes developed which supported individualised learning. Both used the computer for management purposes).

"Intermediate Science Curriculum Study" (I.S.C.S.) developed by Florida State University with Federal Government support. This consists of written material where the use of experiments is emphasized (Vickery 1968).

Furthermore individual teachers adapted the new Physics Curricula to an individualised learning approach e.g. the Harvard Project (Payne 1974). In other cases schemes of individualised learning developed for Higher Education such as audio-tutorial (Postlethwaite et. al. 1972) and Keller Plan (Keller and Scherman 1974) were used by Physics teachers in their courses (Knoup 1974, Werner and Bono 1977).

I do not intend either to give a complete list of the different approaches to individualised learning nor to comment on the difficulties encountered in their implementation but to illustrate the variability of projects, schemes and terms used around the idea of individualised
learning. This wealth of approaches led to confusion and, in some cases, to the fragmentation of effort. Gibbons (1971) describes the different approaches as follows:

"Together such programs constitute a widely diverse family. They are based on different interpretation of individualization. They are inspired by different technology and expertise, and confounded by the ambiguity of their label" (pg. 2).

In this country the movement towards individualised learning in secondary schools has emerged quite differently. The science curriculum development of the last twenty years has been discussed in the document "Alternatives for Science Education 1979", (The Association for Science Education 1979). Their document considers that the work in the science curriculum has been influenced by, among other factors, two important funding agencies - The Nuffield Foundation and the School Council -. It criticises the fact that these two agencies did not take into account the idea of individualised learning, e.g.

"From the theoretical standpoint a major criticism of Nuffield and School Council development is their failure to acknowledge the psychology of individual differences." (pg. 22).

In this line Green (1976) said:

"There is considerable dissatisfaction among science teachers in regard to these developments (Nuffield sciences and School Council Integrated Science Project) arising from the content of the curriculum, the applicability of the content for the whole ability range, the centralized authoritarian nature of the developments and so on ... 'Science for all' is a vital and relevant objective, but 'O' level Nuffield Physics is only for some of our students". (Pg. 1-2)
The recent individualised learning movement in this country was started by individual teachers, and small groups of teachers, from different schools. It emerged as a response to changes in educational contexts such as comprehensive re-organisation, de-streaming and mixed ability grouping (Kelly 1974). The point I want to highlight here is that the movement towards individualised learning in this country has emerged from the schools themselves and not from "agencies" like in the U.S.A.

Teachers were involved in devising schemes which better suited the needs of their students either using published sources or by developing material on their own. All this was made possible by the wide availability of reprographic apparatus, audio-visual aids and, to some extent, technicians.

Later on organizations such as "Independent Learning in Science" (I.L.I.S.) (Green 1974), "Resources for Learning Develop Unit" (Foster, 1976), Devonshire Independent Learning (Healy 1977) CAMOL in the Methodist College of Belfast (Brown 1976), "Working with Science" (Wild and Gilbert 1977), and "Advanced Physics Project for Independent Learning" (A.P.P.I.L. 1978) emerged to support the movement.

Looking at the different definitions of individualised learning given by these organizations and projects, it can be concluded that in this country also the interpretations of the term "individualised learning" varied widely. Thus the use of the phrase must vary among the teachers who use the material.

2.3 Attempts to unify the idea of individualised learning

As the term individualised learning has been used to describe widely diverse approaches of teaching, educationalists have tried to unify the idea. Edling (1970) after visiting more than 100 schools (primary and secondary) in the United States of America, concluded that the general orientation in all the individualised learning approaches was the same

"The individual instead of the group or class" (pg. 2)
and that the implementation of this orientation took many forms in actual practice. He considered that individualised learning requires, by definition, individual pace and divided into four groups all the different approaches he found in schools (Table 2.3.1)

Edling's types of Individualised Learning

<table>
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<tr>
<th>OBJECTIVES</th>
<th>School Determined</th>
<th>Learner Determined</th>
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<tr>
<td><strong>Type A</strong></td>
<td>System (Individual diagnosed and prescribed)</td>
<td><strong>Type C</strong></td>
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<tr>
<td><strong>Type B</strong></td>
<td>MEDIA</td>
<td><strong>Type D</strong></td>
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<tr>
<td>Learner (Self-directed)</td>
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Table 2.3.1.

The four groups are based on "who" determines the 'objectives' and 'the media'. Edling found that types A and B were more used in compulsory subjects such as languages, arts and mathematics and types C and D were used more in science, social studies and elective courses. On the other hand, types A and C were used with students of average ability whereas types B and D were more frequently used with above average learners.

Another attempt to unify the term individualised learning was made by Gibbons (1971). From a review of the literature on individualised learning, he developed the classification shown in Table 2.3.2. based on the nature of the conditions for learning provided by the teachers.
Table 2.3.2.

Gibbons's Classification of the different approaches of individualised learning

Individualised Learning

- Individual
  - Active
    - Direct
    - Indirect
  - Responsive
    - Direct
    - Indirect
  - Permissive
    - Direct
    - Indirect

- Class or Group
  - Active
    - Class
      - Sub-group
  - Responsive
    - Class
      - Sub-group
  - Permissive
    - Class
      - Sub-group
The first division of Gibbons' classification - individual and class or group - corresponds to whether the teacher directs instructions to an individual or to more than one student (i.e. groups). Gibbons identifies the latter as the best way to approach the problem of mass instructions. This first division is based on his interpretation of individualised learning, since he pointed out that:

(First...)

"Every program is unavoidably individualised to some degree by the perception each person has of it and the response he makes to it. Second, when an administrator or teacher increases the number of alternatives open to every student, he may be said to have individualised instruction, but the individualization will be relative and possible rather than absolute or necessary. Third, different aspects of individualised instruction are emphasized by different people, depending on their role in the schooling process". (pg. 16)

The following sub-division in Gibbons' classification - active responsive and permissive - is based upon the "decision-making pattern" that the teacher establishes in the classroom:

active: teacher makes all the decisions about curriculum

responsive: teacher-student co-operation in the decision about the curriculum

permissive: teacher allows the student to make decision about the curriculum.

Gibbons described 'active' as opposite to 'permissive'; for him 'active' imposes dependence on the student (in pace, method and content) and the student learns for others, while 'permissive' makes independence possible for the students and the student learns for himself.
The second sub-division into individual-direct or individual-indirect, corresponds to the media by which the teacher instructs. 'Direct' means that the teacher confronts the students personally and 'indirect' means that the teacher uses 'mediant devices' to instruct the students.

Gibbons' and Edling's classifications differ mainly in the following aspects:

1) the determination of pace  
2) the way the teacher instructs the students  
3) the possibility of teacher-group interactions

According to Edling the term 'individualised learning' implies, by definition, self-pacing and the use of 'mediant devices' to instruct the students. Gibbons considers that in individualised learning courses pace could be controlled by the teacher and the teacher could instruct directly. He also considers that individualised learning does not imply that the teacher has to interact with each individual.

Fox and De Vault (1974) in a study on the use of individualised learning defined two approaches:

1) The educational Technology approach: 
   use of independent activities, unitary tasks and pre-packaged material

2) The educational humanism approach: 
   use of group activities, holistic task and real life situation.

In their literature review, they found that the separation of these two approaches has increased lately but they found that in practice teachers attempted to be both 'technocratics' and 'humanistics'.

According to Fox and De Vault the main problems that the teachers meet in the classroom are how to support an environment
that is both technocratic and humanistic, if the programmes are characterized by only one of the two approaches.

In the same way Charles (1976) made a classification of the different approaches to individualised learning (Table 2.3.3.). He used the term 'behaviour referenced' instead of 'educational technology' and 'experience referenced' instead of 'educational humanism'. Charles also considered a third possibility which was a combination of 'behaviour referenced' and 'experience referenced'. This combination corresponded to the findings of Fox and De Vault. Furthermore he suggested that the four elements which, according to him, characterized individualised learning - content, time, objectives and activities - should be variable as far as school policy and teacher's mental and physical conditions allow.

Charles's classification of the different approach of Individualised Learning

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<td>Behaviour referenced</td>
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<tr>
<td>Emphasis on specific behaviour objective</td>
</tr>
<tr>
<td>Combination</td>
</tr>
<tr>
<td>Emphasis on qualitative experience and specific objective</td>
</tr>
<tr>
<td>Experimental referenced</td>
</tr>
<tr>
<td>Emphasis on providing quality learning experience for S's</td>
</tr>
</tbody>
</table>

These two last classifications of the different approaches to individualised learning show the influence of the new humanism. Carl Rogers, with his book 'Freedom to Learn' (1969) has re-developed the humanistic approach of individualised learning which had apparently been forgotten under the strong influence of behavioural psychology.
Graystone (1977), based on his experience with teachers using material produced by The Resources for Learning Development Unit, suggested the following classification related to the way the teacher 'uses the resources' (U.R) (see Table 2.3.4.).

Graystone's classification was to be tested in future research, so he expected to be able to place a given lesson in any of the four segments A, B, C or D. The dichotomy, 'individualised-class/group', corresponded to whether the instructions given to the students were according to individual needs or to the class needs, and the other dichotomy 'dependent-independent' corresponded to the degree of independence that the students could achieve in the classroom.

**Graystone's classification of the use of Individualised Learning**

![Diagram showing Graystone's classification]

Davies (1978) looking at the elements of individualised learning from the teacher's viewpoint, considered that any teaching-learning situation is composed essentially of four 'dimensions' (Table 2.3.5.).
These four dimensions represent a range of choice and can interact with each other.

<table>
<thead>
<tr>
<th>Instructional Ethos</th>
<th>People Patterns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning</td>
<td>Individual</td>
</tr>
<tr>
<td>Teaching</td>
<td>large group</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Means of providing content</th>
<th>Control Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resources intensive</td>
<td>Independent</td>
</tr>
<tr>
<td>Person intensive</td>
<td>Externally controlled</td>
</tr>
</tbody>
</table>

Table 2.3.5.
Summarizing, we have that Edling's and Gibbons' classifications were concerned with 'who' decides the objective, time and media, Fox and De Vault, and Charles, were concerned with the approach used - behavioural or humanistic - and Graystone and Davies were concerned with the degree of freedom the teacher allowed in the classroom, i.e. how much the student depends on the teacher to learn the content of a subject. This seems to imply that these attempts to verify the different practices which take into account the individual differences in the classroom have gone through different periods which reflect the evolution of the idea.

However within this chronological review, there are some points in common:

1) For some of them (Gibbons, Greystone and Davies) the teacher, in individualised learning could interact with groups or with individuals.

2) Only two of them (Gibbons and Davies) considered the possibility of having individualised learning without 'instructional devices'.

2.4. The role of the teacher

It is not the intention of this section to enter into a discussion on the various meanings of the term 'role' or of the many ways in which the concept has been used in the literature (see Biddle and Thomas 1966). Nor is it intended to discuss the role of the teacher in a wider sociological context, i.e. how the role of the teacher is affected by the social environment of the school and by the community outside the school from which the teacher and students come (see Wilson 1962; Weswood I, II 1967). The intention is to discuss the 'behavioural role' of the teacher in the classroom.
2.4.1. The role of the teacher in traditional classrooms

One of the main problems in any investigation of the teacher's role is that of de-limiting the area to be examined. Most studies of the teacher's role have been concerned with the teacher's status, the social origins of the teachers, etc. (see Weswood I, II 1967). The studies undertaken on the role that the teacher might assume in the classroom are frequently related to the expectations of different groups. (Sorenso, Hurek and Constance 1963; Soles 1964; Musgrove and Taylor 1965, 1969, Cohen 1965, Finlayson and Cohen 1967). These roles frequently take the form of educational aims or general attitudes towards specific classroom situations rather than being related to specific actions in the role. For example, the roles that Sorenso et. al (1963) and Soles (1964) tested with their questionnaires on teachers' role expectations, only tells us how teachers felt they ought to act in the school, not how they actually did act. On the other hand, the studies where teachers were asked to identify themselves with a set of roles presented to them, were found unreliable. This is due to the fact that one cannot assume that the interpretation given by a set of teachers, to a particular role, is unique. (Graystone 1978).

According to Hoyle (1969) the teacher's role is performed in the classroom according to personal ideas of how a teacher should act. These ideas are based not only on practical experience in teaching but also on a model based on experiences as a student. Therefore some teachers' roles could be considered as institutional and others could be considered as the product of individual style and choice. Many writers have devised sets of institutional roles; for example, Sorenso et. al (1963) suggested six main roles for the teacher in the classroom: those of adviser, counsellor, disciplinarian, information giver, motivator and reference. Blyth (1965) basing work on Wilson (1962) and Flond (1962) defined six roles for primary-school teachers: those of instructor, parent-substitute, organizer, value bearer, classifier and welfare worker. Hargreaves (1975) summed up all these in two main institutional classroom roles
from which, he thinks, no teacher could escape: 'instructor' and 'disciplinarian'. Although Hargreaves describes these two roles extensively, he considers that they are strongly affected by the other roles that the teacher has to perform in the school, e.g. outside the classroom when interacting with other teachers or students, in what is called the 'role-set'. These teacher's roles may be performed in a variety of ways which are called role styles (individual styles). Waller (1967) in his book "The sociology of teaching" made the first attempt to categorize the different styles in which teachers perform their role. He considered that teachers adopt different defence mechanisms (role styles) to perform their role in the classroom (behavioural role). Thelen (1954) who conceived role style in terms of models, developed seven models using 'principles of educational method' as his guide. Hoyle (1969) on the other hand, talked about five models based upon a family relationship metaphor.

It seems that it is more meaningful for these authors to present their viewpoints about the teacher's role style in metaphorical terms based on their own experience rather than on research work. In spite of this all of them would appear to accept that the role style represents the teacher's personality and the interpretation of his/her own role in the classroom.

Summarising here, it can be said that each teacher has a set of classroom behavioural roles and a specific way or style by which these are performed. The behavioural roles are influenced by the teacher's background, and by the school's expectations. The way in which these are performed represents the 'teacher's style' which is determined by the nature of the teacher's personality and by the teaching situation encountered.

All these studies on the teacher's role have shown that there is a generally accepted concept of the teacher's behavioural role in a traditional classroom and a general idea of what a teacher does and is.
In this respect, Goble and Porter (1977) said that "... the role of the teacher, and more particularly of the teacher within the public institutions of the school, was established in most parts of the world in very similar terms by the second decade of the present century - so similar, in fact, that it is possible to use phrases like 'the traditional school' and the 'traditional teacher' with every expectation of being understood". (pg. 17)

2.4.2. The role of the teacher in individualised learning

Since the appearance of the Winnetka plan and the Dalton Plan at the beginning of the century, educationalists have discussed the changes in the teacher's role which take place when an individualised learning approach to teaching is used (Fox and De Vault 1978).

With the reappearance of individualised learning on a large scale in the sixties, the projects developed at that time emphasized the changes in the guidance, diagnostic and prescriptive roles of the teacher with less emphasis being placed on instructional roles. Some examples are:

1) The Individually Prescribed Instruction Project (I.P.I.) defined the new role of the teacher in terms of three major functions (Lindvall and Bolvind 1970):
   a) operating the system, i.e. being an evaluator, diagnostician, developer of individual study plan, planner and organiser of the classroom, b) supplementing the system to enhance adaptation to individual needs, i.e. being an assessor of individual learner characteristics and aptitudes, c) providing help for the achievement of realistic goals, i.e. being a counsellor, a listener, etc.

2) The Project for Learning According to Needs (PLAN) states that:
"The teacher will play an important new role in this educational
In this role the teacher will work with the students as individuals rather than as a class. The teacher needs to become better acquainted with each student both as a learner and as a person. The teacher's functions will be primarily those of a diagnostician, tutor and special resource to the student". (p. 174) (Flanagan 1971).

3) The Learning Activity Packages (L.A.P.) defines the teacher's role as diagnostician, prescriber, motivator and facilitator of learning. (Candarelli 1972).

Other projects developed later on emphasised the social interactive roles of the teacher with students, for example

The International Science Curriculum Study (I.S.C.S.) states that:

"The I.S.C.S. materials are designed to release the classroom teacher from the authoritarian role of lecturer, demonstrator and central classroom figure. The teacher is supposed to become a resource person who interacts intimately with each student throughout the self-paced course." (Lazhier and Nieft 1975, pg. 359).

Wolfson (1968) discussing the role of the teacher in individualised learning, tried to explain the changes of ideas on the role of the teacher, in the two different epochs, through analogies with other professions. Wolfson explained that in the first approaches (during the fifties) the teacher's role was compared with the doctor's role in terms such as "he diagnoses needs, deficiencies or problems and prescribes appropriate treatments". Walfron suggests that this analogy could call for attention by teachers because of the high status that doctors have in Western society. He continued by saying that more recently the best analogy is teacher-as-travel-consultant, which involves the teacher helping the students to identify intentions and approaches to their achievement, suggesting possibilities and planning flexibly. This analogy, he says, is more open-ended.
than that of doctors and allows more self-direction by the student.

Furthermore, individual schools or groups of schools have been reporting new roles for the teacher as they developed their own scheme of work. These are quite extensive and rather confusing because all of them are similar to, or imported from other disciplines. Among these roles are: the teacher as a social specialist, a programme designer, a social engineer, a facilitator of learning, a media specialist, a supervisor, a manager, a designer of learning, a consultant, etc. (Wolfson, 1968; Blake and Mc Pherson 1969, Moore 1973, Farley and Moore 1975, Charles 1976 and Noway and Tenveer 1977).

In Great Britain, the new role of the teacher in individualised learning has also been the subject of discussion. Ormerod and Duckworth (1975) when discussing the critical role of the science teacher in individualised learning said that:

"...the teacher has become a 'manager of the learning situation', a role which calls for a thorough knowledge of the strengths and limitations of all the pupils as well as versatility, patience and control of a very open situation". (pg. 85)

Green (1976) and Beswick (1977) defined 'the new role' of the teacher (teacher's role in individualised learning) in contrast with the old role. For example they said that the teacher is not the director of learning but a resource, and is not now the instructor but a collaborator with the students. In the project 'Working with Science' (1977) the main role assigned to the teacher is the one of supervisor (give continuity and direction), it also considers that the teacher should be a consultant (expert advice), a guide (in the choice of work), helper (in the process). As we can see here again the new role of the teacher is stated by using new terms and therefore it is very likely that it is interpreted in different ways by different teachers.
Although there is evidently great concern about the role of the teacher in individualised learning, few research studies have been carried out. In 1969, Hill and Furst conducted a study on the role of the teacher in Computer Assisted Instruction Classrooms (C.A.I.). While Vickery L (1968) conducted a study of the possible changes in certain aspects of teacher behaviour resulting from the adoption of I.S.C.S. material. In both cases the idea was to study, through observation, what was happening in the classroom and compare the results with those observed from traditional teaching. These two studies have the following common findings on the new role:

1) The teacher has to inform students more about matters of procedure than matters of control.

2) The teacher has more individual contact with the students.

3) The teacher spends less time asking questions and selecting students to answer these questions.

4) There are fewer disciplinary problems.

Flynn and Chadwick (1970) conducted a study of the teacher's behavioural role in schools that were using "Learning Activity Packages" (L.A.P.) material. In the classroom using this material, the teachers felt that they had less direct control over the subject matter acquisition than the teachers in classrooms where the L.A.P. material was not used. Also the L.A.P. teachers found that they spent more time in housekeeping and odd jobs.

On the other hand Steward and Love (1970) also conducted a study in schools using L.A.P. material. In this study it was found that the new role of the teacher was to diagnose and prescribe for each student individually. Teachers did not feel that they should be curriculum developers, and because of the lack of clarity of the teacher's role in individualised learning they acted entirely as they intuitively thought that they should.

Comparing what the developers of the project said about the
role of the teacher and what the teachers actually felt they were doing, it can be seen that there are certain differences. What the L.A.P. project defines as "facilitator of learning" could have been interpreted as "having less control" or "being a curriculum developer" and the role of "manager" as "having more housekeeping jobs".

These mismatches between theory and practice might be presented due to lack of clarity in the definition of the new role of the teacher or in the transmission of that definition. Although the expectation of the material will, to some extent, govern the teacher's role, the question arises here as to whether in fact individualised learning leads to a drastic change in the behavioural role of the teacher or whether it merely implies a new emphasis on, and redistribution of, components of the teacher's traditional role.

2.5 Interactions in the classroom

Numerous studies have been made on interactions in classrooms where the teacher's communications are directed to the class as a whole, the teacher being the centre of activity, the dominant actor, (i.e. in 'traditional classroom'). The literature is vast enough to yield innumerable ways of classifying classroom interactions studies, e.g. according to the approach used, purpose or aim, sources of variables, components, etc. (Rosenshine and Furst 1973, Simon and Boyer 1974, Eggleton, Galton and Jones 1975, Power 1977, Galton 1978). As far as Science is concerned, the different studies made on interactions could be classified according to the observation system employed in the study: i.e.

- category I: studies which develop their own system
- category II: studies which modify, adapt or expand other researcher's system
- category III: studies which use other researcher's systems.

What follows is a brief description of different studies made in science classrooms according to the three categories mentioned above.
Category I
Parakh, J.S. (1965):
This study focused on the cognitive behaviour of individual pupils in biology classes. The systems used had four models of talk subdivided according to categories along a cognitive dimension.

Fisher and Zimmer (1967):
This study was concerned with drawing a profile of the teacher's behaviour in class in order to detect if teachers change their style of teaching according to the group they teach.

Balzey, Levan (1969):
Focusing on teacher behaviour only, this study provided the verbal and non-verbal behaviour in the biology classroom and during laboratory presentation.

Smith, J (1971):
The purpose of this study was to record the behaviour of teachers using E.S.C.P. (Earth Science Curriculum Project) material. The idea was to check the teaching recommendations and philosophy of inquiry learning.

Munby, A.H. (1973):
This study dealt with intellectual consequences of varying kinds of science teaching behaviours.

Alexander, D.J. (1974):
This study was an attempt to find out the quality of the pupil participation which was evident in lessons using the Nuffield Secondary Science Teaching Project.

Eggleston, et. al (1976):
Based on the assumption that students' cognitive growth in science is determined largely by those intellectual transactions between teacher and students. This study dealt with the effects of different science teaching methods.

Category II
Mathews, C.C. (1966):
Combining Piaget Theory and Flanders system (Amidon and Hough 1967) classrooms using material from Science Curriculum System Project were studied. This study looks at students and teachers in activities related and unrelated to the lesson.
Hunter, E (1968):
This study used modifications of Achner-Gallagher, (Simon and Boyer 1974) cognitive dimensions systems, Flanders affective dimensions and Amidon-Hunter (Simon and Boyer 1971) verbal interaction category to evaluate a training program in science. It showed the comparison between the goals of curriculum developers for the new science program and the practice of teacher teaching the new curriculum.

Adding a separate level of cognitive coding to Flanders system, this study investigated enquiry behaviours among learners during the implementation of an enquiry based curriculum.

Altman, H (1969):
Combining the dimensions of Flanders, Fluisher and Zimmer (Simon and Boyer 1974) and Karplus and Theier, this study looked at the interaction in science classrooms from different points of view.

Studied the cognitive style and logic of science teachers using an adaptation of Smith and Minx logic system (Simon and Boyer 1974).

Category III
Snyder, R.M. (1966):
This study looks at the nature of Physics teaching using Flanders system of interaction.

This study deals with several dimensions of the structure and function of communication in science classrooms using the Bellack instrument. (Bellack et. al. 1966).

Using Mathews system (Simon and Boyer 1974) the effects of student structure and teacher structure instructional strategies on their behaviour were studied.

The main intention of all these studies has been to monitor the implementation of new science programs, i.e. to determine whether the new curriculum is implemented according to the program specifications.
or the intentions of the developers. All these studies provide us with a fairly detailed map of what teachers and students do in science classrooms in terms of the relative frequency with which events occur. They provide little information about the social and temporal context within which the events occur and which helps to give them a meaning.

One of the characteristics of an individualised learning classroom is that the students are active, both teacher and students relating to commonly available material. The teacher-learning situation is defined in terms of interpersonal communication rather than the transmission of information. Interactions can occur between the teacher and an individual or group of students and/or between two or more students alone. Studies in these classrooms have been influenced by the methodology used in interaction studies in traditional classrooms. They have been concerned with the "average" student, not with the interaction of individual students with the teacher, i.e. the unit of study has been the class not the student. On the other hand these studies often describe the interaction in terms of frequency of occurrence, as the interactions or events are closely monitored. (e.g. Honigan, F and Stephens 1969, Lindval (I.P.I.) 1967, Lipe, Steen, and Quirk (PLAN, student) 1969, Steen, Quirk and Lipe (PLAN, teacher) 1969.) Among the systems developed for classifying the interactions of teachers and students within classrooms using an individualised learning approach, there are three studies which have been using interactions systems specifically to study science classrooms.

1) Vickery, R (1968) -
   used a modification of Flanders system with 21 categories divided according to 3 different situations to study teacher-student interactions in the classrooms using Intermediate Science Curriculum Study material.

2) Tisher and Power (1975) -
   used a combination of different systems of observation to develop their own method which had 40 categories with multiple coding, specially designed for analysing videotapes. The study was done in classrooms using material from the Australian Science Experimental Project (A.S.E.P.).

The main finding of these studies is that students spend a lot of time on experimenting and directly participating in classroom activities and far less as a passive audience compared with traditional classrooms. The teacher is no longer the provider of information. One criticism made of these studies is that they do not look at why students and teachers act in a specific way, i.e. they do not relate the interactions to the structure of the situation in which they take place. Thus Walker and Adelman (1975) say that:

"Theoretically it (The observation) also demands that we look at any incident in terms of continuously changing relationships between talk and identify-for-self and identify-for-others within their social context..."(pg.74)

There seem to have been very few studies of dyadic interactions (one-to-one interactions) in classrooms in which some form of individualised learning has been introduced. This is despite the fact that this teaching method requires intensive teacher interaction with individual students, and provides many opportunities for peer group interactions.

This kind of study has been strongly supported by Good and Brophy (1971). They argue that most studies of interactions in the classroom have ignored the differences between individuals in the same class and that, because of the different interests and needs of the students participating in the class, the teacher's message is never the same for all students and moreover that the teacher's perception of individual students influences the interactions. In this respect I think that although the teacher can apparently interact with a particular student, the interaction is still between the teacher and the whole class, because the individual student's behaviour probably depends upon the role being performed by the teacher in respect to the whole class. In an individualised learning
situation the study of the one-to-one situation is especially critical, as it provides all the conditions necessary for dyadic interactions.

Shymansky (1976) and Newjahr (1976) in order to look at one-to-one interactions, carried out studies in science classrooms which were using individualised learning approaches to teaching. "Activity-centred elementary science" classrooms were used by Shymansky to study dyadic teacher-student interactions. Seventy-eight observations were made with a modified version of Mathews and Phillips student's behaviours categories (Simon and Boyer 1974). This system consisted of 9 categories, based on Flanders, and for this study was divided into lesson-related behaviours and non-lesson related behaviours. Shymansky's study showed that a) lengthy one-to-one teacher-student interactions may have produced feelings of insecurity in students regarding their performance in activities and b) students with whom the teacher interacted for longer periods of time, tended to be very dependent upon the teacher. Although Shymansky looked at the dyadic interactions between teacher-student, he only describes statistically the effects of what was observed and he did not look at the reasons why a particular student tended to be very dependent or why the interactions produced feelings of insecurity in students.

Newjahr (1976) using a "Middle school" (10-14 years students) for his study, recorded the behaviour of a science teacher in four sixth-grade classes on videotape over a week. An analysis of the videotapes was made using a modification of Bellack's system and it records verbal, non-verbal and spatial aspects of interactions. The analysis is based on the exchange between the teacher and individual students and, due to the great difference found between boys and girls, included an analysis according to sex. Some of the general findings of Newjahr were:

1) Interactions usually involved two pupils with the teacher (male). Boys tended to delegate communication with the teacher to one of the pair and they interacted with the teacher more than girls did when the pupils were gathered together as a full class.
2) The differences noted between boys and girls were not as great as those between individuals, e.g. one pupil may be 49 times as interactive as another, but in general girls tended to go to the teacher's desk whereas boys tended to converse.

3) The Teacher (male) tended to initiate the interactions more with boys, but girls tended to talk to the teacher more about subjects other than the one that they were studying.

4) The interactions were dominated by the teacher, i.e. the teacher did most of the talking of which 40% was fact stating and 49% explaining.

5) The sequence of interactions between teacher and students tended to occur at the will of the student, and the student determined the topic.

As has already been said, the Newjahr study was based on the analysis of interactions recorded on videotapes and although this system is considered very reliable due to the fact that different people could check the data as many times as necessary, the study did not produce any reason why the teacher or the student behaved in a particular way. For example the data presented showed that the teacher behaved differently in various classes. (e.g. in class No. 11 84% of the interactions took place at the teacher's desk and 75% of the interactions initiated by the students were made in pairs. Whereas in class No. 12 61% of the interactions initiated by the students were made by individuals and 49% took place at the teacher's desk). However Newjahr did not consider this as an important element of the study. This is, maybe, a consequence of being isolated from the classrooms where the study took place. This fact was criticised by Flanders (1970) who said:

"The procedure makes no sense at all when what is lost by the process is more important than what is gained" (pg. 30).

Newjahr realised that something was missing in his study where he suggested that further research should be done to look at the context in which the interactions take place, i.e. the reasons for the actions.
These two studies of one-to-one interactions in individualised learning classrooms lacked an understanding of why the teacher and students interacted in a particular way. In addition to this, they did not take into account the dyadic interactions between students.

2.6 The laboratory work in teaching Physics

During recent decades the most significant characteristic of new Physics Curricula for schools has been the emphasis made of the use of lab. work by students. (Shulman and Tamir 1973). In a study of "Science Education in Nineteen Countries", carried out between 1968 and 1972 (Coomber and Keever 1973), it was found that in the English-speaking countries there is a marked empirical approach to science teaching, with an emphasis on lab. work and practical experience. Also in the "European Curriculum Studies" concerned with Physics, carried out in 1971, it was found that "The United Kingdom" (Great Britain) is the only country in which lab. work may take up as much as 50% of the total time given to Physics and also is the only country that gives a practical examination for candidates at University entrance (Hall 1972). Furthermore on the GIREF (1978) (International Group for the Advancement of Physics teaching) and I.C.P.E. (1978) (International Conference for Physics Education) conferences held at Oxford University on "The Role of the Laboratory in Physics Education", experimental work was accepted by the participants as an essential element in Physics teaching (Conference Newsletter). All this makes it appear that, nowadays, there is no doubt about the importance of the laboratory work in the teaching of Physics.

2.6.1 Reasons for using laboratory work.

Psychologists have supported the idea of lab. work in teaching Physics, e.g. Piaget's followers state that it is "to help students who are in transitional periods to move into the next sequential stage" (Kolodig 1977) and Gagne's followers state that lab. work is to provide the "images" and "episodes" needed by the learner to link some elements with others in memory, and therefore to understand the concepts (White 1978).
In spite of this it always has been considered expensive in time and equipment (Richmond, 1978).

Some of the reasons given by educators to justify the emphasis on the lab work in Physics courses are:

"To develop a scientific attitude" (Unesco 1964)
"To reinforce the concept taught" (Akhmator A.S. 1970)
"To understand the processes of science" (Spears and Zallman 1977).
"To improve the knowledge and understanding of the facts and theories in Physics" (Richmond 1978).

Ogborn (1979) had identified three main aims, present in varying degree, in most experiments:
- learning the ideas of science
- learning the techniques of experimentation
- learning the arts of experimental enquiry.

The aims of Physics Laboratory work at secondary school were identified by Kerr (1963) in his enquiry into the nature and purpose of practical work. He found that the aims concerned with "scientific thinking", "getting to know by investigation" and "problem solving" remain fairly uniform throughout the school course, while other aims concerned with "accurate observation and carefully recording", "elucidation of the theoretical work", "promotion of interests" and "appreciation of basic phenomena by real experience" become much more or much less important as the student becomes older.

The main aim assigned to lab work at the VIth form level, in the Kerr enquiry, was "to encourage accurate observation and description". This was confirmed by Thompson (1975) in his enquiry into practical work in Sixth Form Science. It should be pointed out that teachers at Sixth Form level are preparing the students for the 'A' level exam, therefore one of the aims of the laboratory work at this level is to help the students in their preparation for the practical examinations. It was found by Kerr and Thompson that teachers rated this aim
very low (in the tenth and ninth place respectively). However Dynan and Kempa (1977) found that in teachers' opinions the external examination attached more importance to the manipulative and observation areas than to areas such as interpretative, planning and attitudinal, which were considered to be important by the teachers. As the main aim of lab. work was found to be "to encourage accurate observations and description" it would appear that Dynan and Kempa's findings imply that the lab. work at sixth form level is oriented towards "passing the exam".

Thompson (1975) comparing the views of Nuffield and non-Nuffield teachers found no significant differences between these two groups in the aims of the laboratory work. However when Thompson compared his general findings with Kerr's he pointed out that:

"Teachers now see practical work more as an exercise, an aspect of Physics, which has importance for its own sake rather than as a means to the end of supporting and illustrating theory". (pg. 28)

It should be pointed out that studies made to assess the relative affectiveness of laboratory work have shown that there is no significant differences between the outcome of knowledge tests of Physics concepts and principles for courses with laboratory instructions and for courses without such instruction (Kruglak 1952, 1953, Babikian 1971).

2.6.2 Types of lab. work

The types of laboratory work have also been the subject of discussion and study. Researchers have shown that each type attains different aims. On 'short item performance tests' students who have done individual experiments performed better than those who have seen demonstrations (Kruglak 1952). On the other hand 'non-structured experiments have been found to be better than 'structured experiments' for long term retention (Halcomb 1971), but the latter have been shown to be better for learning the processes of science (Spears and Zallman 1977).
The most popular type of lab. work used at VIth form level, according to Kerr (1963) and Thompson (1975), is 'The repetition of standard qualitative and quantitative experiments'. However Nuffield teachers were found to use more 'discovery experiments' (Thompson 1975).

All this supports what Ogborn (1976) said about aims and types of experiments:

"There are many differing objectives which teachers seek to attain for their pupils in their practical Physics courses and consequently different types of practicals which are most suitable for fulfilling these".

2.6.3 Laboratory work in individualised learning

It seems that it has been accepted by teachers and curriculum developers that the individualised learning approach to teaching science should include some kind of laboratory work, however there is no written evidence as to "why" this should be so. An example of this situation is the well-known Keller Plan (Keller 1974).

"Lab. session units were like any other units in that students went to the lab. only when they had mastered the previous and prerequisite reading units".

Another example of the situation mentioned above is Postlethwaite (1972) in his audio-tutorial system which substitutes lab. work for "study sessions" where

"The student has to perform a set of integrated experiences including lectures, reading of tests on other appropriate material, making observations on demonstrations set-ups, doing experiments, watching movies and/or any other appropriate activities helpful in understanding of subject matter".
The only project based on individualised learning which presented specific aims for doing lab. work is the Unesco 'Pilot Project' for teaching Physics (Unesco 1964). This project used programmed instruction manuals with very structured experiments which were intended to give the students the opportunity to "experience, personally, the principles of cause and effect which is a basic component of the scientific attitude and probably a powerful aid to concept formation".

Although the lab. work has been considered as an important element in the new Physics curricula during the last two decades, it seems that very little research has been done about the role the lab. work plays in individualised learning.

2.7 Conclusions

This Chapter started out with the aim of considering those research studies that have contributed, in some way, to the field of individualised learning in the classroom. The review of this literature has shown that many things have been written about it but very few classroom situations have been investigated. The literature has demonstrated that individualised learning could be considered as a philosophy or as a curriculum innovation. In the latter case the development of material has been the centre of attention. However the different activities suggested by the material have been included without a clear idea of why students and teachers should do them (e.g. the experiments).

The studies of the changes in the behavioural role of the teacher in the classroom seem to imply that the so called 'new role' is just a new emphasis on a different aspect of the traditional role of the teacher. Furthermore the studies about interaction in the classroom have not taken into consideration either the teacher's role or the social context of the interaction, as elements which determine the kind of interactions.
CHAPTER III

Research Methodology

3.1 Introduction
3.2 Curriculum and classroom research
3.3 The selection and development of the techniques used in the study.
   3.1 Schools visits and interviews
      3.1.1 Initial visits
   2. Participant observation
   3. Follow-up visits
3.2 The interaction guide
3.3 The repertory grid technique
3.4 The laboratory work questionnaire
   3.4.1 Attitude scale
      2. Aims of laboratory work
      3. Types of experiments
      4. Problems encountered
      5. A.V.A. and laboratory work
3.4 Summary
3.1 Introduction

The research described in this thesis could be summarised as follows: "There are some factors of classrooms which change when an individualised learning approach to teaching and learning is introduced. The study of these factors provides an account of teachers' and students' behaviours that could be useful for teachers willing to use individualised learning".

The exploratory nature of this research implied that the standard approaches of educational research - surveys and theory-based experimental (Nesbit and Entwistle 1974) could not be used for the following reasons:

a) It cannot rely on a theory-based experimental approach because there is not an established theory on how teachers and students should behave when using individualised learning. In addition to this, experimental research implies the use of control groups, independent and dependent variables which have to be pre-established before the research starts. Furthermore in this kind of research it is assumed that a change made in the 'independent variable' (cause) implies a change in the 'dependent variable' (effect), i.e. the concept of cause and effect leads this kind of research (Elton and Laurillard 1979). This research was more concerned with the relationship between all the variables rather than with identification and study of some of them.

b) It cannot be survey based research because this requires the researcher to know in advance the characteristics and properties of the aspects to be studied plus the selection of a representative sample of the characteristics established by the researcher. On the other hand survey research contributes little to the understanding of the factors which influence the research and usually the important factors may have been measured too crudely or have been omitted from the investigation (Nisbet and Entwistle 1974).
Furthermore, the bulk of research about new methods of teaching, which have followed any of the two approaches mentioned before, are usually concerned with the effectiveness of the method - the outcome - rather than what is going on in the classroom - the process - which was my main concern.

This chapter aims to present the principles of the new curriculum and classroom research and to describe how these principles link to the methodology employed.

3.2 Curriculum and classroom research

The field of curriculum research has been interpreted according to the definition of curriculum adopted by the researcher. Examples of this are the diversity of studies published in journals concerned with curriculum (e.g. "Curriculum studies", "Journal of Curriculum studies"). However in all of them there are some common factors, such as planning, content, methods, implementation, evaluation, which seem to have identified the area of study of a curriculum researcher. There has been discussion, for more than a decade, about the little impact that studies in the area of curriculum (i.e. curriculum research) seem to have had on classroom practices and in the little practical help provided for the teachers (see for example Atkin 1967, Silverman 1970, Hamilton 1973, Walker 1973, Nuthall and Snook 1973, Stenhouse 1976, Power 1977, Westbury 1978, Shaw 1978 and Frazer 1978). The reason for that seems to be the approach used in the research. The models of curriculum research most frequently used are:

a) the "innovation versus traditional" model, used particularly in teaching methods which aim to compare the outcome of two contrasting methods of teaching.

"Typically the favoured method has been compared with its theoretical opposite" (Nuthall and Snook 1973, 71)

b) the "objective model", used particularly in researchers' concern with evaluations of new curriculum. This model aims:
"To see how far these objectives (the objective of the educational programme) have actually been realised" (Tyler 1949 pp. 105-108).

In both models it has been assumed that teachers understand and can make optimal use of whatever material or idea is available to them. Little attention has been given to the fact that teachers, students and classroom environment might be affecting the process. The activities in the classroom have been largely ignored, i.e. the actual teaching-learning process.

Besides this, research into classroom process has been carried out more by Psychologists, Socio-psychologists, Sociologists and Linguistics than by educators with a clear interest in the field of curriculum (Hamilton and Delamont 1974, Wragg 1975, Chanan and Delamont 1975, Delamont 1976, Westbury 1978). The different methodologies used by these specialists in classroom research seem to look at the classroom process from different points of view and the end result has been so segmented that it has little relation to the total classroom life.

Westbury (1978) in his review of research in the classroom has come to the conclusion that:

"a comprehensive understanding of the task of curriculum planning and curriculum development demands an understanding of the classroom". (pg. 283)

This seems to imply that curriculum researchers have recently been looking at the classroom with a different frame of mind (see for example Chanan and Delamont 1975).

Curriculum researchers, following researchers in other educational areas, have been attracted by the use of anthropological techniques, also called qualitating, phenomenological, ethnographic or descriptive (Hamilton, Delamont 1974, Adelman and Walker 1975, Wilson 1977, Elliot 1978). Ethnographic techniques are part of a research tradition that has been developed by anthropologists and
community-study sociologists. This methodology is based on the following two hypotheses about human behaviour:

a) the naturalistic-ecological hypothesis:
   "Human behaviour is complexly influenced by the context in which it occurs" (Wilson 1977 pg. 259)

This means that any research on student and teacher behaviour should take place in the classroom. Researchers should immerse themselves in classrooms to study those aspects that are important for explaining students and teacher behaviour.

b) qualitative-phenomenological hypothesis:
   "Human behaviour often has more meaning than its observable facts" (Wilson 1977 pg. 253).

This would appear to indicate that to understand student and teacher behaviour it is necessary to understand the framework within which they interpret their thoughts, feelings and actions. The activities of framing hypothesis and defining categories a priori i.e. before understanding the study, are considered inappropriate in this approach.

The methodology of ethnographic research is participant observation. The researcher is involved in observation within a holistic framework, discovering how the informants see their world (McCall and Simmons 1969). Wilson (1977) describes this methodology as follows:

"One of the most important ideas behind participant observation is that there is no one right method; the method should match the study" (pg. 259)

Hamilton and Delamont (1974) adapted this methodology for classroom research as follows:

"In addition to observing classroom life, the researcher may conduct formal interviews with the participants and ask them to complete questionnaires. Usually to record his observation the observer compiles field notes or more recently field recording." (pg. ?).
One of the main criticisms of the ethnographic approach is that it rejects the conventional scientific method and forms of proof which are based on 'reliability' and 'validity'. Power (1977) has said:

"Until suitable ways of checking on the reliability and validity of ethnographies (in education) are developed there is no way of knowing whether the accounts are insightful and accurate models of reality or trivial mishandling impressions" (pg. 23) (bracket added)

This point has been discussed by Magoon (1977) who stated that:

"The strengths of ethnographic studies (in education) are claimed to lie in their heavy emphasis on validation and, as one might expect, the emphasis is on construct validation - the meaning of events or situations to participants - rather than traditional predictive or concurrent validation. Whereas predictive and concurrent validity are limited by low correlational estimates of reliability, construct validity depends to a large degree on reliability in the 'credible witness' and/or 'specimen record'" (pg. 669) (bracket added).

McCall and Simmons (1969) commented that participant observation is less likely to be biased, unreliable or invalid than other methods because it provides more actual internal checks and is more responsive to the data than the imposed systems of other methods.

Curriculum researchers who want to offer a comprehensive range of information about new methods or materials have merged the ethnographic methods with the case study approach to research. One common problem of the case study approach is extrapolation, i.e. to what extent it is possible to generalise from the case studied. This problem has been discussed by Macdonald and Walker (1975), Hamilton (1976) and by Stenhouse (1978) for the area of curriculum research.
All of them concluded that in the case study approach classrooms are examplars rather than samples of the population and that generalisation comes later with the analysis and understanding of these examplars. Furthermore small numbers of intensive classroom-based studies can reveal a very great deal about the curriculum. Classroom settings will be different but usually there will be substantial areas of overlap that permit a degree of generalisation.

Summarising, it can be said that the ethnographic techniques, used in curriculum research through the case study approach, seek an understanding of the characteristics of the environments within which particular methods or materials affect the classroom life and therefore the teaching and learning process. This is what Elliot (1978) has called "Educational Research" in contrast to "Research on Education". As far as science curriculum is concerned, very little research using this approach has been carried out.

Walker and Adelman (1972) used a participant observation technique as well as time-lapse photography to study life in informal and open classrooms. The principal focus has been in classrooms where particular curriculum projects have been adopted and developed (Nuffield courses). Hamilton (1973) used ethnographic technique with observation, interview and questionnaires over a sixteen week period in classrooms following the Scottish Integrated Science Scheme.

Roebuck, Bloomer and Hamilton (1974) were involved in the evaluation of the project PHI (Independent learning materials for science teaching in small schools in the Highlands and Island of Scotland). Participant observation, open interviews and open-ended questionnaires were the methods used in the second part of the evaluation of this project.

Adelman and Walker (1975) have been working in the Safari project (which stands for "success and failure of recent innovations") using the ethnographic approach of research. Observation, interview, revision of documents and participation in the decision making of the schools is the methodology used.
3.3 Selection and development of the techniques used in the study

The methodology used in the research described in this thesis is consistent with the two ethnographic hypotheses mentioned in section 3.2. In order to understand the context in which teachers and students behaved, the 'unit of work' selected was the classroom and a variety of techniques were used to interpret teachers' and students' actions, thoughts and feelings. A description of these techniques is now presented.

3.3.1 School visits and interviews:

Table 3.3.1 shows a distribution, in time, of the different types of visits made to schools using different approaches to individualised learning.

3.3.1.1. Initial visits:

During these visits different aspects of the classroom life were taken into consideration. These aspects included: patterns in the use of individualised learning material, the place that the material occupied in the total approach of work, how students and teachers handled the material, the places where the different materials were stored and its accessibility to the students, the kind of discipline and norms imposed by the teacher, the degree of grouping adopted by students, the teacher's pattern of communication, visible signs of boredom, exceptional interest, confusion among students, etc.

Apart from the general notes about the classroom, a semi-structured interview was held with the teacher and some students. Each of the teacher interviews lasted about half an hour and each of the student interviews varied in length according to the working group at the time of the interview. While each visit usually took a different form, each interview was built around the following ideas:
- Reasons for using individualised learning
- Opinions on the material in use
- Way of working
- Problems encountered in using individualised learning
- Some questions about issues raised in the observation

All the interviews were tape-recorded and field reports for each visit were written.

**Distribution in time of the school visits**

<table>
<thead>
<tr>
<th>Year</th>
<th>Spring Term Schools</th>
<th>Summer Term Schools</th>
<th>Autumn Term Schools</th>
</tr>
</thead>
<tbody>
<tr>
<td>1976</td>
<td></td>
<td></td>
<td>14 A.P.P.I.L. *1</td>
</tr>
<tr>
<td></td>
<td>6 A.P.P.I.L. *3</td>
<td>3 A.P.P.I.L. *3</td>
<td>4 A.P.P.I.L. *3</td>
</tr>
<tr>
<td>1978</td>
<td>7 R.F.L.D.U. *1</td>
<td>1 CAMOL I.L. *1 *3</td>
<td>1 WORKSHEET *1 *3</td>
</tr>
<tr>
<td></td>
<td>4 A.P.P.I.L *3</td>
<td>5 A.P.P.I.L. *3</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>2 WORKSHEET *1</td>
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</tbody>
</table>

A.P.P.I.L. school = schools using "Advanced Physics Project for Independent Learning" material

R.F.L.D.U. school = schools using a new scheme of management with material from the Resources for Learning Development Unit

CAMOL I.L. school = VIth form students at Methodist College in Belfast using individualised material and computer assisted learning

WORKSHEET school = schools using worksheet developed by the teachers

*1 = Initial visit
*2 = Participant observation (case study)
*3 = Follow up visits

Table 3.3.1.
3.3.1.2 Participant Observation

Five A.P.P.I.L. schools were selected for the study of individualised learning in depth (see Chapter VI). The classes were visited a minimum of twice a week for four consecutive weeks, and notes were taken about the different events observed as in the initial visits. Formal and informal interviews were also held with students and teachers during these visits. These visits offered me the opportunity to gain access to information which was sensitive and to take account of the social reality of classrooms using individualised learning material.

3.3.1.3 Follow-up visits

Some schools were visited more than once in order to focus my attention on a particular area. During these visits observations and informal conversations with teacher and students were held.

3.3.2 The interaction guide

The ethnographic technique of observation implies that the researcher approaches the classroom with no predetermined observation schedule, but rather with the idea of identifying and investigating certain salient phenomena which contribute to an understanding of the situation under study. All the observations made in different classrooms in this research followed this style.

During the initial visits to A.P.P.I.L. schools, one of the salient phenomena which attracted my attention was the interaction between teachers and students and between students. To study the nature of these interactions, it was necessary to develop an "interaction guide" to be used in the case studies (Chapter VI). It should be borne in mind that the intention of the guide was not to quantify the interactions but to produce a basis for a better understanding of the classroom under study.

Usually the use of an interaction guide implies that the researcher has decided, before coming to the classroom, the kind of interaction that he/she expects to observe. This is so when the guide is developed without and before any experience in the
field. However there are some cases in which the guide has been developed as a consequence of previous research in the area (Rosenshine and Furst 1973).

One of the most widely used and influential interaction systems is FIAC (Flanders' interaction analysis categories) developed by Flanders (Amidon and Hough 1967). It is based on work done between the late thirties and middle fifties by Anderson (1939), Lewin, Lippit and White (1939), Withall (1949), and Bales and Strodtbuck (1951). In FIAC all statements that occur in the classroom are categorized into one of the following three major sections:

a) teacher talk,
b) student talk,

and
c) silence or confusion which is used to handle anything else that is not teacher or student talk.

Teacher's statements are classified first as either indirect or direct, these ideas being taken from Anderson's basic categories of integrative and dominative behaviour of teacher in their contact with children (Anderson 1939) and from the authoritarian and democratic roles described by Lewin, Lippit and White (1939).

In all, FIAC has ten categories (7 for the teacher, 2 for students talk and 1 for silence) each of which is given a number, (there is no scale implied by the number). The observer makes a coding of the talk every three seconds and records them sequentially. Once a large enough sample of talk has been collected, the codings are arithmetically processed and various scores computed for the teacher.

Lately FIAC has been the object of much criticism. It has been found that FIAC is only appropriate where classroom talk is of the public dialogue form, as in the traditional classroom, and even that in those classrooms it only reports the meaning of the talk but not the structure of the interaction (Walker and Adelman 1975, Delamont 1976).
Recently, researchers in the field of interactions have extended the term "interaction analyses" to include observations schedules which cover non-verbal communication, such as movement and gesture, besides those which are simple analysis aspects of pupil and teacher talk. Nowadays there are more than 200 systems of observation instruments (Rosenshine and Furst 1973, Simon and Boyer 1974, Power 1977 and Galton 1978). One of the main criticisms made of even the most sophisticated observation system is that they omit a great deal of what happens in reality (Galton 1979).

The interaction guide developed for the case studies in this research was the product of the observations made in the initial school visits. It is based on two issues which emerged during these visits, that:

- students and teachers seemed to enter into interaction with a definitive notion of what they want to get from a particular interaction, e.g. a 'student A' went to the teacher to seek explanation of a point in order to get help in a question in which he did not have any idea of how to answer it. There was a specific aim for the interaction.

- students and teachers apparently had a relatively clear preconception of the role each one was expected to play in the interaction, e.g. in the example mentioned above the student (A) went to the teacher and not to other students because he thought that the role of the teacher was to explain Physics.

The guide attempts to categorize the dyadic interaction (one-to-one interactions) that occur between teacher and student (S ←→ T), and between two students (S →→ S). The S ←→ T interactions include those interactions initiated by the students (S →→ T) and those initiated by the teacher (T →→ S). In S →→ T interactions the kind of response the teacher gave (S ←→ T) was also categorised. (See fig. 3.3.2).
## Interaction Guide

### S → T

<table>
<thead>
<tr>
<th></th>
<th>Explaining</th>
<th>Asking some questions</th>
<th>Informing of correctness</th>
<th>Telling what to do</th>
<th>Inhibiting the student</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requiring some material</td>
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<tr>
<td>Asking what to do</td>
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<td>Checking correctness</td>
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<tr>
<td>Seeking explanation of a point</td>
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<td>Seeking conceptual understanding</td>
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### S → S

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<tbody>
<tr>
<td>Seeking explanation of a point</td>
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<td>Seeking conceptual understanding</td>
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<td>To check the questions</td>
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### T → S

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<th>7</th>
<th>8</th>
<th>group 1</th>
<th>group 2</th>
<th>group 3</th>
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</thead>
<tbody>
<tr>
<td>To see what is happening</td>
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<td>To check the questions</td>
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<td>To give conceptual understanding</td>
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Figure 3.3.2.
The unit of record is the initiation of a verbal interaction, that is, when a student or the teacher initiates a verbal interaction to a specific member of the classroom.

After many trials and modifications in different A.P.P.I.L. schools the categories were defined as follows:

S --→ T interactions:

"Requiring some material": when the student goes to the teacher to ask for some books, A.V.A. equipment, etc. e.g.:
S: "Where is the book called Forces, Matter and Energy?"
S: "Have we got a loop projector?"

"Checking correctness": when the student goes to the teacher just to find out if what is being done is the right thing. e.g.
S: "I don't think it's right to use this equation in this question."
S: "Is this the right graph?"

"Asking what to do": when the student goes to the teacher without any idea of what activity to do next. e.g.
S: "What should I do next, Mr. X?"
S: "Are we supposed to do extension 5?"

"Seeking explanation of a point": when the student cannot understand the concept or question being worked on, or does not know how to do it. The teacher is asked for help in such a way as to reveal a general lack of understanding. e.g.
S: "How do you do this question?"
S: "I don't know how to calculate 'F' in this question."
"Seeking conceptual understanding" when the student consults the teacher because of having 'got stuck' on a concept or question. Usually in this case the student who starts the interaction shows, at the outset, some knowledge of the question but believes that it cannot be pursued. e.g.
S: "I worked this question but now I don't understand what I did."
S: "I thought I'd understood momentum, but I've got stuck in this part."

The response that the teacher could give to a student varied from situation to situation. As a student could initiate an interaction in five different ways, the teacher could respond to each of them also in different ways, i.e. there is no unique way in which a teacher responds to a student. That is why in the five ways the teacher could respond to a student (s ← t) presented below no example has been given.

"Explaining" when the teacher clarifies and explains a concept or question. The interaction does not involve the student, it is expository teaching, the student being passive.

"Informing of correctness" when the teacher answers with a short reaction of 'yes' or 'no'.

"Telling what to do": when the teacher answers by giving some instructions or an order.

"Inhibiting the students" when the teacher's manner of answer blocks the student's further interactive behaviour.
"Asking some questions": when the teacher tries to explain or clarify the subject through questions, the teacher guides the student to find the answer to the question. This involved the student in the interaction, and he/she was therefore active.

T → S interactions were divided into three categories:

"To see what is happening": when the teacher goes to a group of students who are idly talking in order to make them work.
T: "You have finished chapter two, haven't you?
T: "What are you planning to do after this?"

"To check the questions": when the teacher goes to the student to look at the question that the student has done.
T: "Which question are you working on?"
T: "John, bring your notes up here."

"To give conceptual understanding": when the teacher goes to:

a) a group of students who are discussing a concept or a question in order to help them, or to be involved in their discussions, e.g.
T: "You are contradicting yourself."
T: "Do you think it's likely that it happens?"

b) a student, after having realised that the student has a problem, e.g.
T: "What are you worried about?"
T: "Do you know how to do it?"
The interactions between two students "S → S" were divided into three categories:

"Seeking conceptual understanding" when one student "gets stuck" on one concept or question. The student knows what the question is about but cannot do it. Usually this interaction produces an interchange of ideas and both students are active.

"Seeking explanation of a point" when the student cannot understand the questions being done, having no idea of how to do it. Usually one student explains and the other listens. Only one student is active.

"To check the questions" when one student goes to another student in order to see if an answer is right.

One of the disadvantages of this interaction guide is that it could only be used effectively with groups of students no larger than 8. For example in the case study "large class" (12 students) it was impossible to keep the record of all the S → S interactions. Since it was developed for teachers and students using A.P.P.I.L. material, the categories are expressed according to interactions which are characteristic to those classrooms and therefore the transferability of this guide to other situations, using other kinds of material, is unlikely.
3.3.3. Repertory Grid Technique

Repertory Grid Technique is a method for exploring personal construct systems. According to Kelly's Personal Construct Theory, through a personal construct system one lives, has expectations, acts, evaluates outcomes, changes, that is, makes sense out of oneself in a particular situation (Kelly 1970).

Repertory Grid Technique has been defined by Fransella and Bannister (1977) as follows:
"It is an attempt to stand in others' shoes to see their world as they see it, to understand their situation, their concerns." (pg. 5)

This technique, evolved from Kelly's Personal Construct Theory (1955) has been used in many forms and in different fields of social science. In Education it has had relatively little use (Pope 1978). At school level it has been used by Nash (1973) for studying teacher's perception of pupils' performance, and by Olson (1979) studying how teachers make use of innovative ideas. In the research described in this thesis, the Repertory Grid technique was used with both students and teachers. It was used with 30 students in order to determine the nature of students' interactions in individualised learning classrooms, i.e. to find how students perceive people around them in the classroom. It was employed with teachers using different approaches of individualised learning. This was done in order to determine a) the teachers' perceptions of the new activities that they had undertaken when using individualised learning and b) to get to know how teachers draw distinctions between the different words used around the idea of individualised learning.

Although the technique can be used outside the context of the theory, there are some basic aspects of the theory from which the grid is always directly derived. (Bannister and Fransella 1977).
According to Fransella and Bannister (1977) these aspects are:

1. Grids are about constructs; constructs are discriminations that we make between people or events or things in our lives.

2. Grids are bipolar; we never affirm anything without simultaneously denying something.

3. Range of convenience: constructs operate within a context, that is, all elements of the grid must be given within the responder's range of experience. The elements and constructs should have an applicable meaning for the responder.

4. Individuality corollary: constructs represent how we perceive and interpret our world. The grid explores individual perceptions of events.

5. Commonality corollary: constructs are similar only if they manifest similar behaviour, not if they have the same verbal labels. People are similar because they interpret, see the implications of events, or discriminate in similar ways. People are similar if events have the same meanings for them.

6. Organisation corollary: constructs are interrelated. The relationship among constructs is often one of inclusion or subsuming. Constructs systems are hierarchical, we talk about important ideas, central ideas, the main feature of this or that as contrasted with, detail, trivial.

Bearing in mind these aspects, students were asked to compare and contrast five elements of the classroom: self, the teacher, the student he/she asks most about Physics in the classroom, the student who asks him/her most about Physics and the student to whom he/she talks more about Physics. Usually in a grid, the number of elements is larger than 7. In this case I had to choose 5 because some of the classes had only four students and a larger number would have led to forcing the students to choose elements outside his/her classroom, i.e. to choose elements outside his/her range of convenience (condition 3).
The process of elucidation of the constructs was as follows: The students were first asked to give names to the role title given (e.g. self: John, the teacher, Mr. Smith, etc.). They were then presented with three of these elements and asked to specify some important ways in which two of them were alike and thereby different from the third with respect to work and behaviour in the classroom. This process was done with the ten possible combinations of elements \( \binom{5}{3} = 10 \).

Once the constructs were written the students were asked to place each element on one or other of the two poles of the construct by using a five point scale. The middle point of the scale was used for those elements which could not be described by either pole of the construct. After completing the grid, students were interviewed about it.

On the other hand teachers were asked to compare and contrast eight (see page 56) different approaches to teaching Physics with respect to the different activities that they have to perform. During the trial of the technique it was found that teachers could not produce constructs for all of the approaches because some of them were new to the teacher (e.g. for teacher working with A.P.P.I.L. material, Resource based learning was new). Bearing in mind that the elements should be within the range of convenience of the respondent (condition 3), the elements were reduced to five. Teachers were then asked to choose 4 elements out of 7 and "traditional teaching" was fixed for all the teachers. As with the students, teachers were asked to compare and contrast 3 elements each time. Thus ten constructs were elucidated and then each element was placed on one or other of the two poles of the construct.

In my experience the repertory grid technique provides an opportunity to study the aspects of the classrooms from both the teacher and student viewpoint. As such it was a powerful tool to be used in conjunction with observation and interviews.
One of the disadvantages found in its use, especially in this case where students and teachers have to elucidate on the constructs, is that in the majority of the cases they tended to repeat the written statements with different meanings, i.e. teachers and students produced two characteristics with the same words but in different contexts. Usually the repetition was in one pole of the construct which very clearly showed that the responder was referring to two different constructs. This problem was overcome through the interview being done after students and teachers had completed the rep. grid. With the interview and by bearing in mind that constructs are interrelated (condition 6) and that two constructs are identical only if they manifest similar behaviour (condition 5), the real meaning of the construct was identified.

The main limitation found in the use of repertory grid technique in this research was the nature of the element presented to the teacher. This problem seems to be very common where the elements given to the respondent represent situations (Yorke 1979). It was not possible to use this technique with a great number of teachers because they found it to be difficult to make distinctions between the different terminology used around the idea of individualised learning.

3.3.4 The laboratory work questionnaire

The lab. work questionnaire aimed to find out the place of the Physics experiments in an individualised learning course. The idea of the questionnaire was stimulated by the earlier work of Kerr (1963) and Thompson et. al (1975). It was intended to take their work further by applying it to individualised learning. Also, by trying to assess students' and teachers' perception of laboratory work in terms of two situations - their actual course and an ideal course - to follow the technique developed by Bond (1974).
It was hoped that the use of such a questionnaire would be an outcome of practical use for the future use of those preparing and using material for individualised learning. The questionnaire consisted of the following five parts.

3.3.4.1. Attitude towards laboratory work

From the A.P.P.I.L. teachers' and students' interview a list of items was prepared. These items showed the different opinions and reactions that teachers and students gave about laboratory work. The final list consisted of 10 items, 5 worded positively and 5 worded negatively.

Teachers and students were asked to place themselves on an attitude continuum for each item - running from "strongly agree", to "agree", "undecided", "disagree", and "strongly disagree". The list of items is shown in Table 3.3.4.1.

Items of the attitude scale

1. Without lab. work Physics is not Physics.
2. Teachers are compelled to teach mainly facts, so lab. work is not used.
3. Lab. work can give a student a deep appreciation of Physics.
4. Lab. work is largely a waste of time.
5. Learning Physics without lab. work is like learning to swim without water - nearly impossible.
6. Lab. work raises students' interest in Physics.
7. If you do much lab. work you cannot cover the syllabus.
8. Lab. work tends to become a cooking exercise.
9. Lab. work makes Physics very real and understandable.
10. School experiments are not related to Physics theory.

Table 3.3.4.1.
3.3.4.2 Aims of laboratory work

The list of aims used by Kerr (1963) - 10 aims - and Thompson et. al. (1975) - 20 aims - plus the aims of the lab. work expressed by the A.P.P.I.L. and CAMOL I.L. documents (Chapter VIII) were analysed and assembled to produce a final list of fourteen aims, which were used in the teachers' questionnaire. These aims are given in Table 3.3.4.2. The aims were then expressed as activities and used in the students' questionnaire.

Teachers and students were asked to rate the importance of each of these aims or activities on a five point scale from 1 (not an aim) to 5 (very important aim) in two different situations - their actual Physics course using individualised learning material and an ideal course of individualised learning. This questionnaire approach aimed firstly, to avoid idealization of the actual situation, and secondly to let me know if students' and teachers' expectations were fulfilled.

<table>
<thead>
<tr>
<th>Table 3.3.4.2. List of laboratory work aims</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) To develop specific manipulation skills.</td>
</tr>
<tr>
<td>b) To familiarise students with important standard apparatus and measurements techniques.</td>
</tr>
<tr>
<td>c) To reinforce theoretical knowledge.</td>
</tr>
<tr>
<td>d) To promote a logical reasoning method of thought.</td>
</tr>
<tr>
<td>e) To train students in making deductions from measurements and in the interpretation of experimental data.</td>
</tr>
<tr>
<td>f) To enable the students to find facts and arrive at a new principle by investigation.</td>
</tr>
<tr>
<td>g) To develop an ability to communicate in Physics.</td>
</tr>
<tr>
<td>h) To provide closer contact between students and teacher through discussion of experiments.</td>
</tr>
<tr>
<td>i) To stimulate and maintain students' interest in Physics.</td>
</tr>
<tr>
<td>j) To develop critical attitudes towards experimental work.</td>
</tr>
<tr>
<td>k) To give practice in seeing problems and seeking ways to solve them.</td>
</tr>
<tr>
<td>l) To help the students to bridge the gap between theory and practice.</td>
</tr>
<tr>
<td>m) To prepare the students for a practical examination.</td>
</tr>
<tr>
<td>n) To make phenomena more real through actual experience.</td>
</tr>
</tbody>
</table>
3.3.4.3. Types of experiments:

The analysis of the different types of experiments used in the A.P.P.I.L. material, plus the ones used by Kerr (1963) and Thompson et. al (1975) in their enquiries, produced a list of 5 types of experiments which were included in the questionnaire. These are in Table 3.3.4.3.

Teachers and students were asked to rate the use of each of these types of experiments on a five point scale from 1 (never used) to 5 (frequently used) in the two different situations mentioned earlier.

Table 3.3.4.3. List of types of experiments

1. Demonstration (by the teacher) that verify facts and principles (This might or might not involve the students in discussion).

2. Repetition (by students) of standard qualitative experiments, e.g. "to show that ..." procedure well defined and clear instructions given.

3. Repetition (by students) of standard quantitative experiments, e.g. measurement of physical outcomes of physical constants procedure well defined and clear instructions given.

4. Discovery experiments designed to answer a question raised in the development of the theoretical work.

5. Project, e.g. problems (new to the students) involving some investigational work and study in depth to reach a solution.
3.3.4.4. Problems encountered in the laboratory work.

During the school visits students and teachers complained about the different difficulties that they were facing in doing the experiments. Two open questions were asked of teachers and students about the kind of problem that they had and also if their problems were, in their opinion, due to the specific fact of using individualised learning material.

3.3.4.5. The use of audio-visual aids (A.V.A.) in the laboratory.

From different uses given to audio-visual aids in education (Wittich and Schuler 1973), six different uses concerned with A.V.A. and laboratory work were determined. These uses are in Table 3.4.3.5. Teachers and students were asked to place themselves in a - strong agree - agree - undecided - disagree - strongly disagree - scale for each of them in the two different situations mentioned earlier.

Although the A.P.P.I.L. material includes some A.V.A. some schools did not use them at all. Bearing this in mind, some students and teachers were asked to omit that part of the "actual course" questionnaire. Due to this fact in the analysis of the questionnaire only the "ideal situation" for the use of A.V.A. was taken into account.

In addition to these instruments and techniques, documents and material about each approach were analysed in order to build up a comprehensive picture of the different classrooms. As a member of the A.P.P.I.L. evaluation team, I also was in contact with the A.P.P.I.L. schools through unit feedback questionnaire and feedback and training meetings.
Table 3.3.4.5. List of the uses of A.V.A. in the laboratory

1. Some experiments are replaced by films, film-loops, video, computer exercises.

2. Experiments are explained by using film-loops, videos, film.

3. Films, videos or film-loops are used to show how to use some sophisticated apparatus.

4. Experiments which require very sophisticated apparatus are replaced by films, film-loops, videos.

5. Experiments are set-up by a teacher on film, videos or film-loop and the students then set-up the same experiments by themselves.

6. Dangerous experiments are replaced by films, film-loops, videos.

3.4 Summary

I have briefly described the ideas on which the ethnographic approach to curriculum research is built. The main aspect of this approach is that the researcher seeks to understand the meanings of the participants' actions through checking the questions that emerged against the reality with which the researcher is dealing. This approach offers the researcher the opportunity to use a range of methods which elicit information not accessible to researchers using a hypothesis-testing approach.

By adopting this flexible approach it was possible for me to give attention to the salient issues as they emerged. The techniques used were products of the immediate demands of the research rather than any narrow pre-specification procedures. The information gathered at each stage of the research was used to plan the subsequent stage of it.
The process of progressive focusing allowed unexpected phenomena to be accounted for and facilitated the cross-checking of earlier findings. The problems encountered in the use of any of the techniques selected were overcome by this fact.
CHAPTER IV

The idea of Individualised Learning

4.1 Introduction

4.2 The use of the term 'individualised learning'

4.3 Teachers' perception of the terminology

3.1 Teachers using "independent learning"

3.2 Teachers using "resources based learning"

3.3. Teachers using "worksheets".

4.4 Conclusions
4.1 Introduction

The recent movement towards individualised learning in the school has again gained the support of many teachers, organizations and educationalists.

The present interest in individualised learning has its roots in the early decades of this century (section 2.2) and since then it has been used as an alternative to the traditional system of teaching. The popularity of different theories of learning in successive decades has influenced the development of individualised learning approaches, but the use of these approaches in the school has been more influenced by social-economic effects and the integration of appropriate technology in the schools.

Numerous proposals now exist for individualised learning programmes and the term has developed in so many different ways that it has caused confusion among the teachers so that it seems it is no longer a useful way of describing a teaching method.

The intention of this chapter is to discuss how teachers involved in the individualised learning movement are affected by this confusion of terms surrounding the idea of individualised learning.

For simplicity, I have used the term individualised learning as any activity where individual differences of students are taken into consideration.

4.2 The use of the term 'individualised learning'.

One of the terms most used in this country for individualised learning is "independent learning". This is so, for example, for the projects 'Advanced Physics Project for Independent Learning' and 'Independent Learning Project in Advanced Chemistry' and for the organization "Independent Learning in Science" and "Devonshire Independent Learning".
As many educationalists use the two terms indistinctly, Davies (1978) has drawn attention to this fact and points out that:

"'Individualised' is often confused with 'Independent'
but they are not the same thing at all although
'individualised learning' and 'independent learning'
are often thought of as identical". (pg. 11).

Furthermore, the term individualised learning has even been associated with the term "mixed ability teaching" as it is pointed out in the conference report of the "Association for Science Education" (1976):

"We wanted to distinguish between mixed ability teaching and individualised learning, two phrases which some confused as if they were synonymous". (pg. 85).

and in practice by teachers at the schools:

"I heard quite a lot about self-paced learning and ... mixed ability teaching ... with a mixed ability group, to be at the right level of each child is very difficult ... so you've got to individualise really, ... you just play with mixed ability if you don't. (Worksheet Teacher)

More recently, the term 'resource based learning' has been widely used. This term was introduced at the beginning of the movement as being synonymous with independent learning (Taylor 1972). There is now a tendency to use independent learning as the largest component of a resource-based learning system and to define resource based learning in the same way that individualised learning used to be defined. (Sturges 1976 pg. 18 and Foster 1979 pg. 7). This was pointed out by Berwick (1977) when he said:
"Some people use the term (Resource Learning) to mean learning that is closely sequenced, teacher-directed, and programmed, others used it for very open-ended work based on enquiry and discovery techniques with a considerable element of student choice". (pg. 12) (bracket added).

Furthermore the term "resources" encourages confusion among science teachers as they usually use 'resources' (meaning different apparatus, models etc.) in their lessons. This problem was pointed out during my visits to schools using material from the Resources for Learning Develop Unit.

e.g. "...I think all learning in a practical subject has to be resource-based, you have to have things to use." (R.F.L.D.U. teacher).

The different context in which the terms have been used has produced confusion and contradiction in the practice of individualised learning. Even if a group of teachers used a particular individualised learning project material, the different practice of the project would differ so much that at the end they would represent different approaches to individualised learning. This was demonstrated in the introduction of the A.P.P.I.L project where four different approaches were identified (González 1978). These four approaches are described below.

1. Teacher and students work together discussing the unit (teacher's pace). The teacher uses the unit as a guide, he/she sends the students to read the unit and answer some questions from the unit in order to discuss them in the next lesson. Lab. work is usually set up and done by the teacher.

2. Students work in groups and all groups go at the same pace (teacher's pace). The teacher treats the students as a whole class giving explanations and going through some chapters. Laboratory work is done by the students either by all the group working together or in pairs.
3. Students work in groups and each group goes at a different pace (Group's pace). The group can work either discussing the questions before they answer them or discussing the questions after they have done them. Lab. work is done either independently or in groups.

4. Students work separately at their own pace (student's pace). Only occasionally they talk to each other or to the teacher. Lab. work is done by individuals or pairs.

4.3 Teachers' perception of the terminology

Based on the confusion that teachers in general present, and educationalists in particular support, on the use of the terminology around the idea of individualised learning, I decided to use Kelly's Repertory Grid Techniques (see section 3.3.) to determine the characteristic elements of the different approaches to individualised learning.

Twenty teachers using apparently different approaches to individualised learning were asked to elucidate constructs (13 teachers actually managed to do it) by comparing and contrasting the activities that they had to perform in five different approaches to teaching. One of these was 'traditional teaching' and the other four were selected by the teacher from a given list. (see section 3.2.)

A repertory grid is formed by elements (in this case the elements were the different approaches to teaching) and constructs (in this case the constructs are the activities). The analysis of the grids was made by using the 'Ingrid' and 'Prefan' computer programmes developed by P. Slater (1964). The outcome of these programmes were the principal components of the grid or grids.

Principal components are mathematical abstractions of the relationship between the dispersion of the elements in the C-space (space with an axis for every construct) and the dispersion of the constructs in the E-space (space with an axis for each element).
If the elements are given a similar rating on a large number of the constructs, the main differences between them can be shown on a single scale. The scale which shows the greatest amount of variation is the axis of the first component. Similarly, the one that shows the next greatest amount of the variation is the axis of the second component, etc.

Each component is specified by its latent root or eigenvalue, a normalized vector $C_i$ referring to the constructs and a normalized vector $E_i$ referring to the element. The components are independent of one another and ordered from the largest to the smallest.

The axis of the principal components connect the dispersion in the two spaces to one another, i.e. the variations among elements in the C-space and the variation among the constructs in the E-space. By taking the axis of the first two principal components, usually accounting for most of the variation in the grid, it is possible to show the relationship between the two dispersions on the plane (with the horizontal axis for the first component and the vertical axis for the second component). The plane is treated as a section of the component space within the C-space, the elements being indicated by points and the constructs by directions (see Fig. 4.1). The degree of accuracy depends on how much of the variation recorded in the grid is absorbed by the latent root of the first two components.

The point of the elements are found by taking their loading as co-ordinates. A circle with a convenient radius is drawn around this distribution with its centre at the origin and the loading of the construct define axis crossing it. The final diagram (e.g. Fig. 4.1) shows the relationship among the elements and among the constructs, and their relation with each other as well.

The 13 completed repertory grids were divided according to the kind of approach used at the moment of the enquiry, i.e. "independent learning" 6 teachers, "resource-based learning" 4 teachers and "worksheets" 3 teachers.
Diagram showing the relation among the methods and among the activities of teachers using material called Independent Learning at Sixth Form level.

\[ A = 81.4 \]

1. \( \text{IP} \) = independent learning
2. \( \text{TT} \) = traditional teaching
3. \( \text{NC} \) = Nuffield courses
4. \( \text{W} \) = worksheet

Figure 4.1.
4.3.1 Teachers using "Independent Learning"

Fig. 4.1 shows the dispersion on the plane of the four common approaches or elements (the points inside the circle) and the characteristics or constructs (numbers in the circle) of each of them for the six teachers using schemes called "Independent Learning" at Sixth form level.

The fact that "Independent Learning" (Ip.L) is the element most salient in the diagram implies that it was the most important element for the six teachers. The diagram also shows that "Independent Learning" (Ip.L) is opposite to "Traditional Teaching" (T.T.) and "Nuffield Courses" (N.C.) opposite to "Worksheets" (W.).

The constructs which define each of the methods were taken within a range of $30^\circ$ to the left and to the right of each method. According to the constructs five characteristics defined each of the methods, and these are shown in Table 4.2. The characteristics in this table are defined as follows:

**Activities:** This refers to the kind of activities that the teacher offers to the students

**Communication of the subject:** This refers to the way the students get the information about Physics.

**Control of information:** This refers to who determines what is going to be learned.

**Interactions:** This refers to how the teacher interacts with the students.

**Pace:** This refers to who determines how much is to be learned in each lesson.
Type of S's: This refers to the ability the students have.

Table 4.2 Characteristics of four approaches to teaching according to teachers using "Independent Learning"

<table>
<thead>
<tr>
<th>CHARACTERISTIC</th>
<th>APPROACH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Traditional Teaching</td>
</tr>
<tr>
<td>Activities</td>
<td>uniform</td>
</tr>
<tr>
<td>Communication of the subject</td>
<td>teacher</td>
</tr>
<tr>
<td>Control of information</td>
<td>teacher</td>
</tr>
<tr>
<td>Interaction</td>
<td>class</td>
</tr>
<tr>
<td>Pace</td>
<td>teacher/class</td>
</tr>
<tr>
<td>Type of S's</td>
<td>-</td>
</tr>
</tbody>
</table>

It can be seen that teachers using Independent Learning made distinctions between approaches which support a strategy of learning, (i.e. discovery learning, directed, etc.) and methods which support a management of learning (i.e. working on their own, at their own pace, etc.). Nuffield courses and worksheets were considered, according to the kind of activities the teacher offers to the students, as two strategies of learning very different from each other. The Nuffield courses involved discovery learning activities - open ended - whereas worksheets involved direct learning activities - well structured and pre-planned -. As these two methods are not involved with the management of learning, the difference in pace among the students was not important. However as they are concerned with strategy of learning the type of student was important.
Although 'Independent Learning' has some elements in common with 'Worksheets', (communication of the subject and interactions), both 'Independent Learning' and 'Worksheets' were considered as two different methods with 'Worksheets' being a mid-point between 'Traditional Teaching' and 'Independent Learning'. On the other hand, as 'Independent Learning' was located between 'Worksheets' and 'Nuffield Courses', it could appear that the type of activities in 'Independent Learning' are considered as a mixture of 'pre-planned' and 'open-ended', and at the same time variable, i.e. each student doing something different.

4.3.2. Teachers using 'resources-based learning'

Figure 4.3 shows individual diagrams of the four teachers involved in the use of material from the Resources for Learning Developed Unit. It can be seen that these teachers did not have any common pattern either in the way they chose the elements or in the importance they gave to them. The only reason that could have influenced this aspect is the variety of experience that these teachers presented. As these teachers only had two elements in common each teacher was studied individually. According to the constructs by which each teacher defined Worksheets (W) Individualised Learning (I.L.) Resources-based Learning (R.L.) and independent learning (Ip.L) four characteristics were identified for each approach (Table 4.4).

The most important issue from these characteristics is that these teachers did not consider 'pace' as an element in the idea of individualised learning. The main differences between the four approaches are seen in the communication of information, between Worksheet and Resources-based Learning. They specify that, in the former, it is through written material, whereas in the latter it is also done through audio-visual aids.
Diagrams showing the relation among the elements and among the constructs.
(Teachers using material from the Resources for Learning Developed Unit)

Figure 4.3

TT = traditional teaching
W = worksheet
NC = nuffield courses
RL = resource based learning
IL = individualised learning
IPL = independent learning
Characteristics of four approaches to teaching according to teachers using 'Resources-based Learning'  

<table>
<thead>
<tr>
<th>CHARACTERISTIC</th>
<th>Worksheet</th>
<th>Individualised Learning</th>
<th>Resources based Learning</th>
<th>Independent Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activities</td>
<td>uniform</td>
<td>variable</td>
<td>variable</td>
<td>variable (S's)</td>
</tr>
<tr>
<td>Communication of the subject</td>
<td>written material</td>
<td>material</td>
<td>A.V.A. &amp; written material</td>
<td>material</td>
</tr>
<tr>
<td>Control of information</td>
<td>teacher</td>
<td>teacher</td>
<td>teacher</td>
<td>student/teacher</td>
</tr>
<tr>
<td>Interactions</td>
<td>group</td>
<td>individual/class</td>
<td>group/individual</td>
<td>individual</td>
</tr>
</tbody>
</table>

(The terms 'Activities', 'Communication of the subject', 'Control of information' and 'Interaction' are defined on page 71).

Table 4.4.

Another main difference between the different approaches was in the activities that the teachers offer to the students. Teachers considered that in worksheets all the students do the same kind of work at the same time (uniform) whereas in the other approaches the activities that the students do could be different for different students (variables). It should be noticed that teachers considered that the activities they have to do in 'Independent Learning' are uniform, that is, they considered that the teacher in 'Independent Learning' does the same all the time. It seems that for these teachers it offers some degree of freedom to the students as they could select what they wanted to learn in a specific topic (control of information).
4.3.3 Teachers using 'Worksheets'

The diagram shown in Fig. 4.5 represents the relationship among the four common elements and the constructs of the teachers who were using Worksheets developed by themselves. In this case the most salient element is 'Traditional Teaching' (T.T.) and this appears to indicate that 'Traditional Teaching' is a very important approach of teaching for these teachers.

Looking at the constructs which define each of the methods it was found that the four approaches were defined with the following characteristics (see Table 4.6).

From the Fig. 4.5 it can be appreciated that for these teachers 'Worksheet' and 'Individualised Learning' are very closely related. The characteristics by which they were described were found to be very similar, the only difference being that 'Interaction' was not mentioned as a characteristic of 'Worksheet'.

Characteristics of four approaches to teaching according to teachers using 'Worksheets'

<table>
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<tr>
<th>CHARACTERISTIC</th>
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<tbody>
<tr>
<td></td>
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<td>Activities</td>
<td>uniform</td>
</tr>
<tr>
<td>Pace</td>
<td>teacher</td>
</tr>
<tr>
<td>Communication of info</td>
<td>teacher</td>
</tr>
<tr>
<td>Control of information</td>
<td>-</td>
</tr>
<tr>
<td>Interaction</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 4.6.
Diagram showing the relationship among the elements and among the constructs of Teachers using Worksheets.

1. TT = traditional teaching
2. RL = resource based learning
3. W = worksheet
4. IL = individualised learning

Figure 4.5.
Resources-based learning differs from the other two approaches in two aspects, namely 1) the pace, determined by the student, and 2) the control of information made by the material. The latter seems to have its roots in the fact that these teachers produce material (Worksheet) by themselves and 'Resources based Learning' seems to imply the use of material produced by other people.

Tables 4.2, 4.4 and 4.6 show that teachers tried to differentiate between the different terms used around the idea of individualised learning. These differences are based on their experience in the use of one of these approaches.

The teachers who were using Worksheets developed by themselves considered that 'Individualised Learning' and 'Worksheet' were very closely related. An example of this was that this group of teachers considered that the activities the students have to perform in the classroom are variable, i.e. different students doing different activities. For the teachers using Resources-based Learning (R.L.) the activities the students had to perform on 'Worksheets' are uniform and in 'Individualised Learning' are variable. Therefore for the R.L. teachers 'Individualised Learning' is very closely related to 'Resources-based Learning'. This seems to imply that the term 'Individualised Learning' is interpreted according to the teacher's experience.

The term 'Independent Learning' seems to have been perceived differently from the other terms by most of the teachers. Teachers considered that 'Independent Learning' gave the students freedom in pace and in the control of information.

Although each teacher made distinctions in the different terms used in 'Individualised Learning', the distinction cannot be considered to be general, i.e. the distinctions between the different terms are not based on the same elements.
4.4 Conclusions

This chapter has looked at the problems involved in the use of the idea of 'Individualised Learning'. The methodology used to detect the teachers' perception of the different terms presents the advantage of revealing what the teacher thinks about these terms based on their experience. Teachers elucidated on characteristics for each term according to the interpretation they gave to them. The analysis of these characteristics has shown that the 'idea of Individualised Learning' involved two main aspects:

1. Physics classrooms become more student-activity-centred in contrast to Physics classrooms using a traditional approach.

2. The communication of any Physics concept, principle, etc. is made through material, in contrast to traditional teaching.

These two main characteristics are in line with the findings of Edling (1970) in the U.S.A. It was also found that although each teacher made distinctions between the different approaches, these could not be considered to be general, because they were based upon different elements, such as:

1) The kind of material used: i.e. written material or audio-visual material.

2) The activities the teacher offered to the students in the classroom, i.e. uniform (all the students doing the same activity) or variable (different students doing different activities).

3) Control of information: who decided what was going to be learnt in the class. It should be pointed out here that teachers felt that they lost control when they used other people's material.

4) Interactions: i.e. teachers interacting with groups or with an individual.
There was no way of restricting these characteristics to a specific approach and label it with a unique name because any classroom could present a combination of all the elements depending on the teacher's experience and not on the approach used.

Pace of working, which for many educationalists represents a characteristic of Individualised Learning, was not considered as such by all the teachers. This point was discussed with teachers in most of the interviews I held with them and as a consequence I came to the conclusion that pace in the long term (e.g. one academic term) was considered to be controlled by the teachers whereas within a lesson or set of lessons (e.g. two or three weeks) it was considered to be controlled by the students. This idea of pace was expressed by Reid and Booth (1974) in their review about Independent Learning in science, and by Kimmins and Rennie (1932) in the Dalton Plan.

It could be argued that the diversity of interpretation of the terms showed in this chapter could be a consequence of the number of teachers who participated in the exercise in which the technique was involved. However the fact that only 13 of 20 teachers could elucidate constructs related to all the terms presented to them shows that there does exist a problem of terminology in the teacher population. In spite of this the distinctions made by the 13 teachers, between the terms, are based on the same factors.
CHAPTER V

The teacher's behavioural role in Individualised Learning

5.1 Introduction

5.2 Teacher's perception of activities in Individualised Learning

5.3 Student's perception of the teacher in Individualised Learning

5.4 Conclusions
5.1 Introduction

There seems to be a tendency to omit from the literature an adequate specification of how to use Individualised Learning material. Also to believe that the material could be effectively used by any teacher without specifying the changes that the teacher has to make. One reason for this is that it is difficult to translate into guidance a situation which has not been formulated in a precise way.

The concern of this chapter is the teacher's perception of the changes made in the behavioural role in a classroom based on Individualised Learning and how the students perceive these changes.

The term 'role' will be used in the same sense as that of Harre and Secord (1972) i.e. as a set of actions and activities that the teacher performs in the classroom. Thus knowledge of the different activities give knowledge of the Teacher's behavioural role.

5.2 Teachers' perception of their role in Individualised Learning

In Chapter II (sections 2.3.1 and 2.3.2) a review has been presented of research into the role of the teacher in the classroom - in traditional classrooms and in classrooms using Individualised Learning -. In both cases pre-established behaviours or activities were tested. No previous study attempted to have the teacher present a personal description of what really happened in the classroom, including feelings, or observed changes in the classroom. It seems that in order to discover the role of the teacher in Individualised Learning, where changes in teacher behaviour have occurred, some measure of the teacher's personal perception of these changes is needed. For this reason the Repertory Grid technique (Chapter III) was used in the study reported here. This method suggests that if we want to know what activities a teacher performs in the classroom we should make it our task to discover what these actually are, rather than to test a list of pre-established behaviours, designed on the basis of the researcher's perception of what should happen.
To discover the behavioural role that a teacher performs in a classroom where individualised material is being used, 13 teachers elucidated constructs (see section 3.2.3.) by comparing and contrasting different approaches of teaching. The list of constructs represents a very powerful source of information about the activities that the teacher is now undertaking and the activities that have been dropped. This gives insight into the new role of the teacher in Individualised Learning classrooms.

Each teacher elucidated a set of different activities that he/she considered personally were important.

These activities are expressed according to the teacher's reality and the problems of using Individualised Learning. In many cases the activities were expressed in terms of the students as they form part of the classroom where teachers have to perform the activities. This also implies that the teacher cannot specify how he has changed his behaviour, without at the same time specifying how the students have changed. This is what Hargreaves (1972) calls a teacher's definition of the situation, i.e.

"Implicit in the teacher's definition of his own role is a definition of the pupil role. The teacher cannot specify how he intends to behave without at the same time specifying how he intends the pupil to behave". (pg. 124).

The teacher defines the situation in such a way that he can perform his/her role as teacher in a way he/she regards as adequate. The definition of the situation must be congruent with teacher's conception of his/her classroom role (see Chapter VI).

The activities provided by the teachers (Appendix D) were analysed by the constant comparative method (Glaser 1965). This method consists of coding each activity in as many categories as possible by comparing each activity with the next one. When an activity is coded in one category, it is compared with the previous ones coded in the same category. This constant comparison generates
the properties of each category. After all the activities were indicated in a category (see Table 5.1) the constant comparative units change from comparison of activities with activities to properties of a category with properties of other categories. The diverse properties of a group of categories become integrated and originated, what I have called an "area of change". (see Fig. 5.1).

Four areas of change were recognized and labelled as follows:
1. Preparation (P)
2. Control (C)
3. Interaction (I)
4. Motivation (M)

These areas of change are presented by all the teachers and in respect of all sorts of Individualised Learning approaches. The properties of the area "P" refers to those activities related to the preparation of soft and hardware, seating arrangements, the accessibility of supplies and equipment. The "C" properties are concerned with the fact that the teacher has delegated, to the student, responsibility for the control of activities, time, and in some cases, amount of learning. The properties of the area "I" refers to the new ways of interaction with the students, and the new reasons for doing it. And finally category "M" which is a category labelled as the 'tacit category', this category did not form an area but is intimately involved with the areas "P", "C" and "I".

Each area was formed by three categories, and each category represents a well-defined behavioural role for the teacher. Table 5.2 presents the properties of each area and each category. It is not implied in this analysis that a teacher involved in Individualised Learning performs all the roles of each category, but at least one role of each area is performed.
<table>
<thead>
<tr>
<th>PREPARATION</th>
<th>CONTROL</th>
<th>INTERACTIONS</th>
<th>MOTIVATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Producer</td>
<td>Planner</td>
<td>Organizer</td>
<td>Consultant</td>
</tr>
<tr>
<td>Teacher</td>
<td></td>
<td></td>
<td>Tutor</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>14, 18</td>
<td>22, 23, 30</td>
<td>16, 17, 19</td>
</tr>
<tr>
<td>3</td>
<td>30</td>
<td>33, 38</td>
<td>20, 21</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>38, 40</td>
<td>24</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>48</td>
<td>25, 26</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
<td>48</td>
<td>32, 41</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
<td>51, 53, 54</td>
<td>43, 46</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td>52</td>
<td>58</td>
</tr>
<tr>
<td>9</td>
<td>4</td>
<td>63, 68</td>
<td>56</td>
</tr>
<tr>
<td>10</td>
<td>4</td>
<td>63, 68</td>
<td>56</td>
</tr>
<tr>
<td>11</td>
<td>4</td>
<td>71, 76</td>
<td>74, 75</td>
</tr>
<tr>
<td>12</td>
<td>4</td>
<td>77</td>
<td>74, 75</td>
</tr>
<tr>
<td>13</td>
<td>4</td>
<td>86</td>
<td>80</td>
</tr>
</tbody>
</table>

Table 5.1
Table 5.2 Description of the areas and categories in the teacher behavioural role

<table>
<thead>
<tr>
<th>Areas</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation</td>
<td></td>
</tr>
<tr>
<td>&quot;P&quot; (teacher is involved in any kind of activity which demands preparation or planning)</td>
<td>Producer (Pd)</td>
</tr>
<tr>
<td>Planner (Fn)</td>
<td>Teacher involved in educational activities which include the PRODUCTION and distribution of material</td>
</tr>
<tr>
<td>Organizer (O)</td>
<td>Teacher makes arrangements for doing something and using something considerably in advance of a lesson. Preparation takes place well ahead of time.</td>
</tr>
<tr>
<td>Teacher makes sure that everything needed for the class is in working order and/or that the classroom is properly prepared immediately before the beginning of the lesson and during the lesson.</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td></td>
</tr>
<tr>
<td>&quot;C&quot; (teacher is involved in the supervision of individual work but not in conducting activities or demonstrating)</td>
<td>Not Director of the class (N Drt)</td>
</tr>
<tr>
<td>Not Demonstrator (N Dmst)</td>
<td>Teacher does not control and conduct activities with the whole class in the classroom during the lesson.</td>
</tr>
<tr>
<td>Teacher does not tell and/or show to the whole class how and when to do something in the classroom.</td>
<td></td>
</tr>
<tr>
<td>Teacher watches and/or controls the work and/or progress of the students individually.</td>
<td></td>
</tr>
<tr>
<td>Interactions</td>
<td></td>
</tr>
<tr>
<td>&quot;I&quot; (teacher contact or is contacted by individuals)</td>
<td>Consultant (C)</td>
</tr>
<tr>
<td>Advisor (A)</td>
<td>Teacher is approached by a student (or a very small group of students) to get expert information</td>
</tr>
<tr>
<td>Teacher gives a student (or a very small group of students) recommendations and information about individual work</td>
<td></td>
</tr>
<tr>
<td>Tutor (T)</td>
<td>Teacher meets a single student (or a very small group of students) to discuss some work prepared and submitted by a student(s)</td>
</tr>
<tr>
<td>Motivation</td>
<td></td>
</tr>
<tr>
<td>&quot;M&quot; (teacher contact individual work or is contacted by individuals)</td>
<td>Motivator (M)</td>
</tr>
<tr>
<td>Teacher provides incentive for the students to work or acts as an incentive for the students to work</td>
<td></td>
</tr>
</tbody>
</table>
In area "P" the three categories - Producer (Pd), Planner (Pn) and Organizer (O) - forms a kind of hierarchy in which "Pd" is the highest level, "Pn" the middle and "O" the lowest level. That is, the properties which characterize "Pd" include all of the properties included in "Pn" and "O", and "Pn" all the properties included in "O". For example, if a teacher is using an approach of individualised learning which required production and distribution of material - producer -, at the same time the teacher is a planner and an organizer. A teacher cannot be a producer without being a planner and organizer, and a planner without being an organizer. Any teacher involved in individualised learning is performing the role of organizer.

In Table 5.1 we can see how some teachers refer to production of the material, planning and organizing it (Teachers 1 and 6). Others, however, refer only to "production", ignoring the other two elements (Teachers 2, 9, 13). It should be emphasised here that the Repertory Grid technique made the teacher think about those aspects which are personally important. Therefore, in the case where the teacher specifies only "production", it means that this activity is of greater importance but it does not mean that 'planning' and 'organizing' are not being performed. These two properties, plus something else, constitute the category "producer".

Area "C" is the area which shows the transition from traditional teaching to individualised learning, as it expresses the activities that the teacher does not perform any more. This area also shows the role style of the teacher and how much responsibility the teacher has delegated to the student. Table 5.1 shows that most of the teachers were concerned with the fact that they were no longer the 'directors' of their classes. (They do not control and conduct activities with the whole class in the classroom during a lesson) or the demonstrators (they do not tell and/or show to the whole class how and when to do something in the classroom). However, teachers 2 and 8 did not show signs of being affected by not being a 'director'. The reason for this could have been that these two teachers were in their second year of teaching and since they started teaching they have been involved in individualised learning. It would appear that these
teachers did not have time to develop a role style (i.e. way of performing their interpretation of the teacher's role) specifically for traditional teaching.

The role of supervisor (teacher watches and/or controls the work and/or progress of the students individually) is recognized by most of the teachers but again it has to be emphasized that whilst supervision was not mentioned by teachers 1, 5, and 7, it does not mean that they did not perform this role. It means that they were not affected by it.

The three categories of the area "I" demonstrate the complexity of interactions in individualised learning. This makes this area very difficult to interpret. There is no doubt that when using any kind of individualised learning the kind of interaction the teacher has to perform with individual students is different from the interaction performed with a whole class. The one-to-one interaction depends on how the teacher perceives the student as an individual and vice versa rather than how the teacher perceives the students in the group (see Chapter VII).

Furthermore this area is the one which shows the role style of the teacher in individualised learning. Interactions varied because teachers' personalities vary: what works well for one teacher may be completely ineffectual for another. The kind of interaction which takes place when the teacher performs the role of advisor (teacher gives a student recommendations and information about individual work) is quite different from the kind of interaction which takes place when he performs the role of tutor (teacher meets a student to discuss some work prepared and submitted by the student). These two roles are also very different from the role of consultant, (Teacher is approached by a student to get expert information). In all these interactions the teacher deals with individuals and the decision is made by the teacher to act as a consultant, a tutor or an advisor in any situation and any classroom. Each teacher is unique in his way to interact, and the resultant mixture of personalities,
attitudes, interest in the classroom, makes the interactions in a class unique (see Chapter VI). Table 5.1 shows that all the teachers, except one, performed the role of advisor and 6 out of 13 showed that they also performed the role of consultant. It is impossible to determine one specific role as far as interaction is concerned. Perhaps the most accurate conclusion that can be drawn at this point is that the variability in the area concerned with interaction is both inevitable and desirable.

The role of motivator (teacher provides incentive for the student to work or he acts as an incentive for the students to work) is one implicit in all the teachers' activities and as Frieder (1970) says:

"Motivation has usually been subsumed under the other components in a formal learning system". (pg. 30).

While only two teachers "talked" specifically about motivation in the Rep. Grid, the others used expressions such as "more freedom for the students", "more activities performed by the students", "different experiments", to define a more attractive way of working which enhances motivation among the students. Although they refer to the motivating potential of individualised learning, the teacher's role as a motivator is there, and it is intimately connected with the other roles.

So far, it can be concluded that the teacher's perception of the changes in their role when using individualised learning material could be defined in four areas: preparation, control, interaction and motivation.

The role the teacher performed in each of these areas depended on the kind of material being used, how much responsibility had been delegated to the student and the perception of the new way of interaction with individual students.
5.3 Student's perception of the teacher in individualised learning

In Chapter IV it was shown that in the classroom where individualised learning material is used, the teacher gave the students some participation in the process of teaching and learning. In the last section it was shown that the teacher, using individualised learning material, had to change some activities for others. These changes in their teachers' behaviour were perceived by the students and interpreted according to their experience.

In order to determine how the student perceived the teacher in individualised learning, relative to other people who were working in Physics around him/her and helping with the work, the student was asked to compare and contrast five persons (elements) of the classroom according to the way they talk, interact and in general, work in the classroom. The five elements were self, the Physics teacher, the student he/she asks most about Physics in the classroom, the student who asks him/her most about Physics, and the student to whom he/she talks more about Physics (see section 3.3.3 The Repertory Grid technique).

The thirty students who were selected for doing this were from seven groups in seven different classrooms. Each group was selected bearing in mind that it was also necessary to observe them when they were working and to interview them. Therefore each group consisted of students who worked at the same table.

The analysis of the Repertory Grid was made by use of the 'Prefan' computer programme developed by Peter Slater (1968). The outcome of the programme gives the principal components of the 30 grids aligned by elements but not by constructs. It showed how the elements were seen by the group as a whole and the constructs which defined each of them. The axis of the principal components connected the variation among the elements in the space of the constructs and the variation among the construct in the space of the elements (see section 4.3). The elements are represented by points and the constructs by axis crossing a circle which involved all the elements (Fig. 5.3).
Diagram showing the relationship among the teacher and the other elements and the constructs which defined them, for the two principal components.

1. T = teacher
2. A = asked most
3. F = friend
4. L = knowledge leader
5. S = self

Figure 5.3.
In Fig. 5.3 it can be seen that the teacher is the most salient element, i.e. the teacher is the element most important among the group and at the same time is isolated from the other elements. The constructs which defined the students' perception of the teacher were taken within a range of $30^\circ$ to the left and to the right of the point where the prolongation of the teacher axe cut the circle.

Following the constant comparative method, the constructs which defined the students' perception of the teacher were sorted into three groups with the following proportion:

- Teacher's personal characteristics: 46%
- Teacher as expert in Physics: 38%
- Teacher as the authority: 16%

The constructs related to teacher's personal characteristics were found to be the nearest to the element T in the diagram 5.3. This fact and the fact that teacher's personal characteristics were in the group with highest percentage seemed to indicate that in individualised learning the personal characteristics of the teacher are perceived to be very important. This seems to indicate that in situations where the teacher has to have more direct contact with the students the personal characteristics of the teacher have an effect on students' perception of the teacher. This finding was in line with the findings of Musgrove and Taylor (1969) who studied "the expectation of the pupil" in different kinds of British schools. They found that in groups where individual difference had to be met, the personal qualities of the teacher were of special importance.

According to the Coats and Swierenga study (Coats and Swierenga 1972) about "students' perception of teachers", this finding was expected. In their study they concluded that teacher charisma and popularity determined, to a large extent, how students reacted to questions about their teacher, and that the students' rating of a teacher may be a measure of teacher's charisma rather than a measure of actual teacher's effectiveness. The main difference between the Coats-Swierenga finding and the one presented here is that they used
the "teacher image questionnaire" where the students have to rate the teacher according to a given list, and where the students could idealise the teacher by combining the characteristics of various teachers. In the present case students were asked to express how they perceived the teacher in the actual situation of the classroom by comparing him/her with the other people who most interacted with the students, and it was also found that teacher's personal characteristics played an important role in the students' perception of the teacher.

5.4 Conclusions

The focus of this chapter was to determine whether the teacher had perceived changes in the classroom role when using individualised learning material and how these changes had been perceived by the students.

There appeared to be four areas where the teacher had perceived changes or where the teacher described changes in the behavioural role. These have been called: preparation, control, interaction and motivation. The behavioural role which the teacher could play in each of these areas was affected not only by the teacher's background, or the school's expectations, but by the approach of individualised learning used, how much responsibility was delegated to the student and the reaction to the new way of interaction with individual students.

There is no doubt that the use of individualised learning material leads to a change in the behavioural role of the teacher as new roles are incorporated into the teacher's repertoire. Some teachers have a much wider repertoire than others. The introduction of individualised learning material in the classroom could demand that the teacher plays different roles in terms of preparation of the material and the classroom. The role of organizer is necessary to be performed in any individualised learning approach. This coincides with the findings of Flynn and Chadwick (1970) in their work about the use of L.A.P. material. In this study the teachers felt that they spend more time in "housekeeping
and odd jobs". The use of individualised learning material allowed the teacher to interact with students in small groups or in a one-to-one situation and, as a consequence of this, to perform new roles. The way the teacher performed these roles represented his/her style of interpersonal relations and the sharing of expectations. One-to-one interactions, as a characteristic of individualised learning, has been found in all the studies so far made. As teachers' personalities varied, so the roles involved in interactions varied as well. Teachers adapt their role in the area of interaction according to their own background, personality and interpretation of their role (see Chapter VII), but it does not mean that a role adopted is equally effective for all the students, as they also vary. The variability in the roles related to the one-to-one interaction is both desirable and inevitable.

The use of individualised learning material also allowed a reduction in teachers' activities relating to the dissemination of information, the control over the subject matter and the student's time. The new role in this area is 'supervision of individuals'. This was also found by Flynn and Chadwick, with the remark that the teachers felt that they were doing more administrative jobs, than jobs directly related to education. In this line Musgrove (1965) wrote:

"Many of the setbacks to curriculum development since the second world war are to be attributed less to the intrinsic character of the new method and content than to the difficulties of making new social roles acceptable" (pg. 101).

The students' perception of the teacher, when using an individualised learning approach to teaching, is strongly affected by the teacher's personal characteristics and by the fact that he is an expert in the subject. Although it has not been proved that the teacher's personality affects the learning outcome (Ausubel, Novak and Hamesian, 1968), it may influence students' effective response to the new way of learning.
Teacher's personal characteristics may also influence the hidden role of motivator that the teacher performed in individualised learning. As these characteristics are presented to the students when they interact, the role the teacher plays in the interaction is extremely important.

The four areas where the teacher has changed roles, are considered as a first step in determining the changes of the behavioural role in individualised learning. They are not to be considered as specifying where the changes should occur. Rather, what the teachers, who are using individualised learning approach to teaching, think they have changed in the light of their own experiences.
CHAPTER VI

Individualised Learning in the classroom. Five Case Studies

6.1 Introduction

6.2 Advanced Physics Project for Independent Learning. General aspects

6.3 The case studies
   3.1 Definition of terms
   3.2 Small class
   3.3 School sharing a class
   3.4 Class with two teachers
   3.5 Class with VIth and VIIth together
   3.6 Large class

6.4 Conclusions
6.1 Introduction

In this chapter I shall present the use of individualised learning in some classrooms. As a member of the evaluation team of the Advanced Physics Project for Independent Learning (A.P.P.I.L.) I frequently visited the schools involved in the project. Subsequently I carried out classroom visits (for observation and interview) to schools using different approaches. This experience, in addition to my own experience as a Physics teacher, helped me to try to understand the classroom situation where individualised learning was being used.

For an understanding of the use of individualised learning it was necessary to study and interpret the actions in such classrooms over a period of time, using the ethnographic approach through case studies (section 3.3.1.3). The main purpose of a case study of this kind is to concentrate attention on the manner in which particular groups of people confront specific problems by taking a holistic view of the situations (Shaw 1978).

My familiarity with the A.P.P.I.L. project made it easier to select, for the case studies, five schools out of 25 using the project in 1977. Part of this chapter has been published in the A.P.P.I.L. teacher's Handbook (1978).

6.2 The Advanced Physics Project for Independent Learning. General aspects

It is generally accepted that, in individualised learning, the information on the subject under study is provided mainly through materials. Since this chapter is concerned with classrooms using material from the Advanced Physics Project for Independent Learning (A.P.P.I.L.), I do feel that some information about the development of this project is needed.

The A.P.P.I.L. project was set up by the Schools Sub-Committee of the Inner London Education Authority to provide support to those schools in which only a few students study Physics at Advanced Level.
Thus of the 571 of I.L.E.A. schools which, in 1975, offered 'A' level Physics, 32% of the classes had 10 or more students, 29% had between 5 and 9 students and 39% had between 1 and 4 students (see fig. 6.1). This situation led to doubts as to whether classes were viable in the subject at this level, bearing in mind the demands made on the time of highly qualified staff.

The material produced by the project, enabled students to work independently for part of the time, thus relieving the pressure on the teacher's timetable. Experimental work is an integral element in the project and the independent learning mode implies that books and other resources are available. The materials can be used with any of the G.C.E. Advanced Level Physics syllabus, except for the Nuffield Advanced Physics scheme and, ideally, students should have 'O' level grade A, B, C (or equivalent) in Physics, Maths, and English before commencing the course.

The main intention is to prepare the students for the 'A' level examination. In addition to the educational aims of the project there are other broader aims such as developing independence in learning and the ability to use a range of resources. The project started work in September 1975 with four people - three writers who were Physics teachers seconded from London Schools, and a part-time Director who is a staff Inspector for the I.L.E.A.

The course has been developed with three basic ideas in mind:

i) A 'concept-centred' approach to materials design. A unit of work is built around a fundamental concept such as "waves". This contrasts with the arrangement by topics as used by many textbooks and implied in syllabuses.

ii) A spiral approach to structure. Since concepts are developed gradually, rather than fully acquired at one attempt, the materials return to these basic ideas in the second year, and deal with them in more depth.
Advanced Physics Entries 1975

London Secondary Schools
198 (100%)

Offering Physics 'A' level 113 (57%)
Not offering Physics 'A' level 85 (43%)

Classes with 1 - 9 students 77 (68%)
Classes with 10 students and over 36 (32%)

Between 1 & 4 students 44 (39%)
Between 5 & 9 students 33 (29%)

iii) An independence of units from each other. Wherever possible the sequence in which units are used can be decided by the teacher or students.

These three ideas have led to the following design facets for the course.

a) It is a two-level course of 10 units. (6 units in the first level and 4 units in the second level).

b) The units are built around the concepts of "matter", "fields" and "waves", which are presented in the first level and extended in the second. (see Fig. 6.2.)

c) There are four possible starting units and three pairs of units with strong links.

d) Each of the four starter units has a pre-test. Its purpose is to make sure students have the necessary prerequisite knowledge, concepts and skills to start the unit.
e) Each unit has three different type of questions: 'study question', 'development question' and 'self-assessment question'.

f) Throughout the course students should have easy access to 'A' level text books and other reference books which are needed as a resource in answering study questions and supplementing the text of the units.

g) Each unit suggests the use of some audio-visual material or computer programmes. It varies considerably from unit to unit, depending on the subject matter.

h) There are some sections in each unit called 'extension'. The work involved in these sections is in the nature of an Optional Extra. It can be used by quick students, and those with a particular interest in a topic.

i) Experimental work is an essential part of all units.

j) At the end of each unit a test is provided, in order to know if the students have achieved the objectives of the units.

Structure of A.P.P.I.L. Material

<table>
<thead>
<tr>
<th>MATERIALS</th>
<th>FORCES AND FIELDS</th>
<th>WAVES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1ST LEVEL</td>
<td>2ND LEVEL</td>
<td></td>
</tr>
<tr>
<td>Structure of Matter</td>
<td>Electrical Properties</td>
<td>Forces and Motion</td>
</tr>
<tr>
<td>Material Properties</td>
<td></td>
<td>Forces and Fields</td>
</tr>
<tr>
<td>Thermal Properties</td>
<td>Electrons and the Nucleos</td>
<td>Electromagnetism</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vibrations and Waves</td>
</tr>
</tbody>
</table>

Figure 6.2.
The first trial of the units started in September 1976, with a list of 25 participant schools. Schools varied considerably, ranging from Grammar Schools to (I.L.E.A.) Comprehensive Schools with a large non-academic intake, and included boys only, girls only, and mixed schools. Group size for Physics in the Lower Sixth varied from 1 to 14 students, 68% of the trials schools having what I called a "small group" (less than 6 students in either year of the VIth form). The average number of students per class of this group of schools was 4. A.P.P.I.L. material has been used by schools which approach the problems of teaching Physics to small groups in different ways, i.e. 24% of the schools had the "L VIth and U VIth taught together" and 20% had "classes taught by two teachers". Most of the teachers involved in the trials had previous experience in teaching Physics at 'A' level but the range of such experience was from 1 year to 20 years. None of the teachers had experience in using material of this kind at Sixth Form level.

During the school visits, it was found that a variety of different interpretations were given to A.P.P.I.L. Each of these interpretations led to a different way of working with it and each way of working had a different level of student dependence. In some cases the level of dependence that the teacher expected of the students had led him/her to select a particular way of working and therefore to a particular interpretation of A.P.P.I.L.

6.3 The case studies

Schools in London have approached the problem of teaching Physics in the VIth form in different ways. This is particularly difficult when the number of students in a group is small, because this demands a lot of contact time by 'highly trained' staff. One of the most popular approaches to solve this problem is to have the L VIth students working together with the U VIth students. With this approach the teacher faces the new problems of how to teach these two groups together. What usually happens is that the teacher splits the syllabus into two and then teaches one part during one year and the second part the following year. In this way, sometimes, the students
deal with difficult content before easier. Another approach which has been used is the sharing of the teaching of VIth form subjects between schools, e.g. one school is in charge of the Physics classes and the other of the Chemistry. A.P.P.I.L. material has been used by some schools which have such problems. Five schools, with different characteristics were chosen for the study of the use of the material. The schools have been typified according to the predominant administrative characteristics they present which are as follows:

"Small class"  VIth form classes with less than 6 students.

"Large class"  VIth form classes which have between 6 and 14 students (this latter was the biggest class using A.P.P.I.L. in 1977).

"Class with two teachers" School having two teachers involved in the teaching of Physics to a VIth form class.

"School sharing a class" Two or more schools whose VIth forms students go to one school to attend the Physics lessons.

"Schools with U VIth together" School where the L VIth and U VIth students are in the same classroom with the same timetable, and with the same teacher, for the Physics lessons.

The case studies were undertaken between May 1977 and December 1977. The main aims were:

- To look at the use of A.P.P.I.L material from a humanistic and educative viewpoint.

- To find students' reactions to this new way of learning in different types of class.

- To identify those teachers' activities which facilitate the learning process.
- To look at the classroom interactions.

- To attempt to answer the question: to what extent is A.P.P.I.L. a solution to the problem of Physics teaching in the VIth forms of London schools?

6.3.1 Definition of terms

This section is to introduce some of the terms and symbols used in the case studies in order to avoid repetitions.

"S → T" This means interactions between student and teacher or between teacher and student. They are divided into two:

"S → T" When the student initiates the interaction
"T → S" When the teacher initiates the interaction
"S ← T" represents the responses made by the teachers.

The different categories in all these interactions are described in section 3.3.2.

"S → S" This means when one student interacts with another student. (section 3.3.2.)

Two ways of working were identified and defined as follows:

"Work done in parallel": When a group of students are working on the same concept at the same time, but without consulting each other. Each one works by himself but all the students of the group work at the same pace.

"Work done collaboratively": When a group of students are mutually checking the questions immediately or even before they have finished them.
In some groups a student worked harder in order to be first in answering the questions. Usually this student was the most consulted, but not necessarily the most sociable. This student was called "knowledge leader".

6.3.2 Small class

The school selected for this case study was a very old-established grammar school which had four girls in the Physics L Vth class using A.P.P.I.L. Seven lessons weekly were designated for Physics and they were distributed as follows:

<table>
<thead>
<tr>
<th>Day</th>
<th>9.55 - 11.15</th>
<th>2.00 - 2.40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Wednesday</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Friday</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

Table 6.3

The lessons were given in the Physics Laboratory, which was more or less fully equipped, but did not have a technician. The school started to use the A.P.P.I.L. material because the Head of the Science Department thought that it would possibly be a solution to the problem that the Department had, i.e. Physics teachers who did not stay in the school for a period of longer than 2 years. The idea was that, with A.P.P.I.L. the students would not suffer if a teacher left before the course ended. The actual teacher involved had been working at the school since September 1976. His background was in Computing Science and he defined himself as being "a teacher by accident".

The students' background and interests are shown in the following table:
<table>
<thead>
<tr>
<th>Passes ('O' levels)</th>
<th>Doing 'A' levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maths.</td>
<td>4</td>
</tr>
<tr>
<td>Physics</td>
<td>4</td>
</tr>
<tr>
<td>Chemistry</td>
<td>4</td>
</tr>
<tr>
<td>Biology</td>
<td>3</td>
</tr>
<tr>
<td>History</td>
<td>4</td>
</tr>
<tr>
<td>English Language</td>
<td>4</td>
</tr>
<tr>
<td>English Literature</td>
<td>4</td>
</tr>
<tr>
<td>French</td>
<td>4</td>
</tr>
<tr>
<td>Latin</td>
<td>4</td>
</tr>
<tr>
<td>Geography</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 6.4

Only two of the students had made up their minds to go to University.

a - How students worked

The students worked in the same place, at the same table for all lessons, except for the lab. sessions (usually Wednesday afternoon) when they went to another table where the teacher kept the material. The diagram below shows the students' positions at the table

![Diagram of students' positions]

Figure 6.5

They worked in parallel but consulted each other when they had a problem. The teacher was in the classroom all the time, answering the questions in another unit, or marking the questions the students had finished. At the end of each unit the students had to hand in the questions to the teacher.

At the beginning of each lesson the teacher asked the students how much progress they had made at home. Usually they had not done the same amount of work. He then asked for any difficulties which
had arisen whilst doing the work at home. Frequently a question about this work emerged and the teacher then asked the other students whether they had some difficulty. Then each student talked about the question they had answered and this led to a group discussion which usually lasted about 10 minutes. After the discussion was over, the students started working with the unit again. They consulted both the teacher and each other during the lesson. The teacher told the students how much he wanted them to work at home: typically to do 6 or 7 questions, and also decided whether each student should do an extension question.

b - Interactions

S ←→ T interactions

The student-teacher interactions in the classroom were not only related to the role the teacher thought he should perform as a teacher but also strongly to the role that the school evidently expected him to perform. He never approached any particular student, all of whom were girls, not even when a student called him, for even then he addressed all the group. For the girls the teacher was not an important element in the classroom situation. They saw him strongly related to the girl who played the role of "knowledge leader" in terms of being good at Maths and being keen on working and thinking by themselves.

The system of work, established by the teacher, may have affected the interactions between teacher and students. The interactions presented in Table 6.6 were made with the teacher during their individual work.

According to the kind of interaction initiated by the students and the type of response that the teacher gave, it seemed that there was a good balance between the students' expectation of the teacher's role and his performance of it.
The students did not go to the teacher, they used to make the teacher come to the table they were working at, after they had discussed the problem amongst themselves: This was done at least four times in each session, and always the students who called him were the most able and the most sociable in the group.

The T → S interactions were only "to give conceptual understanding" and happened when the teacher realised that the group was having a discussion about the question. This intervention in the group discussion was not authoritarian, as they continued the discussion until the points were clarified either by themselves or by the teacher.

Table 6.6

(In Appendix F the distribution of the S → T interactions by individuals are presented)

<table>
<thead>
<tr>
<th>S ←→ T</th>
<th>Explaining</th>
<th>Informing of correctness</th>
<th>Telling what to do</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>S → T</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Requiring some material</td>
<td></td>
<td></td>
<td>31%</td>
<td>31%</td>
</tr>
<tr>
<td>Seeking explanation of a point</td>
<td>41%</td>
<td></td>
<td></td>
<td>41%</td>
</tr>
<tr>
<td>Seeking conceptual understanding</td>
<td>9%</td>
<td>19%</td>
<td></td>
<td>28%</td>
</tr>
<tr>
<td>Percentage of the total of interaction initiated</td>
<td>50%</td>
<td>19%</td>
<td>31%</td>
<td>100%</td>
</tr>
</tbody>
</table>

S → S Interactions

Two students were important in the group and they have been identified in the observation and by the Rep. grid. The following data was obtained from the observation.
<table>
<thead>
<tr>
<th>S --→ S</th>
<th>Students number</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students number</td>
<td>1</td>
<td>7%</td>
<td>3%</td>
<td>25%</td>
<td>35%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>5%</td>
<td>2%</td>
<td>23%</td>
<td>30%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>3%</td>
<td>3%</td>
<td>7%</td>
<td>13%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>12%</td>
<td>2%</td>
<td>8%</td>
<td>21%</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>20%</td>
<td>12%</td>
<td>13%</td>
<td>55%</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

**Table 6.7**

From this table it can be seen that student No. 4 was the most consulted by the others. From the Rep. grid we can draw the answers to the questions

a) whom do you ask most about Physics?

b) who asks you most about Physics?

![Diagram showing student consultations and question directions](image)

**Figure 6.8**

This diagram shows that student No. 1 was the most consulted about Physics and that student No. 4 is the one who asked most about Physics. During informal conversations with the students they identified student No. 1 as the one who knows more about Physics and from whom they could get more benefit when they have a problem,
and student No. 4 as the student with whom they could talk and interchange ideas more easily. That is why they defined, in the Rep, grid, student No. 1 as being similar to the teacher using such terms as "likes experiments", "likes maths.", "works on her own". From the Repertory grid it can be concluded that according to all the students in the group student No. 1 was very similar to the teacher as all of them linked these two elements very high, and also to student No. 4., these two students playing very important roles in the group. But a good knowledge of Physics and good powers of communication were seen as separable virtues.

In general the reasons for the S --\(\rightarrow\) S interactions were as follows:

- "seeking explanation of a point" 15%
- "seeking conceptual understanding" 40%
- "to check the questions" 45%

Usually when the students checked the questions amongst themselves and their answers did not coincide, they discussed them until the teacher was asked to explain who was right and why.

c - The Lab. work and A.V.A.

Although the students did not like to do experiments the teacher insisted on it. This happened in the afternoon session, sometimes once a week and sometimes once each fortnight. The students argued that they did not like the experiments because they could not see the objective

"They are not difficult, we just do not like experiments" (student)

"The theoretical part of the course takes a lot of time leaving little time for experiments" (student)

Most of the lab. equipment was available because the necessary material had been borrowed from a boys school. The teacher decided
beforehand which experiments the students had to do and he used to do it first, in order to avoid frustrating the student

"The majority of experiments using school standard equipment, give large errors which do not reinforce the idea that they set out to prove" (Teacher)

The fact that he used to do the experiments beforehand allowed him to help or ask questions of the girls at the right moment.

The teacher borrowed the film loops from the South London Science Centre, but since they could only be kept for a limited period of time, the students had to look at them when they were at the school and not when needed, and for this reason the students found the loops to be 'not particularly helpful'.

The students had an opportunity to do the computer exercises, which are included in the A.P.P.I.L. units, at the school. Experiments, loops and Computer exercises were followed by a group discussion with the teacher.

d - General aspects

1. Teachers and students were satisfied with the work they had done.

"I think I like it better than just sitting quiet and listening to the teacher" (student)

"It is good you can stay longer where it is hard without interrupting the others" (student)

"I like it ... I think we get on better" (teacher)

2. Students did not agree with the idea of having the teacher in the classroom for less time than timetabled. They said they needed the teacher in the classroom to solve any problem they could have at any time. The teacher thought that they did not need him all the time.
"I think they miss my attention, they don't need me all the time but they need me to be in the classroom. I think they are more confident if they know I am there" (teacher)

3. Experiments and A.V.A. were found not to be worthwhile because of the time they had to spend on them with very few benefits.

4. The students' notes were the answers to the questions of the units. The students could retain the units or ask for them at any time.

5. Students found that they had to write quite a lot, compared with the other subjects they were doing, and because of that they thought that they could remember more.

6. The girls agreed that they were finishing the unit on time because the teacher has pushed them to do so.

6.3.3. School sharing a class

This school had an agreement with another school in the same I.L.E.A. Division, to interchange students in the VIth form. The aim of this interchange was to offer a wider spectrum of VIth form subjects, i.e. some VIth form students went to Chemistry lessons in the other school and two VIth form students came to attend the Physics lessons in the case study school.

The Physics lessons were given in a classroom with very small tables where the head of science stored some Physics material. The timetable was as follows:

<table>
<thead>
<tr>
<th></th>
<th>9.15 - 10.45</th>
<th>1.45 - 3.15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Tuesday</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Friday</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

Table 6.9
On Tuesday the students were alone in the classroom because the teacher had to teach the Vth form, and that is why they called the Tuesday session "study periods" and it did not involve compulsory attendance by the students from the other school.

The Head of Science was the person in charge of the VIth form Physics teaching. She has many years of experience and especially in teaching innovations, i.e. is keen on curriculum development. She decided to use A.P.P.I.L. in order to help the team with the trial and feedback of the units.

The students were five in number with the following background and interest

<table>
<thead>
<tr>
<th>Passed 'O' level</th>
<th>Doing 'A' level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passed C.S.E.</td>
<td></td>
</tr>
<tr>
<td>Mathematics</td>
<td>4</td>
</tr>
<tr>
<td>Physics</td>
<td>4</td>
</tr>
<tr>
<td>Chemistry</td>
<td>4</td>
</tr>
<tr>
<td>Biology</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 6.10

Four of the girls wanted to go to University: three to read Medicine and one Psychology.

a - How the students worked

For the first three weeks of the observation there were only four girls in the classroom, as the other student was ill during this time. Although the girls tried to group themselves according to the school where they came from, the teacher insisted, on many occasions, in separating them - one onto one table. The reason given for doing this was that the teacher thought that if they worked together it would not be "independent learning", i.e. the
teacher's interpretation of the project aims was to this effect. The teacher gave the students a list which contained:
a) the questions that they should do and the order in which they should do them, and
b) the pages they should consult in the reference books.

She had the same list herself with the names of the girls in order to monitor which questions had been done.

"You have to keep a control of what they have done and what they are doing" (teacher)

The girls worked in parallel with the exception of the girl who very seldom attended the lesson and about whom little is known. When the teacher was not in the classroom they consulted each other.

If the teacher found, when marking the questions, that all girls had difficulty with one of them, she explained that question to everybody. The girls handed in questions at least every week.

During the lesson the teacher was, for most of the time, at her table marking the questions, and the students each one at one table doing the questions.

b - Interactions

During the observation period on this class (4 students) I found that the S — T interactions were very few in number (19% of the S ←→ T interactions). In the interview the home-based students said that they did not interact with the teacher because they felt that they did not know her despite previously having been taught by her.

"I keep pointing out to them, with independent learning you have to get to know the teacher" (student)

For all the students the teacher was a very important element in classroom life but was very distant from them. They described her as "having no sense of humour", and felt that "you have to talk
to her in a respectful manner". For the two visiting students the teacher was the one who "taught in a different school" and was therefore generally alien.

In this classroom there was a conflict between the teacher's conception of his role and the students' expectations of the teacher's role, i.e. the teacher saw his role as an organiser, consultant, dealing with individuals, not promoting class discussion, and not needing to direct the students. The students thought that the teacher should guide them through the course, explaining the relevant points, and promoting discussion.

"If there were a teacher, even if she would not talk to us, we can discuss as a group ... teacher included" (student)

These perceptions underlay the following distribution of S --- T initiated interaction and S <- T responses:

<table>
<thead>
<tr>
<th>S &lt;-- T</th>
<th>Explaining</th>
<th>Asking some Questions</th>
<th>Informing of correctness</th>
<th>Telling what to do</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>S --&gt; T</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Requiring some material</td>
<td></td>
<td></td>
<td></td>
<td>15%</td>
<td>15%</td>
</tr>
<tr>
<td>Checking correctness</td>
<td>28%</td>
<td></td>
<td>15%</td>
<td>14%</td>
<td>57%</td>
</tr>
<tr>
<td>Seeking explanation of a point</td>
<td></td>
<td>28%</td>
<td></td>
<td></td>
<td>28%</td>
</tr>
<tr>
<td>Total</td>
<td>28%</td>
<td>28%</td>
<td>15%</td>
<td>29%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 6.11
(Interaction by students in Appendix F)
The fact that the students did not interact with the teacher made the teacher interact with them.

"... in this way they work on their own for quite a long period without any contact with me" (teacher)

The distribution of teacher initiated interactions was as follows:

<table>
<thead>
<tr>
<th>T--→S</th>
<th>Students number</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>To see what is happening</td>
<td>3%</td>
</tr>
<tr>
<td>To check the questions</td>
<td>14%</td>
</tr>
<tr>
<td>To give conceptual understanding</td>
<td>7%</td>
</tr>
<tr>
<td>Total</td>
<td>24%</td>
</tr>
</tbody>
</table>

Table 6.12
(Students 1 and 2 were from the school in which the class was being held)

The teacher tried to perform his role mainly by checking the questions that the students had done individually. Because of this and because it was the teacher who established the rules in the classroom, the students mainly interacted with the teacher to check if the answers were right or wrong. This was demonstrated when, in one of the interviews, the students said that they answered the questions without understanding their own answers and then, if the answers were wrong, they were sure that the teacher would come and help them with the question. The students were not happy with this way of working:
"You shouldn't feel that the faster you go the better it is, ... and you don't bother about the answers ... The feeling I have got is that ... if it is the right answer nobody bothers if you understand." (student)

The kind of response the teacher gave to the students was related to the degree of difficulty the student had in getting the final answer to a particular question.

In the S → S interactions we found that the students tried to group themselves according to the school where they came from. As I said before, the teacher insisted, on many occasions, on separating them, one onto a table, which reflected the teacher's interpretation of independent learning.

The students interacted with each other when the teacher was not in the classroom (especially on Tuesday afternoon). The few interactions being made when the teacher was in the classroom were between students from the same school or between students who sat near each other. That is why their answer to the questions

a) Whom do you ask most about Physics?  
   Students 1 and 2 from the case study school.
   Students 3 and 4 from the visiting school

b) Who asks you most about Physics?  

The kind of interactions between the students were as follows:

"To check the questions" 31%
"Seeking conceptual understanding" 42%
"Seeking explanation of a point" 27%
Most of the S → S interactions "seeking conceptual understanding" were made between students from different schools. They said in interviews that they preferred to ask students from the other school because, if the latter could not answer the question, neither would appear "foolish". In the analysis of how they perceive the classroom, students No. 3 and No. 4 saw themselves as being very similar to each other and different from the others, using such terms as being "friends outside the class", having "much more contact", both "study zoology" at "the same level". But they saw student No. 1 very close to them as regards background (their parents were all Indian immigrants).

It is apparent that the fact that these were students from different schools interfered in the interactions between the students and between the students and the teacher. However the problem of the role strain between teacher and all the students was of greater influence in the interactions. If we compare the S → T interactions with the S → S interactions, we see that the students generally expected the teacher to "promote discussion and explain the relevant points" rather more than she actually did.

c - Lab. work and A.V.A.

The students did the experiments in the classroom. The technician brought the apparatus into the classroom and it stayed there until it was needed. The girls could do the experiments when they wanted, and usually the teacher explained to everybody how to use the apparatus and how to do the experiments. After that, if the teacher was in the classroom, the experiment was done by one or two students. If the teacher was out of the classroom all the students did it at the same time.

The only A.V.A. used were some transparencies. The girls liked these because "it made a change" and they had the opportunity to work together, being allowed to interchange ideas and discuss.
d - General aspects

1. The students were not satisfied with their work

No. 1
"I prefer a person who stands up in front of you and tells you ... and if you don't understand ... put your hand up and said I don't understand and she explains again."

No. 3
"Well, they said that it is not independent learning if she teaches in that way."

No. 2
"But when you've got the teacher on the blackboard you are also independent, ... it is up to you to write your notes and learn."

No. 4
"Oh, yes ... you've got the choice, you make your own notes anyway."

2. The students complained because they did not have the teacher all of the time. The fact that the teacher was outside the classroom most of the time plus the lack of contact between students and teacher made the problem worse.

No. 2
"I think it should be teacher in the classroom, because we don't know how we are going on ..."

No. 3
"Somebody to assess us ..."

No. 4
"All of us are just moving in a vicious circle, she doesn't know, W.... doesn't know, I don't know, we aren't getting anywhere, sometimes."
"The teacher hasn't got time, but I would like to know what she does ... she is all the day at the school."

3. The teacher was very confused in her work, as she did not know how much freedom she could give to the girls.

"It is a good idea that they learn to work on their own ... but what will the cost be? Will a few fail because of it? (teacher)

4. The teacher complained that the fact that she did not know the girls from the other school made her treat them differently.

5. The students said that because the teacher did not push them to work they were lazy in Physics.

"It is a very slow thing isn't it? ... I mean it encourages people to be lazy ... she (the teacher) said on Friday that we've got to finish chapter one ... and we could do it, so easily ..." (student)

6. The students liked the experiments and A.V.A. because, when doing them, they have the opportunity to work together.

7. The teacher complained about the lack of technical help in the organization of equipment.

6.3.4. **Class with two teachers**

One of the teachers involved in the teaching of 'A' level Physics was the Head of Science and the other one an assistant teacher with three degrees in a specialist branch of Physics.

Sessions were given in two Physics labs. (one lab. for each teacher and were distributed as follows:
Table 6.14

The school had started using A.P.P.I.L. because it had fitted their circumstances in 1976-77, i.e. one L VIth student, one U VIth student, one R U VIth and two teachers. In 1977-78 they were using A.P.P.I.L. with 8 L VIth students and, depending on students' reactions will continue to use it.

The school had a technician who was in charge of arranging the material (lab. equipment and books) on a trolley. Although he was around for most of the time nobody asked him directly for material or help.

The Physics Department had 9 students in the VIth form, 8 L VIth and one U VIth. They had the same timetable but they worked in different rooms and interacted with each other occasionally.

As far as Physics, Maths. and Chemistry are concerned the students' background and interest were:

<table>
<thead>
<tr>
<th>Passed</th>
<th>Doing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C.S.E.</td>
</tr>
<tr>
<td>Physics</td>
<td>8</td>
</tr>
<tr>
<td>Chemistry</td>
<td>2</td>
</tr>
<tr>
<td>Maths.</td>
<td>8</td>
</tr>
<tr>
<td>Engineering</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 6.15
Five of the students wanted to go to University to read Engineering or Physics, but the others did not have any clear intentions.

**a - How the students worked**

At the end of the participant observation period the students were grouped differently compared to the arrangement at the beginning of it, and this happened because they did not know each other well initially in terms of way of working, interest, attitudes, etc.

Figure 6.16 shows the placing of 8 students as they were grouped at the beginning of the participant observation (first week).

![Figure 6.16](image)

Group I Students No. 1, 2,
Group II Students No. 3, 4, 5,
Group III Students No. 7, 8,
Student No. 6 worked alone.

After two sessions the students changed their placing and grouped in a different way as shown in Figure 6.17.

![Figure 6.17](image)

Group I Students 1, 2, 3 and 5.
Group II Students 4, 7, 8

These two groups then remained fixed until the last observation and had the following characteristics:

a) Present interests: They were doing the same subjects, i.e.
   Group I: A-levels in Physics, Maths. and Chemistry.
   Group II: A-levels in Physics, Maths. and Engineering.

b) Future interests: They had a common intended future, i.e.
   Group I: all of them wanted to go to University, (No. 1, 2, 3, Engineering, and No. 5 Physics)
   Group II: they "did not know"
c) Style of work: They worked in a common style, i.e.

  Group I: They worked parallel
  Group II: They worked collaboratively.

The student No. 6, who worked alone for most of the time, wanted to join Group I, i.e. he only consulted the students of this group and he said in informal conversations that he would like to work with them when he "caught up". The "lesson-tone" differed depending on the teacher in charge, i.e. the attitude that the students had to work, seemed to vary. In the lessons with Teacher A the students apparently felt more free to interact with each other and with him. It seemed that the fact that the teacher was working with the unit (although on a different chapter to the students) and that he was readily available to help the students quickly made the students feel confident. On the other hand Teacher B preferred to read Physics books in the classroom or to go out of the classroom and this led to the students chatting rather than working. The fact that he had not prepared the questions before the students asked him meant that, when the students consulted him, they had to spend more time with him, and sometimes even to go back to their places without an answer.

"If you ask Mr. B you say: Oh yes,.. and you don't really understand". (student 2)

"He explains in a different way, and in a different language" (student 1)

b - Interactions

As was said before, the students interacted more with Teacher A than with Teacher B (85% of the S → T). The reasons for that could be:

a) Teacher A spends more time with the students (3 hours)
b) Teacher A was always in the classroom
c) Some students said that they could not follow the explanation of Teacher B.
d) Teacher A was perceived by the students to be "The Physics Teacher" in the Rep. grid.
The S → T (T = A and B) were as follows:

<table>
<thead>
<tr>
<th>S ←→ T</th>
<th>Explaining</th>
<th>Asking some questions</th>
<th>Informing of correctness</th>
<th>Telling what to do</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>S → T</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Requiring some material</td>
<td></td>
<td></td>
<td></td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>Asking what to do</td>
<td></td>
<td></td>
<td></td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>Checking correctness</td>
<td></td>
<td></td>
<td>4%</td>
<td>8%</td>
<td>12%</td>
</tr>
<tr>
<td>Seeking explanation of a point</td>
<td>48%</td>
<td></td>
<td></td>
<td>2%</td>
<td>50%</td>
</tr>
<tr>
<td>Seeking conceptual understanding</td>
<td>26%</td>
<td>2%</td>
<td>4%</td>
<td>2%</td>
<td>34%</td>
</tr>
<tr>
<td></td>
<td>74%</td>
<td>2%</td>
<td>8%</td>
<td>16%</td>
<td>100%</td>
</tr>
</tbody>
</table>

**Table 6.18**
(Interactions made by individual students in Appendix)

These interactions were made by Group I as Group II did not interact with either teacher on any occasion, and especially by student No. 2 (30% of the S → T were made by him). The teacher responded to the students mostly by "explaining" (79%) which did not meet the expectations of all the students in Group I as two students on different occasions said that:

"The teacher should discuss the questions with the students"
(student No. 1)

"I prefer to ask the others because you can interchange ideas."
(student No. 3)

In the analysis of the Repertory grid one of the main differences between the teacher and the student most consulted about Physics was the fact that they could discuss and interchange ideas.

Most of the T → S interactions were made by teacher A (89% of the T → S interactions). Teacher B interacted only with
Group II in order to know why they were talking.

In order to perform his role, "to help and control individual work", Teacher A interacted most with those students who never went to him, i.e. with Group II. The T → S interactions were as follows:

- "To see what is happening" 22%
- "To check the questions" 37%
- "To give conceptual understanding" 41%

This was a good balance between the reasons for initiating an interaction with the students. However, when the teacher approached either group as it was discussing a question, the students stopped and waited for the teacher's participation, as the teacher evidently represented the "authority".

As was mentioned earlier the students grouped themselves into two groups. The following diagram shows this and represents the answers to the questions:

- "Whom do you ask most about Physics?" →
- "Who asks you most about Physics?" ←→

![Figure 6.19](image)
The S → S interactions were made within a group: Group I did not interact with the students of Group II because the latter was always behind in the use of the unit, but Group II occasionally "checked the questions" with Group I. The student No. 6, who was working alone, wanted to join Group I and he only consulted the students of this group.

The overall S → S interactions were as follows:

"Seeking explanation of a point" 9%
"Seeking conceptual understanding" 35%
"To check the questions" 56%

Most of the S → S interactions "to check the questions" were made within Group II and by student No. 6. Usually in Group I, if their answers to a question did not coincide, they started a discussion which finished by their asking the teacher, or by the teacher approaching the group. The amount of interaction between students was as follows:

<table>
<thead>
<tr>
<th>S → S</th>
<th>STUDENTS</th>
<th>Nrs.</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1  2  3  4  5  6  7  8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>5  6  9</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2  5  15</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>2  4  6  1</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1  7  4  2</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1  1  1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>2  3  2  1</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>2  3  1</td>
<td>9</td>
<td>15</td>
</tr>
<tr>
<td>8</td>
<td>1  1  2</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>7  13  18  3  40</td>
<td>7  12</td>
<td>100</td>
</tr>
</tbody>
</table>
c - The lab. work and A.V.A.

The lab. work was planned so as to be done at any time in the technician's room in order to avoid interruptions to the students doing other work with the unit.

"What happens is that if one of them starts to do the experiments the others join him ..." (teacher)

However it did not work in that way all the time. Of the two groups only one did the experiments as it seemed that the experiments were not compulsory, and from the group who did the experiments, only two went to the technician's room whilst the others brought the experiments into the classroom. The students mentioned that sometimes the experiments confused them instead of helping to understand the principles and that is why they preferred to do the experiments where "the others can help if one gets stuck".

Very few experiments were done due to the lack of apparatus and very few A.V.A. were used due to the lack of availability of equipment.

d - General findings

1. Whilst one group liked the idea of working by themselves (Group I) the other group did not like A.P.P.I.L. at all.

"I found I am working more daily and I found it easier, because I like how they put everything up, they might refer you to books at the precise moment and you read the books and you understand". (student Group I)

"I think I would learn more with the teacher teaching... I think it is very boring." (student Group II).

2. Some students commented that A.P.P.I.L. solved the problem of having two teachers in charge of the Physics teaching in the VIth form.
"It would be difficult if we were taught from the blackboard, because there would be two different topics". (student Group I)

3. Students said that they found it more helpful to ask the other students than to ask the teacher because they could interchange ideas more readily.

4. The notes they made were the answers to the questions, they could keep the units for this year, but they have to give them back for the new 1 VIth class.

5. Students commented that some teaching was necessary in some parts of the units such as at the beginning, in the "key concepts of the units" and at the end, as a summary.

6. Lab. work was not done properly because of the lack of equipment. Students commented that they should have had access to a teacher when doing the experiments.

"If you are on your own ... if you get stuck you give up". (student)

7. Students were worried about A.P.P.I.L. and the 'A' level exam, they could not see how they could go together.

"... with that (A.P.P.I.L.) you know things in detail but you don't know enough to get through the exam." (student)

"It is great if you do not have to care about the exam, because you can do what you want and as deep as you want." (student)

8. Some students thought that the teachers had an incorrect understanding of how to use A.P.P.I.L. materials.

"Teachers get the wrong impression of individual learning ... thus the teacher tends to leave us on our own too much, thinking that everything, 'the so called A.P.P.I.L. project' has been made clear, which in my opinion is far from it ... pity!" (student)
6.3.5. **School with L VIth and U VIth together**

The school chosen for this case study was using the A.P.P.I.L. material because the teacher realised in January 1977, that he was not able to teach the L VIth and the U VIth together as he was in his first year of teaching.

"I was teaching the U VIth and the L VIth together before I started with A.P.P.I.L. and it was pretty chaotic, it was me rushing in ... from one group to other ... perhaps ... I just didn't have time to provide extra material and references to both groups."

(teacher)

Lessons were given in two laboratories - the Physics lab, and the Biology lab. - and they were distributed as follows:

<table>
<thead>
<tr>
<th></th>
<th>9.15 - 10.05</th>
<th>10.05 - 11.50</th>
<th>11.10 - 12.00</th>
<th>12.00 - 12.50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>XA</td>
<td>XA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wednesday</td>
<td>XB</td>
<td></td>
<td></td>
<td>XB</td>
</tr>
<tr>
<td>Friday</td>
<td></td>
<td>XA</td>
<td>XA</td>
<td></td>
</tr>
</tbody>
</table>

XA = Physics Lab.
XB = Biology Lab.  

The L VIth students doing Electronics (in a Technical College) could not attend the last lesson on Friday because of overlapping of timetables.

There were to be six students (boys) in the L VIth and 4 students (girls) in the U VIth; one of the girls came from another school (she had failed the Physics A-level exam. in July 1977).

The L VIth students' background and interests were as follows:
As far as science is concerned the U VIth students' background and interests were as follows:

<table>
<thead>
<tr>
<th>Subject</th>
<th>Passed (O'level)</th>
<th>Doing (A-level)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maths</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Physics</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>English Language</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>English Literature</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Geography</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>History</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Chemistry</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>French</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>German</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Electronics</td>
<td></td>
<td>5</td>
</tr>
</tbody>
</table>

(The U VIth students did the O-level exam in the first year of the VIth form).

All the U VIth students and one L VIth student wanted to go to University.

a - How the students work

Although the L VIth and U VIth students worked in the same classroom during the Physics lessons, they behaved as two different groups not only in terms of way of working but also in the way they interacted with the teacher and the teacher interacted with them.
The U VIth students were on the same table all of the time and in the same place. However the L VIth students changed their places frequently, with the exception of three of them who always tried to be together.

A typical arrangement of the students in the classroom was as follows:

```
  10  7  6  1
  9  8  5  2
  U VIth
  4  3
  L VIth
```

The students 1, 2, and 4 were for most of the time in the same place.

*Figure 6.22*

The Laboratories had four tables but the students were, for most of the time, at two. On some occasions some L VIth students used the other tables; they said that it happened when they realised that they were behind and they changed their place in order to work harder. The L VIth students worked at different paces asking each other and the teacher when they had problems. The amount of work they did varied from one student to another and from one week to another. They tried to follow the time recommended by the unit.

"We have to go along together and see where the difficulties are" (student L VIth)

The U VIth students worked in parallel, doing the same amount of work and keeping to the recommended times.

The teacher was always busy, attending to the students requirements which most of the time were about the questions. The L VIth students handed in the questions to the teacher when they liked, and in the amount that they liked. When the teacher gave the questions back they had a chat about them, sometimes immediately and sometimes after the students had revised them.

"To find out if they fully understand what they are doing I think one needs to do a certain amount of searching questioning. I think sometimes some boys can go through it
and produce what we call a reasonable answer to the question, but when one goes a bit around the circle, one discovers there is a misconception." (teacher)

The U VIth students did not hand in the questions but the teacher checked them orally through individual or small group discussion.

b - Interaction

During the participant observation there were many complaints from the students of both groups (L VIth and U VIth) in the sense that the teacher was seen to spend more time with one group than with the other.

"When we do need the teacher ... he is all the time teaching the U VIth and when they need him ... he is with us." (L VIth student)

"Well the problem is that the teacher is all the time with them (L VIth)" (U VIth student)

That is why the teacher in the Repertory grid was considered to have been a very important element in the classroom. The U VIth students saw the teacher as being very far from all of them and described him as having "an answer to every question", and he "talks a lot about Physics", he "finds Physics easy". Some of these characteristics were also found in student No. 7 who, according to the teacher, was the most able student of the group. On the other hand the L VIth group saw the teacher as being very closely related to the student whom I called a 'knowledge leader' describing him in terms such as "willing to help", "works very hard". According to the teacher this student was not so clever, but a "hard worker". The teacher considered that his role should be "to control what has been learned on an individual basis".

Most of the S —— T interactions were made by the L VIth students (80% of the S —— T interactions). The U VIth students said that the reason for that was:
"If somebody is doing a question and asks him about it ... he explains it and you listen to that explanation because you realise that it can help you ... otherwise he has to explain one question over and over again." (U VIth student)

The S → T interactions presented in Table 6.23 are divided into L VIth S → T interactions and U VIth S → T interactions.

<table>
<thead>
<tr>
<th>S → T Interactions in School with L VIth and U VIth Together</th>
</tr>
</thead>
<tbody>
<tr>
<td>S → T (L VIth)</td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>Asking what to do</td>
</tr>
<tr>
<td>Checking correctness</td>
</tr>
<tr>
<td>Seeking explanation of a point</td>
</tr>
<tr>
<td>Seeking conceptual understanding</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>S → T (U VIth)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seeking explanation of a point</td>
</tr>
<tr>
<td>Seeking conceptual understanding</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
</tr>
</tbody>
</table>

Table 6.23
As can be seen the teacher's responses to the U VIth students were solely "explaining". The reasons for this could be:

1) The unit of work was new for the teacher, so he did not know where the "tricky" points were.

2) The students were short of time, being in their second year.

3) The students were girls. The difference in sex between teacher and students seems to have been important.

4) The students readily worked together.

In the case of the L VIth the teacher had worked with that unit before, which allowed him to ask some more penetrating questions about it and on this he said:

"With the L VIth it is much easier because you have gone through all the questions once and ... you know what a particular question didn't do very well, how you have to supplement it, being careful that they don't misunderstand something." (teacher)

The teacher was aware of this situation and he tried to strike a balance in the number and kind of interactions with the students. Most of his initiated interactions were with the U VIth, the overall analysis being:

Table 6.24

<table>
<thead>
<tr>
<th>T --&gt; S interactions</th>
<th>L VIth</th>
<th>U VIth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>To see what is happening</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>To check the questions</td>
<td>6%</td>
<td></td>
</tr>
<tr>
<td>To give conceptual understanding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>11%</td>
<td>5%</td>
</tr>
</tbody>
</table>
The teacher only went to the L VIth when he noticed that they were talking about a subject other than Physics. It is important to make it clear that the teacher was very busy all the time, attending to the students' requirements. He did not have a moment free and on two occasions he asked some students to stay in the classroom during the lunch hour in order to explain a question he did not have time to do in the class.

"It doesn't make it easier for me, on the contrary it makes it more difficult, I have to change constantly from one thing to another". (teacher)

Although the L VIth and U VIth students worked in the same classroom during the Physics lessons, they did not interact across this division. This might have happened because of -

1. Lack of common work - the L VIth were working with "Forces and Motion" and the U VIth with "Vibration and Waves".

2. The sex of the students - L VIth students were boys and U VIth students were girls.

The diagram below shows the answers to the questions

"Whom do you ask most about Physics?" →
"Who asks you most about Physics?" ↔

![Diagram showing U VIth and L VIth interactions](image)

Figure 6.25
The student No. 2 was what I have called the "knowledge leader", and all the students said that he worked at home quite a lot and that he was ahead in the unit. According to the L VIth students it is easier to ask the questions of student No. 2 and also they knew that he liked to be asked and to help the others.

The style of working of the two groups was different and that affected the way they interacted. The S — S interactions for the L VIth were as follows:

- "Seeking explanation of a point" 21%
- "Seeking conceptual understanding" 29%
- "To check the questions" 50%

and the S — S interactions for the U VIth were:

- "Seeking explanation of a point" 21%
- "Seeking for conceptual understanding" 58%
- "To check the questions" 21%

The L VIth style of work was what I called "work done in parallel". This led to their interacting more to "check the questions" than "seeking for conceptual understanding". The U VIth style of work was "work done collaboratively" that made the students interact more in "seeking for conceptual understanding."

c - Laboratory work and A.V.A.

Books and equipment were kept in the Physics Lab., but as the teacher knew what experiments the students would do in each lesson he removed the equipment from the Physics Lab. to the Biology Lab. on Wednesday (the day when they were in the Biology Lab).

The L VIth students did the experiments individually and at any time, but they were limited because of the lack of equipment. The U VIth students did the experiments together and at any time. They also were limited by the lack of equipment, but they had access
to some A.V.A. which the teacher borrowed for several days from the South London Science Centre. None of the students (L VIth and U VIth) liked to do experiments because they said that they spend a lot of time doing them and the results were usually very poor.

"Some experiments are too time-consuming in order to obtain a very simple solution" (L VIth student)

d - General aspects

1. The U VIth students were satisfied with their work, but the L VIth students had found it quite difficult because they had not done the 'O' level syllabus.

"They assume you know a lot more but we did not do the 'O' level syllabus last year" (L VIth student)

2. The teacher said that it was the only way he could teach L VIth and U VIth together.

"I was teaching the U VIth and the L VIth together before A.P.P.I.L. was introduced and it was pretty .... I was giving them references to read but it was by no means so structured as A.P.P.I.L. has been." (teacher)

3. The students complained that because they were two quite distinct groups, they could not get help immediately.

4. The teacher found it very hard because he was teaching two units and levels of students at the same time.

5. The students did not like to do experiments because of the poor quality of the results.

"We have to do experiments which take you about two hours and then you get insignificant answers."
6. According to the teacher lack of equipment was the main reason for not doing experiments.

"We don't do much experiments because of many things, it is very difficult to get accurate results and it is not worthwhile to reinforce an idea with 25% of error in the experiments ... I tend to do experiments that usually work ... I have sometimes found difficulty in getting the equipment so I tried to do it in another way..." (teacher)

7. The U VIth found the A.V.A. unhelpful because they had to see all of them at once.

8. Some students said that A.P.P.I.L. is not worthwhile for the teacher because he had to explain the same thing several times to different students during one lesson.

"I think that the only person who really understands the work is the teacher himself since he spends so much time explaining the same thing." (student U VIth)

6.3.6. Large Class

This school had 45 students in the VIth form and 25 students in the LVIIth class using A.P.P.I.L. - The class observed had 12 students and the Physics timetable for this class was as follows:

<table>
<thead>
<tr>
<th></th>
<th>9.10</th>
<th>9.50</th>
<th>10.45</th>
<th>1.55</th>
<th>2.35</th>
<th>3.15</th>
<th>3.50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tuesday</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wednesday</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thursday</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Friday</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 6.26
All the lessons were in the Physics lab, which was well equipped to do A-level experiments.

The reason for using A.P.P.I.L. material was that the teacher of this class, who was Head of the Physics Department, wanted to help with the trial of the units. He has many years of experience in the teaching of the A-level Physics syllabus. As far as Maths, Physics and Chemistry are concerned, the students' background and interests were as follows:

<table>
<thead>
<tr>
<th>Subject</th>
<th>Passed ('O' level)</th>
<th>Doing (A'level)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maths</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>Physics</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Chemistry</td>
<td>9</td>
<td>9</td>
</tr>
</tbody>
</table>

Table 6.27

Ten of the 12 students wanted to go to University.

a - How the students worked

There were really two groups working in the classroom, one of 3 students and the other of 6 students. The other student was working alone.

A diagram of how the students were distributed is below:

Figure 6.28
Students at table 1 did not work as a group, they worked at a different pace and did not interact with each other. In short, they were just sitting at the same table. The student No. 3 was the kind of student who needed to frequently check what he was doing and he used to do this with students No. 7 and No. 8, who were defined as the best students by student No. 3, but as "hard workers" by the teacher. While student No. 2 was the kind of student who likes to work by himself, he showed confidence in what he was doing.

Table 2 was formed by the less motivated group of students; they were always behind in their work with the unit because they used to talk and play about most of the time. They worked in a collaborative way, but not at the same pace. Student No. 4 was the leader in this group and used to answer the questions before the other two in the group.

The students on Table 3 and 4 formed the group of the most motivated and most able students: they worked in parallel, interacting only within the group and with the teacher when they had problems with the questions.

The teacher was sometimes in, and sometimes out of the Lab. and when he was in he interacted with the students. He never read or marked in the Lab.; when he saw that everybody was busy he used to go out, and sometimes the less motivated students cheated the teacher by simulating that they were working. This was known by all the students and they used to say that:

"It is better if you have a teacher standing at the blackboard ... if you have got a teacher over there then you learn more ... because some people don't work, just sit around, talk and do what they like ... some people, they want to learn but if they haven't got the teacher to teach them they maybe can't." (student)
When two or three students asked the same question of the teacher, he tended to call the attention of the whole class and explain the point to everybody. The students said that they did not like that because they were sometimes ahead or behind of the explanation and it interrupted their work, i.e. they were not interested in what the teacher was explaining.

The teacher usually marked some questions orally or when the students were working on them. The students did not hand in the questions for written marking.

"To find out if they fully understand what they are doing, I think one needs to do a certain amount of searching questions ... so one needs to look rather closely, or question rather closely ... to make sure they have understood." (teacher)

b - Interactions

To study the S — T interactions the groups had to be divided according to the table at which they were sitting.

Table 1 very seldom asked the teacher
Table 2 never asked the teacher
Table 3 and
Table 4 always asked the teacher.

The S — T interactions were as follows:

<table>
<thead>
<tr>
<th>S — T interactions</th>
<th>Explaining</th>
<th>telling what to do</th>
<th>telling that he is right</th>
<th>asking some questions</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>asking what to do</td>
<td></td>
<td>10%</td>
<td></td>
<td></td>
<td>10%</td>
</tr>
<tr>
<td>explanation of a point</td>
<td>48%</td>
<td></td>
<td></td>
<td></td>
<td>52%</td>
</tr>
<tr>
<td>seeking conceptual understanding</td>
<td>23%</td>
<td>4%</td>
<td>9%</td>
<td></td>
<td>38%</td>
</tr>
<tr>
<td>Total</td>
<td>71%</td>
<td>14%</td>
<td>9%</td>
<td>4%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 6.29
Most of the S — T interactions were done by the students of tables 3 and 4.

The T — S interactions were with those students who did not seek to interact with the teacher, or did it very seldom, and these were divided as follows:

"To check the questions" 58%
"To see what is happening" 27%
"To give conceptual understanding" 5%

Most of these interactions were with the students of Table 2 and the students No. 2 and No. 1. The teacher tried to achieve a balance in the interactions, i.e. he went to those students who did not come to him. However whilst the teacher was found to be helpful by some students - because he explained matters - others found him unhelpful - like a supervisor in a factory, just checking whether they are doing their work or not. The S — S interactions were generally amongst the students of the same group, with some exceptions.

c - Lab. work and the A.V.A.

It was not compulsory to do the experiments although the students were in the Lab. all of the time. The teacher suggested that students do the experiments on Friday afternoons but two students used to do them any day at any time. The Friday afternoon sessions were, for some students, a waste of time. They did the experiments in a circus, which means that most of the students were doing experiments which were not related to what they were doing in the unit. Since the teacher did not do the experiments beforehand, the students complained that the teacher could not help them either in setting up the experiments or interpreting them.

"If the experiment you are doing is new for everybody, it is certain that you won't finish it, or the teacher can't help you to interpret the result you've got." (student)
The students did not use any A.V.A., but every fortnight the teacher showed them a film about engineering.

d - General reactions

1. The most motivated students were satisfied in general with their work whereas the less motivated students did not like to learn by themselves.

"We were told it was an additional thing. If we like it we keep it, but we said we didn't like it, and we still keep it." (student)

"It is pretty good, but it is difficult if you don't have the teacher to start you off." (student)

2. The teacher was satisfied with the work because the result of the test showed better marks than last year's.

"We have given the multiple choice test, and looking through those, we are pretty happy about that at this stage." (teacher)

3. Some students complained that, owing to the fact that the teachers went out often, they were allowed to talk and not made to work.

4. For some students their notes were the answers to the questions and for others they were a summary of the books. The students did not keep the units.

"It is really difficult to cut down because you don't know really what is important and what isn't."

"The main problem is what to put down and what to leave out".

5. For most of the students the experiments were not helpful due to the lack of organisation and time.
6.4 Conclusions

The work I have reported here reflects a particular image of the classroom, it presents an objective description of five classrooms using A.P.P.I.L. material. I see classrooms as social settings of considerable complexity and never predictable. The data collected for each classroom follow the same pattern but at the same time each classroom offered something different and fresh. Now I have to consider the problem of how far individual classrooms using individualised learning material are at the same time both similar and yet different.

The general aspects found in the five classrooms presented here are:

- The use of individualised learning requires that the teacher believes in what he is doing. Lack of confidence in the material or in the approach is transmitted to the student, who could react by rejecting the approach.

- For a teacher who wants to use individualised learning it is not enough to know the Physics presented in the material. The teacher, among other things, has to be thoroughly familiar with the way the content is presented in the units, and should be aware of the type of problems likely to be faced by all participants concerned.

- Teachers' and students' new role in the classroom should be stated very clearly at the beginning and at the same time be accepted by all the participants.

- The interactions between two students, between teacher and student and between student and teacher play an important role in the use of individualised learning material (In the next chapter I present a detailed analysis of the interactions in these classrooms).
- It seems that A.P.P.I.L. material represents a solution for the London Schools as far as administrative problems are concerned. The different administrative changes that may occur in the schools do not affect directly the 'A' level course, as far as Physics content is concerned if the schools use A.P.P.I.L. material, e.g. the teachers in the small class, L VIth and U VIth together and in the school sharing a class left the school at the end of the academic year 1977-78, these did not affect the students as they continued working with the material, and the new teacher could very easily know what material the students have been studying.
CHAPTER VII

Interactions in individualised Learning Classrooms

7.1 Introduction

7.2 One-to-one interactions

7.3 Teacher-student interactions

7.4 Student-student interactions

7.5 Conclusions
7.1 Introduction

This thesis has moved from a study of the use of the terminology around the idea of individualised learning (Chapter IV), through an analysis of the changes in the behavioural role of the teacher and the students' perception of the teacher (Chapter V), to the presentation of five case studies on the use of individualised learning in the classroom (Chapter VI). In this chapter I shall look more closely at the combination of these elements, I shall analyse the interactions which take place in an individualised learning classroom, and consider the reasons for such interactions.

This analysis was based on the interactions that occurred in the classes where the case studies took place, in Hargreaves' model of the process of interactions, (Hargreaves 1972) and in Bales matrix of "who speaks to whom". (Bales 1970).

7.2 One-to-one interactions

It was shown in section 2.5 that a full understanding of dyadic interaction between teacher and student in an individualised learning classroom requires the study of the context in which the interaction takes place. As I mentioned earlier, the use of individualised learning material offers the teacher the opportunity to interact with individual students. On the other hand, it also offers the students the opportunity to interact amongst themselves within the classroom and on the subject being studied.

The data used in the analysis presented here was collected by a variety of instruments: Participant Observation data (with formal and informal interviews) (see section 3.2.1.2.) offered me sensitive information and an account of social reality. Since the main aim of this analysis is to focus the one-to-one interactions, data was gathered by means of an interaction guide (see section 3.2.2.) This guide was addressed only to dyadic contact between teacher and an individual student and between two students. All teacher behaviour directed to the class as a group was ignored, and all student interactions not concerned with the subject matter were ignored.
(see section 1.4). The type of dyadic interaction coded included those initiated by the teacher, those initiated by the students, and the kind of responses that the teacher made to individual students. The guide assumes that students and teachers entered into interactions with a clear set of goals, as opposed to being without any purpose or objective, i.e. teacher and students have some definitive notion of what they want to get from a particular interaction. This was demonstrated also by Newjahr (1976) when he concluded that in individualised learning the students have considerable responsibility in initiating interactions.

The analysis also required a study of the participants' underlying perception of each other and how they perceived their group. The Kelly Repertory Grid technique (see section 3.2.3.) was used with the students in order to get information on how individuals saw themselves and those around them who, in some way, interacted with them in the classroom; and also with the teacher, in order to see how the teacher saw the changes in role he/she had to make according to needs, background and personality.

7.3 Teacher and Student interactions

The teachers and students used in this study belonged to typical classes and schools of the London area (see section 6.3) using individualised learning material developed by the Inner London Education Authority (see section 6.2). For simplicity I have called the classes as follows:

"Small Class" = S.C.
"Large Class" = L.C.
"Class with two teachers" = T.T.
"School sharing a class" = S.S.C.
"Class with L V1th & U V1th together" = L+U.
To present the study of the T → S and S → T interactions, I shall firstly give the end product, i.e. the interactions that occurred in each classroom, and then give an analysis of the ways in which teachers and students defined the situation in reaching a working consensus. I think that, after identifying the different types of interactions that took place between teacher and students, it is possible to study the different elements that influenced them to interact in such a manner.

The proportion of the interactions T → S and S → T are shown in Figure 7.3.1. This graph suggests that in general in individualised learning students initiate more interactions with the teacher than the converse. (Number of S → T > Number of T → S). But to be able to understand why in "S.C." the students initiated all the interactions whereas in the "S.S.C." it was the opposite, it is necessary to look at all those elements which influence in the teacher-student interactions.

What follows is the identification and discussion of all these elements:

A - Reasons for using the material:

Each teacher had a different reason for using the A.P.P.I.L. material, ranging from: "imposition by the Head of Science" to "willing to give feedback on the units to the project team". Due to this each teacher interpreted the A.P.P.I.L. material differently. For example, the teacher in the "L+V class" thought that the use of the unit was the solution to his particular problem (how to teach two groups at different levels together). Although he did not agree with the A.P.P.I.L. approach of teaching (i.e. no class teaching, students working on their own), he found that it was the best way of teaching the L VIth and U VIth together and as a consequence of this he encouraged group work.
Teacher and Students' initiation of interactions

% of total interactions

T → S

S → T

% of total interactions

SSC

L + U

LC

TT

SC = Small Class
LC = Large Class
TT = Class with Two Teachers
SSC = School Sharing a Class
L + U = Class with LVith. and UVith. together

Figure 7.3.1.
"We have to teach upper and lower sixth together, A.P.P.I.L. provides a programme which keeps pupils busy while I discuss work with the other groups ... I have yet to be convinced that this is a successful substitute for having adequate time to lecture separate groups." (teacher).

B - Teacher experience:

The experience the teacher had in teaching and the period of time he had in the particular school influenced the way the teacher interacted with the students. For example the "S.C." and "L+U" teachers who were in their first year of teaching had a different attitude in their interactions with the students.

"When I get a question ... I do try to go into a bit more detail ... so I go round about it... and I so fill out of it ... just to get contact with them really..." (teacher)

compared with the "L.C." and "S.S.C." who had many years of experience in teaching 'A' level Physics

"What I tried to do is ... more or less ... summarise what the question is about." (teacher L.C.)

C - Interpretation of the term "Independent Learning"

As it was shown in Chapter IV, teachers differ in their interpretation of the term "independent learning". The teachers of the case studies are an example of that. For example, the "S.S.C." teacher interpreted the term as each student had to work independently, no need to direct the students, and workgroup and class discussion were not allowed.
"There is a problem with the way it is independent so much ... because the girls in my school are used to working together in science and now ... they come to the VIth form and they have to do two things they are not used to do ... first of all is work not collectively and ... secondly to work on their own.

(S.S.C. teacher)

D - Teacher's perception of his/her role in individualised learning

It is quite difficult for teachers who are starting to use individualised learning material to have a clear idea of their role in the way of teaching. Although the common role for all these five teachers was "to control what has been learned on an individual basis", the way they performed this "control" varied from teacher to teacher. For example, the teachers involved in "class with two teachers" gave opposite interpretations of control one to another; whereas one of them took care that the students were doing the questions correctly, checking the content,

"I insist on it (to do the questions)...
I check the questions through, it takes a long time to check them through ..." (Teacher A)

the other made sure that all the students were working at any time,

"I tried to force them to do the questions, but ... I haven't got the time to supervise them..." (Teacher B).

E - Students' perception of the new role of the teacher

From the students' viewpoint, the personal characteristics of the teacher play an important part in the interaction student-teacher (see section 5.3), but at the same time, what the student thinks the teacher should do in the classroom is an important element of the interaction. In general terms the students said that the teacher should explain the relevant points of the units and interchange ideas through discussions of what has been learned.
"He (the teacher) should make sure that we understand the relevant points of the unit" (student T.T.)

"We should discuss the unit with the teacher" (student L.C.)

F - Teachers' perception of the students

Although it was not possible to determine any common characteristics of those students with whom the teacher interacted more or for a longer time, it was very clear that each teacher behaved differently with different students. One of the most critical cases was the S.S.C. teacher.

"I taught W... and R.... before, they are very conscientious girls ... so we do know each other well ... while with T... and A... I haven't taught them ... so we actually have to get to know each other ... which is always difficult, you don't know how they are going to react." (S.S.C. teacher)

G - The rules of the classroom

Although all five teachers were using the material in a similar manner (the teacher being passive in terms of communication of information and the students being active in terms of looking for the information), each teacher had established different rules in the classroom. For example the S.C. teacher started the lesson by asking what difficulty the students had in their work at home and discussing these, the S.S.C. insisted on strictly individual work and no consultation, whereas the I+U encouraged group work.

H - Students' style of work

It was found that students tended to work in groups or at least to keep the same pace amongst themselves. Two styles of work were identified:
'Work done in parallel' when a group of students were working at the same concept at the same time, but without consulting each other. Each one worked on his/her own but all of them at the same pace.

'Work done collaboratively' when a group of students were mutually checking the questions immediately, or even before they had finished them.

Having summarized the elements which influenced the initiation of interaction between teacher and students when using individualised learning approaches, I shall now analyse how these elements interact one with another for the initiation of a student or teacher interaction.

According to Hargreaves (1972) the behaviour interaction of a person (who he calls "Person") towards other person (who he calls "Other") is determined by two elements:

"...the first concerns his roles and goals which are influenced by his role-set and by his personality needs and background, and the second element is his conception of "other" and his conception of "Other's" conception of him. These two elements influence one another and both contribute to "Person's" definition of the situation." (pg. 120)

Applying these ideas to the initiation of an interaction by the students involved in the case studies, one can see that the two elements were:

1) The aim or objective of the interaction, i.e. there was a clear intention for going to the teacher. The aim depended on the student's interpretation of his/her role, experience and personality,

and

2) Student's perception of the teacher, which depended on student's interpretation of the term individualised learning and student's perception of the teacher's role.
e.g. "When I can't do a question ... I look through my reference books, first... you have to try to do it first (student interpretation of his role) then I ask my friends ... because if I could not do something that I should be able to do, and my friends have been able to do ... (student experience and personality) it could be a silly misunderstanding of mine so there is no point in going to the teacher... (student interpretation of independent learning), but if none of us can do it, ... it's obviously something that we did not understand and the teacher should explain it (student perception of the teacher's role)."

(student from L+V)

Furthermore Hargreaves (1972) established that:

"Once formed, the definition of the situation arouses self-presentation techniques which need to be employed to translate "Person's" definition of the situation into actual behaviour towards "other" which is also conditioned by social norms, situational proprieties games, etc." (pg. 120)

As soon as the definition of the interaction emerged students communicated to the teacher the intention of the interaction. This communication was influenced by the student's style of work and by rules of the classroom, e.g. in the case mentioned before the student decided to ask the teacher alone because he worked in parallel (student style of work)

"We work alone but we try to work at the same pace ... so we can help each other." (student from L+U)

and the way the teacher arranged the interactions made the student know when to ask the teacher. (rules of the classroom)
### Figure 7.2.2.

<table>
<thead>
<tr>
<th>L1</th>
<th>L2</th>
<th>L3</th>
<th>L4</th>
<th>L5</th>
<th>L6</th>
<th>L7</th>
<th>L8</th>
<th>L9</th>
<th>L10</th>
<th>L11</th>
<th>L12</th>
</tr>
</thead>
<tbody>
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</tr>
</tbody>
</table>

#### Student's reasons for initiating an interaction with the teacher in A.P.P.I.L. classrooms.

- Student's style of work
- Definition of the interaction
- Perceptions of the teacher's role
- Interpretation of his role
- Perception of the student's role
- Rules of the classroom
- School's rules and regulations
- Student's competence and personality
- Student's aims for the interaction
- Student's interpretation of interactions

---

**Model of student initiation of interactions in an individualised learning classroom.**
"If they can't do something ... like a D.Q. (Development Question)... they are supposed to ask me... I mark all the questions ... although it depends ... If I am with the U VIth they have to wait or ask the others ... but most of the time I am available." (teacher I+U)

Figure 7.3.2. shows a diagram of how the different elements interact one with another for the initiation of a student interaction, and the % distribution of the different ways a student initiated an interaction with the teacher in each classroom studied and the manner of response the teacher gave (a definition of each term is in section (3.3.2). As far as responses are concerned, Hargreaves pointed out that

"When 'Person' behaves towards 'Other' in a given way he gets feedback on the effect of his behaviour on 'Other' which may cause 'Person' to modify his roles and goals..." (pg. 120)

Looking at the reason for initiation of an interaction and the responses that teachers gave, it can be seen that there was a good balance between the reasons for initiation of the interaction and the kind of response the teacher made, i.e. if the student went "to seek explanation" the teacher answered by "explaining". This means that in most of the cases the student and the teacher reached a working consensus, and no modification was needed.

"...well ... sometimes he started by asking some questions to see if I can get it myself ... The questions are in such a way that I maybe can see the answer and ... sometimes he just explains what I don't understand." (student S.C.)

"I ask them questions, to feed more information ... perhaps it takes 5 minutes to answer a simple question ... there is no yes or no answers ... or the formula is such and such..." (S.C. teacher).
On those occasions when the students initiated the interaction "to seek understanding" and the teacher answered by "explaining", i.e. they did not reach a working consensus, the students showed modification in their goals and therefore dissatisfaction.

"I prefer to ask the others because you can interchange ideas." (student T.T.)

"The teacher confuses you more." (L.C. student)

It should be made clear that not all the students interacted with the teacher the same number of times, and also that in some classes there were students who never initiated an interaction with the teacher. There were many reasons why students did not and no two of them have common characteristics (see Chapter VI for details of the interactions by individuals.) All the teachers were aware of this situation and they tried to strike a balance between the interactions, by interacting more with those students who never asked for the teacher's help (see Chapter VI).

As in the case of the students, the teacher's initiation of an interaction is determined by two elements,

1) The teacher's aim for the interaction, i.e. the teacher went to the student with one specific intention. This aim was affected by his/her interpretation of role, experience and personality,

and

2) The teacher's perception of the student which is affected by the teacher's perception of the student's role and the interpretation of the term independent learning, e.g.

"Usually the L VIth come to me, ... (Teacher's perception of the student). I go back to them during practical work ... actually they sort the apparatus out ... (Teacher's interpretation of independent learning) but I keep an eye ... then I go over (Teacher's interpretation of his role). I ask what the experiment is about, what is the purpose of it, what is the apparatus for ... that sort of thing. (teacher's aim of the interaction) ... With the U VIth
I'm going more frequently to them rather than just waiting for them to come to me... (teacher's perception of the students) ... I have actually been putting in more questions ... I did not quite know how well they were doing ... (teacher's personality and experience). You know you can copy out questions and answers and not understand them ... so I go to them every time ... I feel it is time (teacher's interpretation of his role.) (L+U teacher)

The teacher's communication of the interaction is also influenced by the student's style of work and the rules of the classroom, e.g. In the example shown above the L VIth students were working in parallel, whereas the U VIth students worked collaboratively (student style of work). The teacher, with no intention, fixed the norm of going to the U VIth students and expected the L VIth to come to him (rules of the classroom). Figure 7.3.3.A shows the different elements which influence the teacher's initiation of an interaction, and Table 7.3.3.B presents the different reasons that the teacher had for initiating interactions with a student. In many cases the teacher approached a particular student but then communicated with the group, especially in those cases where the teacher initiated the interaction "to give conceptual understanding."

In most cases students and teachers reached a working consensus, i.e. teachers fulfilled the students' demands, and vice versa. But on those occasions when the consensus about the definition of the situation was poor there was a conflict often ending by the withdrawal of the student in the cases in which he/she had initiated the interaction.

This analysis, presented here, has illustrated that one-to-one interactions in individualised learning are concerned with the social structure rather than with the material used. On the other hand it has shown that in individualised learning classrooms, the student has the opportunity to decide whether to consult the teacher or other students. The difference of power between teacher and student decreases.
Teacher’s reasons for initiating an interaction with individual students in A.P.P.I.L. classrooms.

Figure 7.3.3.
Although the teacher's power is still present, being an adult, an expert in the subject, the traditional and legal authority, the student has now the greater opportunity to define the situation according to his/her own aims. The interaction is still "asymmetrically contingent" (i.e. the behaviour of one of the persons in the interaction depends on the behaviour of the other person) but in this case it is not exclusively from the teacher's point of view (as appears in the traditional classroom) but from the student's point of view. The student decides the aims or intention of the interaction, he is now in the position to profit more greatly from interactions and, to some extent, to exploit the teacher at will.

7.4 Student-student interactions

As was noted before, the A.P.P.I.L. students tended to work in groups and therefore the interactions between students in the classroom tended to be within the "group for work".

The groups used in the study, presented here, represent typical VIth form classes of the London area. These classes are the ones used in the case studies with the exception of the "Large Class" because it was impossible to follow the interactions of each student. The sex and social-economical differences which could influence the interactions, among these groups, were reduced by considering only the interactions concerned with the work the students were doing in Physics.

The elements which characterized the definition of the situation in the students' interactions were very much related to the conditions under which the groups were formed. The group culture (value, beliefs and norms) determined the style of work, i.e. if the students worked in parallel or collaboratively. Background of the students and present interests were also elements which defined the groups especially in "Large Classes" (more than 6 students). To study the interactions between the students within each group it was necessary to look at the dynamics of the informal structure of the group concerning "the differential ranking of the members according to the degree to which members are valued by the Group" (Hargreaves 1972).
The analysis of the factors which influenced the interaction of each group is in Chapter VI).

In order to compare the pattern of interaction among the groups the 'interaction matrix who speaks to whom' and the outcome of the Rep. grid of the students were compared.

The interaction matrix (Bales 1970) is a useful method to analyse the interactions in small groups. It consists of arranging the data of 'who speaks to whom in the group' in a tabulation form like that shown in Figure 7.4.1. Along the vertical axis the numbers assigned to all students in the group are arranged in any order. Then the same numbers in the same order are arranged in the horizontal axis. The scores of the initiation of each interaction is recorded in the appropriate cell, left to right, in percentage. In order to compare the matrices the members of each group were ordered according to their total initiated, i.e. the member with the highest number of interactions initiated in each matrix is indicated in row 1 and so on (see Figure 7.4.3.)

Figures 7.4.1, 7.4.2, 7.4.3, and 7.4.4., show the interaction matrix and the students' perception of the group in terms of 'of whom each individual asks most about Physics' and 'who asks each individual most about Physics.' From these figures the following conclusion can be drawn about the interactions in these groups.

1) The interaction matrixes show that in most of the cases the 'Top Participant' (the student who initiates most interactions) receives fewer interactions than he addressed to the different members of the group. (number of I.I.<I.R. for row one in each matrix). This seems to imply that in these groups the Top Participant does not exercise as much power or influence in the group as he/she did not receive the same attention she/he gave.
Interactions in "Small Class"

<table>
<thead>
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<th>Students Nrs.</th>
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<th>2</th>
<th>4</th>
<th>3</th>
<th>I.I.</th>
</tr>
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<td></td>
<td>7%</td>
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<td>12%</td>
<td>2%</td>
<td>7%</td>
<td></td>
<td>13%</td>
</tr>
<tr>
<td>I.R</td>
<td>20%</td>
<td>12%</td>
<td>55%</td>
<td>13%</td>
<td>100%</td>
</tr>
</tbody>
</table>

I.I = Interactions Initiated
I.R = Interactions Received

Whom do you ask most about Physics?
Who asks you most about Physics?

Figure 7.4.1.
Interactions in "School Sharing a Class"

<table>
<thead>
<tr>
<th>Students Nrs.</th>
<th>1</th>
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<th>2</th>
<th>4</th>
<th>I.R</th>
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<td>I.R</td>
<td>14%</td>
<td>28%</td>
<td>28%</td>
<td>30%</td>
<td>100%</td>
</tr>
</tbody>
</table>

I.I  = Interactions Initiated  
I.R = Interactions Received

Whom do you ask most about Physics?  
Who asks you most about Physics?

Figure 7.4.2.
Interactions in "L V?th and U V?th together"

Who do you ask most about Physics?

Who asks you most about Physics?

Figure 7.4.3.
Interactions in "class with Two Teachers"

<table>
<thead>
<tr>
<th>Students Nrs</th>
<th>G1 2</th>
<th>G1 3</th>
<th>G1 5</th>
<th>G2 7</th>
<th>G2 4</th>
<th>G2 8</th>
<th>G2 6</th>
<th>I.I</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>2%</td>
<td>5%</td>
<td>15%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>22%</td>
</tr>
<tr>
<td>1</td>
<td>5%</td>
<td>6%</td>
<td>9%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>21%</td>
</tr>
<tr>
<td>3</td>
<td>4%</td>
<td>2%</td>
<td>6%</td>
<td>1%</td>
<td></td>
<td></td>
<td></td>
<td>13%</td>
</tr>
<tr>
<td>5</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3%</td>
</tr>
<tr>
<td>7</td>
<td>2%</td>
<td>1%</td>
<td></td>
<td>3%</td>
<td>9%</td>
<td></td>
<td></td>
<td>15%</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td>7%</td>
<td>4%</td>
<td>2%</td>
<td></td>
<td>14%</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td>1%</td>
<td>1%</td>
<td>2%</td>
<td></td>
<td>4%</td>
</tr>
<tr>
<td>6</td>
<td>3%</td>
<td>2%</td>
<td>2%</td>
<td>1%</td>
<td></td>
<td></td>
<td></td>
<td>8%</td>
</tr>
<tr>
<td>I.R</td>
<td>13%</td>
<td>7%</td>
<td>18%</td>
<td>40%</td>
<td>7%</td>
<td>3%</td>
<td>12%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Whom do you ask most about Physics?

Who asks you most about Physics?

Figure 7.4.4.
2) In some of the diagrams it can be seen that one student is perceived by the group to be the one that all the students ask about Physics and one student who asks most about Physics, e.g. students 1 and 4 in Figure 7.4.1, students 2 and 4 in Figure 7.4.3, and students 3 and 2 and 8 and 4 in Figure 7.4.4.

3) Comparing the interaction matrix and the diagrams it can be noted that in some cases the student who was the most important in the group according to the interaction received was found to be the most consulted according to the diagrams, i.e. status received coincided with status expectations. (e.g. 7.4.2, 7.4.3, 7.4.4,G2) On the other hand in two groups the status received was in potential contrast in the status expectation of the group, i.e. the student who was the most important in the group according to the interactions received was not the most consulted by the group in the diagrams, (e.g. Figures 7.4.1 and 7.4.4.G1). This seems to imply that 'who speaks to whom in the group' is a fact which represents a real situation, a necessity, but not the students' expectations or ideal.

4) Bearing in mind what was said in 1, 2, and 3, it would appear that the "Top Receiver" (the student who receives more interactions in the group) exercises some power or influence in the group. He/she had the ability to attract the attention of the others as he/she receives most of the interactions. It seems that the "Resource status" (how much each member of the group can contribute to the group) is more important than the "social status" (how frequently a member initiates an interaction).

Usually the Top Receiver was the student who worked hardest, therefore he had already done the work, he/she was willing to help the others. In some cases this student coincided with the most able student of the group.

The different reasons why the students initiated an interaction in the group are given in Figure 7.4.5.
### Student-Student Interactions

<table>
<thead>
<tr>
<th>s---s</th>
<th>Small Class</th>
<th>Sharing a class</th>
<th>Two Teachers</th>
<th>L VIth</th>
<th>U VIth</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>To check the questions</td>
<td>45%</td>
<td>31%</td>
<td>56%</td>
<td>50%</td>
<td>21%</td>
<td>18%</td>
</tr>
<tr>
<td>Seeking conceptual understanding</td>
<td>40%</td>
<td>42%</td>
<td>35%</td>
<td>49%</td>
<td>58%</td>
<td>41%</td>
</tr>
<tr>
<td>Explanation of a point</td>
<td>15%</td>
<td>27%</td>
<td>9%</td>
<td>1%</td>
<td>21%</td>
<td>41%</td>
</tr>
</tbody>
</table>

Figure 7.4.5.

It can be seen that those groups where one student was perceived to be the most consulted in the diagrams, interacted more by "checking the questions", (e.g. Fig. 7.4.1, 7.4.3.a, 7.4.4.). These groups also worked in parallel, i.e. each student doing his/her work at the same pace but individually.

### 7.5 Conclusions

One-to-one interactions are a dynamic process; they are a process of reciprocal influence and mutual dependence. The use of individualised learning in Physics classrooms implies a change in the student and teacher pattern of behaviour and a change in their expectations of the role-partner. The strong "teacher-to-student group" interactions, which exist in "traditional teaching" situations, have to be replaced by "Teacher-to individual student" or "individual -student to teacher" interactions.

One of the problems faced in implementing individualised learning approaches in the Physics classroom deals with the lack of orientation given to teachers and students about the one-to-one interactions.

"I feel helpless ... I don't quite know what to do ... I am not sure where I fit in." (A.P.P.I.L. teacher)
This chapter has aimed to present how students and teachers using A.P.P.I.L. material initiate interactions in the classroom. It did not aim to discuss what is good or what is wrong in a dyadic interaction but to present the interactions which took place and study them according to the structure of the situation.

The analysis presented suggests that the initiation of interactions in individualised learning classrooms depend on factors related to the individuals themselves and the classroom environment rather than the material used. Interactions between teacher and student are strongly related to how teachers and students interpreted their roles and the "other" role in the approach used, also the students' style of work and the teacher's regulations in the classroom influence the initiation of interactions. The use of individualised learning material implies that the teacher decreases the power he used to have in the interactions. Students are now in the position of initiating an interaction according to their aims and need and taking benefit from it. On the other hand interactions between students are related to the "resource status" that each student could have in the group.
CHAPTER VIII

The role of laboratory work in Individualised Learning

8.1 Introduction

8.2 A.P.P.I.L. and CAMOL I.L. Lab. work

2.1 Students' and Teachers' attitudes towards lab. work

2.2 Difficulties encountered in doing experiments

2.3 A.V.A. and lab. work

8.3 Students' and Teachers' opinions of the role of lab. work in individualised learning

3.1 Aims of lab. work

3.2 Types of lab. work

8.4 Conclusions
8.1 Introduction

Since the beginning of this century, the emphasis on lab. work as done by students has been becoming stronger. (Jenkins 1979) Lab. work has been accepted by teachers, researchers, psychologists and educationalists as an essential element in Physics teaching. Despite being considered expensive in time and equipment, various reasons have been given to justify its use. Lab. work has been used in the different approaches to individualised learning in Physics, in most of the cases as one more activity that students have to do themselves.

This chapter is concerned with the reasons given for doing lab. work in Physics courses taught at VIth form level in two different approaches to individualised learning. It includes the students' opinions about how the lab. work activity has helped them to take the course; the teachers' opinions about the role of lab. work in each of these approaches and an ideal approach to individualised learning.

8.2 A.P.P.I.L. and CAMOL I.L. Lab. work

In order to find out the role of the lab. work in courses taught through individualised learning material, two different approaches were selected: Advanced Physics Project for Independent Learning (A.P.P.I.L.) and CAMOL Independent Learning (CAMOL I.L.)

These two approaches had different views about the lab. work. The A.P.P.I.L. considered that "experimental work is an integral element of the units" (A.P.P.I.L. Teachers' Handbook) and suggests that where possible "all the lessons should take place in a laboratory, preferably the same one". (A.P.P.I.L. Teacher's Handbook), CAMOL I.L. considered lab. work as one more activity to do:

"The main learning activities are organised into units which may involve experiments, reading, solving problems or using audio-visual material." (Brown 1976)
It should be borne in mind that CAMOL I.L. students take the Northern Ireland Physics 'A' level examination which does not include a practical paper. Information about the lab. work in these two approaches was gathered during the summer term 1978 by means of two questionnaires - one for teachers and one for students - which have been designed in the light of previous work (see Chapter III for details). The student questionnaire was administered in twelve A.P.P.I.L. schools (107 students), and to 50 students of the CAMOL I.L. students by personal visits. The teachers' questionnaire was administered to all the teachers involved in A.P.P.I.L. and CAMOL I.L. (36 and 7 respectively) for the academic year 1977-78. This was done by post and by personal visits.

A breakdown on the students who took the questionnaire is shown below:

A.P.P.I.L. Students (107)

<table>
<thead>
<tr>
<th>Type of school</th>
<th>Year</th>
<th>Sex</th>
</tr>
</thead>
<tbody>
<tr>
<td>C = 49%</td>
<td>L VI</td>
<td>F 31%</td>
</tr>
<tr>
<td>G = 51%</td>
<td>U VI</td>
<td>M 69%</td>
</tr>
</tbody>
</table>

CAMOL I.L. Students (50)

<table>
<thead>
<tr>
<th>Type of school</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>G = 100%</td>
<td>U VI 100%</td>
</tr>
</tbody>
</table>

Note C = Comprehensive School  ex grammar school - ('A' level courses)  (no tradition of )
G = Grammar School    ) secondary modern comprehensive school - ('A' level courses)  (tradition of )

A breakdown on the teachers who answered the questionnaire is as follows:

A.P.P.I.L. Teachers (32)
One year's experience using A.P.P.I.L. 35%
Two year's experience using A.P.P.I.L. 65% 39% C 26% G

CAMOL I.L. (7)
5 of the teachers were in their second year using CAMOL I.L.
and the other two have been involved for 4 years in individualised learning.
8.2.1. Students' and Teachers' attitudes towards the lab. work

During my schools visits I found that the VIth form students were not enthusiastic about doing experiments when using individualised learning material.

"The lab. work is not so interesting." (CAMOL I.L. student)

"We spend a long time to make an experiment work ... we understand the instructions ... it's just that we cannot do it". (A.P.P.I.L. student)

"They are not difficult, we just don't like experiments." (A.P.P.I.L. student)

"The experiments ... I don't think they help you." (CAMOL I.L. student)

"We haven't done some of the experiments because we haven't got the material." (A.P.P.I.L. student)

This would appear to be understandable for the students using CAMOL I.L., because they do not take a practical examination in Physics and also because lab. work is not considered by the CAMOL I.L. material as an integral element of the course (Brown 1978). But for the A.P.P.I.L. students the situation is completely different, as they did have to take a practical examination, and the A.P.P.I.L. material considers lab. work a very important element in the course. For this reason an attitude scale was included in the questionnaire with the purpose of finding out those elements which influence the students' and teachers' attitudes towards lab. work when using an individualised learning approach.

The attitude scale was of the rating type and consisted of ten items based on the different reasons given by teachers and students for doing or not doing lab. work in Physics. (see section 3.2.4.1.). This attitude scale allowed a possible range of scores
from 10 to 50 with 30 representing the mid-point between a positive and negative attitude towards lab. work.

I should point out here that equal distances on the scale of scores are not equivalent to equal differences in the attitude and that the only thing that could be assumed about two attitude scores was that the higher scores would represent a generally more favourable attitude. (Oppenheim 1968).

Students' and teachers' distribution of the scores is shown in Figure 8.2.1. As the attitude scale is an ordinal scale, (i.e. the successive intervals on the scale are not equal), non-parametric methods were used to compare the groups. A comparison of the different groups (A.P.P.I.L. and CAMOL I.L. students and teachers) was carried out by means of the Mann-Whitney U test (Siegel 1956). The results are given in Table 8.2.2.

<table>
<thead>
<tr>
<th>Difference in groups</th>
<th>Z (Observable value)</th>
<th>p (critical value)</th>
<th>Significance at 0.01</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAMOL I.L. and A.P.P.I.L. Teachers'</td>
<td>0.17</td>
<td>0.4168</td>
<td>none</td>
</tr>
<tr>
<td>CAMOL I.L. Teachers and Students</td>
<td>1.50</td>
<td>0.0625</td>
<td>none</td>
</tr>
<tr>
<td>CAMOL I.L. and A.P.P.I.L. Students</td>
<td>7.55</td>
<td>0.0003</td>
<td>yes</td>
</tr>
<tr>
<td>A.P.P.I.L. Teachers and Students</td>
<td>8.11</td>
<td>0.0003</td>
<td>yes</td>
</tr>
</tbody>
</table>

Table 8.2.2.

It can be seen that (1) there is no significant difference (at 0.01 level of significance) between A.P.P.I.L. teachers' and CAMOL I.L. teachers' attitudes towards lab. work, and also that there was no significant difference (at 0.01 level of significance) between students and teachers using CAMOL I.L. (2) CAMOL I.L. students and A.P.P.I.L. teachers had a more positive attitude towards the lab. work than the A.P.P.I.L. students, at 0.01 level of significance. The considerable variation in A.P.P.I.L. students' attitudes led me to look at different aspects which could have had influence on their attitudes, e.g. sex of students, type of school, year of Sixth Form study.
Students and Teachers distribution of the score

A.P.P.I.L.

--- Students N = 100
----- Teachers N = 31

CAMOL
+++++ Students N = 47
▲▲▲▲ Teachers N = 7

Scores on attitude scale

Figure 8.2.1.
A comparison of the group:

female - male
comprehensive - grammar school
Lower Sixth - Upper Sixth

was carried out using the Kolmogorov-Smirnov test, (Siegel 1956). Table 8.2.3. shows the effects of differences in the A.P.P.I.L. students.

<table>
<thead>
<tr>
<th>Differences in A.P.P.I.L. Students</th>
<th>Max. diff. in Critical Value</th>
<th>Significance at 0.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex of students</td>
<td>0.099</td>
<td>0.261</td>
</tr>
<tr>
<td>L VIth and U VIth</td>
<td>0.296</td>
<td>0.268</td>
</tr>
<tr>
<td>Type of School</td>
<td>0.363</td>
<td>0.246</td>
</tr>
</tbody>
</table>

Table 8.2.3.

The general conclusion reached was that at 0.1 level of significance there were no differences in the distribution of scores according to the sex of the students but that there was a difference in the distribution according to the type of school and year of the Sixth Form study. Applying $X^2$ to Kolmogorov-Smirnov test (Siegel 1956) it was found that the L VIth students had a more positive attitude towards lab. work than the U VIth students (at the 0.1 level of significance).

Bearing in mind these results, A.P.P.I.L. teachers from Comprehensive schools were compared with A.P.P.I.L. teachers from Grammar schools and it was found that there was no significant difference between their attitudes towards lab. work, as a function in the type of school, at 0.05 level of significance ($k = 2$, critical value $k = 6$). I also compared A.P.P.I.L. teachers with one year's A.P.P.I.L. teaching experience (i.e. teachers with L VIth students) with teachers with two years experience using A.P.P.I.L. (i.e. teachers with both L VIth and U VIth students), and found that there was no significant difference in their attitudes.
at 0.05 level of significance \( k = 4 \), critical value \( k = 7 \).

Although it was found that L VIth students in Comprehensive schools showed the most positive attitude towards lab. work when using A.P.P.I.L. material, this conclusion cannot be generalised to VIth form students using an individualised learning scheme as it was also found that CAMOL I.L. students, who were U VIth students at a Grammar school, had a more positive attitude towards the lab. work than the A.P.P.I.L. students. Therefore it could only be concluded that the variables sex, type of school and year of Sixth Form study did not influence the students' attitude towards the lab. work using A.P.P.I.L. or CAMOL I.L. material at VIth form level.

As the items in the attitude scale were constructed from the students' and teachers' reasons for doing or not doing lab. work, an item analysis was carried out in order to find out the internal elements that could have influenced their attitudes. The item analysis was done by the 'short cut' method known as the 27D (Ebel 1975). Table 8.2.4. presents the agreement index and discrimination index for each item of the attitude scale according to each group of students and teachers. The agreement index expresses how much people agree with the item and the discrimination index shows how much a particular item distinguishes between those students and teachers whose overall attitude to lab. work is most favourable and those whose attitude is least favourable (Ballen 1972).

If every student or teacher of a group had marked a particular item "strongly agree", the relevant agreement index would have been 100%. When looking for differences in attitudes, such items are valueless because they only show this total agreement. In this case I was looking for those items to which the students and teachers reacted in different ways, therefore I looked at the items with a low index of agreement. On the other hand a high discriminative index implies that the item discriminated between positive and negative attitude whereas a low discriminative index (less than 0.14) implies that the item affected the group only in one way. In this case I am interested in low discrimination index items as they affect the group in one way.
Agreement and Discrimination indices to the items in the attitude scale.

<table>
<thead>
<tr>
<th>ITEMS</th>
<th>STUDENTS</th>
<th></th>
<th>TEACHERS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Agreement Index</td>
<td>Discrimination Index</td>
<td>Agreement Index</td>
<td>Discrimination Index</td>
</tr>
<tr>
<td></td>
<td>APPI</td>
<td>CAMOL</td>
<td>APPI</td>
<td>CAMOL</td>
</tr>
<tr>
<td>1</td>
<td>78</td>
<td>77</td>
<td>0.18</td>
<td>0.32</td>
</tr>
<tr>
<td>2</td>
<td>48</td>
<td>69</td>
<td>0.19</td>
<td>0.40</td>
</tr>
<tr>
<td>3</td>
<td>79</td>
<td>72</td>
<td>0.15</td>
<td>0.13</td>
</tr>
<tr>
<td>4</td>
<td>43</td>
<td>85</td>
<td>0.10</td>
<td>0.17</td>
</tr>
<tr>
<td>5</td>
<td>60</td>
<td>63</td>
<td>0.23</td>
<td>0.35</td>
</tr>
<tr>
<td>6</td>
<td>74</td>
<td>83</td>
<td>0.18</td>
<td>0.13</td>
</tr>
<tr>
<td>7</td>
<td>59</td>
<td>61</td>
<td>0.20</td>
<td>0.17</td>
</tr>
<tr>
<td>8</td>
<td>54</td>
<td>59</td>
<td>0.14</td>
<td>0.25</td>
</tr>
<tr>
<td>9</td>
<td>75</td>
<td>73</td>
<td>0.19</td>
<td>0.27</td>
</tr>
<tr>
<td>10</td>
<td>48</td>
<td>80</td>
<td>0.27</td>
<td>0.13</td>
</tr>
</tbody>
</table>

The items were:

1. Without lab. work, Physics is not Physics.
2. Teachers are compelled to teach mainly facts, so lab. work is not used.
3. Lab. work can give a student a deep appreciation of Physics.
4. Lab. work is largely a waste of time.
5. Learning Physics without lab. work is like learning to swim without water - nearly impossible.
6. Lab. work raises students' interest in Physics.
7. If you do much lab. work you cannot cover the syllabus.
8. Lab. work makes Physics very real and understandable.
9. Lab. work tends to become a cooking exercise.
10. School experiments are not related to Physics theory.

Table 8.2.4.
Looking at the Table 8.2.4, it can be seen that for A.P.P.I.L. students, items 2, 4, and 10 are the ones with low indices of agreement. This implies that these three items strongly influence the differences of attitude among the A.P.P.I.L. students.

Looking at the discrimination indices of these three items it can be seen that the discrimination index of item 4 is very low (less than 0.14). This shows that A.P.P.I.L. students react to this item in a similar way. As item 4 is related to "time" it would appear that "time" is an element that has affected the A.P.P.I.L. students' attitude towards lab. work.

For the other three groups the situation is completely different. The items with low agreement indices (lower than 0.70) have high discrimination indices.

Attention should be drawn to the fact that the circumstances surrounding the use of A.P.P.I.L. material are different from those surrounding the use of CAMOL I.L. material. In the first case - A.P.P.I.L. - it is assumed that the student has to do the lab. work as a part of the course whereas it is not so in the case of CAMOL I.L. In addition to this, A.P.P.I.L. students have to prepare for the practical exam whereas this is not so for CAMOL I.L. students.

In the next section I shall analyse the different difficulties encountered by teachers and students when doing lab. work in an individualised learning approach.

8.2.2. Difficulties encountered in doing experiments

Two open questions were included in the questionnaires with the purpose of finding out (1) the kind of difficulties students and teachers found in doing experiments when using A.P.P.I.L. and CAMOL I.L. material and (2) whether these difficulties were due to the use of individualised learning material as such.

The responses regarding the different difficulties encountered were sorted out and classified in the following areas: equipment, time, school facilities, course material, and human problems. (Table 8.2.5 gives details of each of them.)
Table 8.2.5.
Problems encountered in doing experiments when using I.L.

<table>
<thead>
<tr>
<th>Type of difficulty</th>
<th>Specification</th>
<th>APPIL Students</th>
<th>CAMOL Students</th>
<th>APPIL Teachers</th>
<th>CAMOL Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment</td>
<td>Lack of equipment</td>
<td>50%</td>
<td>12%</td>
<td>47%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Old equipment</td>
<td>2%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unfamiliarity with equipment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>Lack of time</td>
<td>53%</td>
<td>47%</td>
<td>28%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Loading of the timetable</td>
<td></td>
<td>8%</td>
<td></td>
<td>14%</td>
</tr>
<tr>
<td></td>
<td>Low work timetable fixed</td>
<td>8%</td>
<td></td>
<td>9%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lack of time for preparation</td>
<td></td>
<td></td>
<td>13%</td>
<td></td>
</tr>
<tr>
<td>School Facilities</td>
<td>Size of the class (school)</td>
<td>16%</td>
<td>12%</td>
<td>3%</td>
<td>14%</td>
</tr>
<tr>
<td></td>
<td>Lack of technical help</td>
<td>8%</td>
<td>8%</td>
<td>31%</td>
<td>14%</td>
</tr>
<tr>
<td></td>
<td>Lack of lab. facilities</td>
<td>7%</td>
<td></td>
<td>16%</td>
<td>57%</td>
</tr>
<tr>
<td>Course Material</td>
<td>Error in the material</td>
<td>6%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Too many experiments</td>
<td>4%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Length of the course</td>
<td></td>
<td>10%</td>
<td></td>
<td>14%</td>
</tr>
<tr>
<td></td>
<td>Lack of emphasis</td>
<td></td>
<td></td>
<td></td>
<td>14%</td>
</tr>
<tr>
<td>Human Problems</td>
<td>Lack of supervision</td>
<td>2%</td>
<td>12%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lack of incentive to do lab. work</td>
<td>1%</td>
<td>4%</td>
<td>3%</td>
<td>14%</td>
</tr>
<tr>
<td></td>
<td>Lack of teaching</td>
<td></td>
<td>4%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lack of organization</td>
<td>-</td>
<td>2%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Different student pace</td>
<td>1%</td>
<td>4%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shortage of teachers</td>
<td></td>
<td></td>
<td>3%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Need for constant help</td>
<td>-</td>
<td></td>
<td>3%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Change of staff</td>
<td></td>
<td></td>
<td></td>
<td>3%</td>
</tr>
</tbody>
</table>

N195                      | N107                               | N49            | N32            | N7             |
To analyse these results the following aspects were taken into account:

1) A large number of A.P.P.I.L. schools were offering Physics at 'A' level for the first time.

2) The CAMOL I.L. school was a very old well-established Grammar school, with laboratories in different buildings which were used by different classes.

3) CAMOL I.L. material does not place as much emphasis on the practical part of the course as A.P.P.I.L. material does. (Brown 1978).

From Table 8.2.6. it can be seen that:

1) Most of the students encountered difficulties related to time.

2) Teachers' opinions were strongly influenced by the three considerations mentioned earlier (school facilities, equipment and emphasis on the lab. work.

3) Teachers also found difficulties in the area called "time".

In general, it can be said that the most common difficulty encountered was related to the time it takes the student to do the theoretical part of the course. Tables 8.2.6. and 8.2.7. show the responses to the question regarding the problem of using individualised learning material in the laboratory. Teachers considered that the difficulties increased in the laboratory because they needed to organise more and to have more space facilities than usual. Most of the CAMOL I.L. students thought that the difficulties increased either because there was a lack of incentive to do the experiments, or because their working at different paces created a lack of motivation and a lack of mutual help. A.P.P.I.L. students also considered that the difficulties increased because of their working at different paces and also that written instructions were harder to understand than verbal ones.
The lab work problems increase when using I.L. because -

<table>
<thead>
<tr>
<th>Reasons given (typical response wording)</th>
<th>APPIL S's</th>
<th>CAMOL S's</th>
<th>APPIL T's</th>
<th>CAMOL T's</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written instructions more difficult than verbal</td>
<td>6%</td>
<td>10%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experiments ahead of theory</td>
<td>4%</td>
<td>8%</td>
<td>19%</td>
<td>29%</td>
</tr>
<tr>
<td>Too many experiments to test the same</td>
<td>1%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experiments are too easy</td>
<td>2%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experiments arise when S's are not in the lab.</td>
<td>3%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students tend to waste time</td>
<td>3%</td>
<td>8%</td>
<td>19%</td>
<td>29%</td>
</tr>
<tr>
<td>Different Students' pace</td>
<td>7%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure to do many things at once</td>
<td>3%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Need more teacher time in preparation</td>
<td></td>
<td></td>
<td>7%</td>
<td></td>
</tr>
<tr>
<td>Setting apparatus by themselves</td>
<td>3%</td>
<td>6%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher loses interest after explaining a point twice</td>
<td>1%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No group discussion takes place</td>
<td>1%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bad interpretation of the term I.L. by T's</td>
<td>2%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>You have to ask the teacher too many q's</td>
<td></td>
<td>4%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of incentive to do it</td>
<td></td>
<td>16%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Easy to copy a lab. report</td>
<td></td>
<td></td>
<td>14%</td>
<td></td>
</tr>
<tr>
<td>Lab. technician work increased</td>
<td>3%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Need more facilities (space)</td>
<td></td>
<td></td>
<td>16%</td>
<td>14%</td>
</tr>
<tr>
<td>Need more organization</td>
<td></td>
<td>8%</td>
<td>41%</td>
<td></td>
</tr>
<tr>
<td>Apparatus must be continuously available</td>
<td></td>
<td></td>
<td>43%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No. of people</th>
<th>107</th>
<th>49</th>
<th>32</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>43/107</td>
<td>25/49</td>
<td>26/32</td>
<td>6/7</td>
</tr>
</tbody>
</table>

Table 8.2.6.
The lab. work problems decrease when using I.L. because -

<table>
<thead>
<tr>
<th>Reason</th>
<th>APPIL S's</th>
<th>CAMOL S's</th>
<th>APPIL T's</th>
<th>CAMOL T's</th>
</tr>
</thead>
<tbody>
<tr>
<td>Develop skills in doing things by yourself</td>
<td>14%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experiments are done when S's needed</td>
<td>10%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Involved the student in the course</td>
<td>3%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students know what to do beforehand</td>
<td>4%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher spends more time with individuals</td>
<td></td>
<td></td>
<td>4%</td>
<td></td>
</tr>
<tr>
<td>No need of the same equipment for all S's</td>
<td>4%</td>
<td>10%</td>
<td>16%</td>
<td>14%</td>
</tr>
<tr>
<td>Instructions clearer by questions to test you</td>
<td>2%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experiments can be repeated</td>
<td></td>
<td></td>
<td>8%</td>
<td></td>
</tr>
<tr>
<td>Experiments can be done in free lessons</td>
<td>1%</td>
<td></td>
<td></td>
<td>3%</td>
</tr>
<tr>
<td>Facilities for change of staff</td>
<td></td>
<td></td>
<td></td>
<td>3%</td>
</tr>
</tbody>
</table>

| No. of persons                              | 107       | 49        | 32        | 7         |
|                                            | 21/107    | 13/49     | 7/32      | 1/7       |

6% (5) not in any way exactly
8% (9) Lab. work is not an element of our I.L. course

Table 8.2.7.

To sum up, although most of the teachers and students said that when using individualised learning material the difficulties in the lab. work increased, they did not associate these difficulties with the ones they found for not doing the experiments. It should be pointed out here that students' responses were associated with their attitudes towards the individualised learning material used.

8.2.3. A.V.A. and the Lab. work.

Usually any approach of individualised learning includes some kind of audio-visual aids as part of the course. In most of the cases the A.V.A. is included to provide the students with a variety of activities, but their content, as far as Physics is concerned, is to show phenomena or situations which are difficult to see or do with normal classroom facilities. This seems to imply that in some cases A.V.A. could be used as a substitute for an experiment.
"... I have found that they use the loops as an entertaining thing, rather than something that you can learn from. They are useful if you can show experiments that you can't actually do in the lab. ... I am generally sceptical about how much they learn from them ... They could in the way that they break the routine, but how much do they learn, I am not sure." (A.P.P.I.L. teacher)

"I think it could help if they (A.P.P.I.L. team) film the experiments for places like this that doesn't have the equipment." (A.P.P.I.L. student)

Influenced by reactions like those mentioned above, and with the idea of finding out to what extent the use of A.V.A. could help to overcome the difficulties of equipment and time in lab. work and also to what extent teachers and students accept the A.V.A. as a substitute for lab. work, teachers and students were asked to agree or disagree with six possible uses of A.V.A. in lab. work. (see section 3.3.4.5.).

From the table of results (Table 8.2.8) the following conclusions can be drawn:

1) Students and teachers agreed, in most cases, with the use of A.V.A. in lab. work.

2) CAMOL I.L. teachers did not accept the use of A.V.A. to show how to set up experiments (case 5). The use of A.V.A. in this way could have been interpreted as a way of taking from them the opportunity of interaction with the students.

3) CAMOL I.L. students were shown to have a reaction that was more favourable than the A.P.P.I.L. students towards the use of A.V.A. in the lab. work. Although A.P.P.I.L. students had more difficulties with equipment than CAMOL I.L. students, it seems that A.P.P.I.L. students did not see the use of A.V.A. as a way of overcoming such difficulties.
### Possible uses of A.V.A. in the lab. work

<table>
<thead>
<tr>
<th></th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
</tr>
</thead>
</table>
| 1. APPIL S's | 64% | 16% | 20% | Some experiments are replaced by film, film-loops, videos, computer exercises.  
| APPIL T's | 73% | 14% | 13% |
| CAMOL S's | 70% | 15% | 15% |
| CAMOL T's | 57% | 29% | 14% |

| 2. APPIL S's | 61% | 13% | 26% | Experiments are explained by using films, videos, film-loops.  
| APPIL T's | 71% | 16% | 13% |
| CAMOL S's | 78% | 11% | 11% |
| CAMOL T's | 57% | 14% | 29% |

| 3. APPIL S's | 56% | 14% | 30% | Films, videos or film-loops are used to show how to use some sophisticated apparatus.  
| APPIL T's | 69% | 14% | 17% |
| CAMOL S's | 76% | 16% | 8% |
| CAMOL T's | 72% | 14% | 14% |

| 4. APPIL S's | 66% | 13% | 11% | Experiments which require very sophisticated apparatus are replaced by films, film-loops, videos.  
| APPIL T's | 84% | 6% | 10% |
| CAMOL S's | 89% | 7% | 4% |
| CAMOL T's | 100% | - | - |

| 5. APPIL S's | 47% | 21% | 32% | Experiments are set up by teachers on film, video or film-loop and the students then set up the same equipment.  
| APPIL T's | 50% | 29% | 21% |
| CAMOL S's | 52% | 18% | 30% |
| CAMOL T's | - | 43% | 57% |

| 6. APPIL S's | 61% | 13% | 26% | Dangerous experiments are replaced by films, film-loops and videos.  
| APPIL T's | 55% | 31% | 14% |
| CAMOL S's | 89% | 9% | 2% |
| CAMOL T's | 86% | 14% | - |

Table 8.2.8.
4) A.P.P.I.L. teachers had a more favourable reaction than A.P.P.I.L. students towards the use of A.V.A. in lab. work, especially in those situations in which sophisticated apparatus is involved (case 3 and 4).

5) Teachers (both A.P.P.I.L. and CAMOL I.L.) considered that experiments with sophisticated apparatus should be replaced by A.V.A. It should be made clear here that the term "sophisticated" could have been interpreted in different ways, i.e. an oscilloscope could have been considered sophisticated for a teacher in a school offering 'A' level Physics for the first time. However the idea was to use A.V.A. in those cases where the school suffered from a lack of equipment.

I think it is fair to summarise this section about the lab. work in A.P.P.I.L. and CAMOL I.L. by saying that the main difficulty found by the students in doing lab. work was concerned with "time". Although "time" presented different levels of difficulty, the most common level was related to the length of the theoretical part of the course. In this case where the material emphasizes the lab. work, i.e. A.P.P.I.L. material, the "time" influenced the students' attitudes towards the lab. work. Teachers' difficulties were related to the characteristics of the school and the approach used. Teachers agreed to A.V.A. to overcome the problem of lack of equipment in the lab. work. Students' reactions to the use of A.V.A. in lab. work were less favourable than those of the teachers. It should be pointed out here that the use of A.V.A. in lab. work is limited by the role of the lab. work in individualised learning. This point will be discussed in the next section.

8.3 Students' and Teachers' Opinions of the role of the lab. work in individualised learning.

As was noted earlier in this thesis, lab. work plays an important role in Physics teaching. For this reason one of the main purposes of the questionnaire was to find students' and teachers' opinions about the role of the lab. work in individualised learning.
In other words, how does lab. work help the students to go through a course by an individualised learning approach,

This section is divided into two parts, the first deals with the aims of lab. work from the teachers' and students' point of view and the second part deals with the type of lab. work used.

8.3.1. Aims of the lab. work in individualised learning

In order to answer the question about the role of the lab. work, a list of 14 aims regarding the use of lab. work was constructed, based on studies done by other workers (Kerr 1963, Boud 1974 and Thompson et al. 1975). Teachers were asked to categorise the aims, and students were asked to categorise activities related to these aims, in both cases according to the degree of importance they had in their actual courses and in any ideal course using individualised learning. This was done in order to avoid the tendency to idealise the present situation, and to find out to what extent the two sets of aims coincided.

The data collected was analysed with the idea of finding out the relative importance of the 14 aims with a very high agreement between the respondents, within each group, and in both situations (present and ideal). For this reason the method adopted was the mid-rank method with a coefficient of concordance (W) developed by Kendal (1970). The categories of importance for the aims were converted into a rank in an order. The use of a ranking method raises the criticism that it does not use all the information gathered. This matter has been discussed by Siegel (1956) who came to the conclusion that this criticism depends on the level of measurement achieved in the research and on the research knowledge of the population. The criticism seems to be strengthened by the large degree of 'tying' (equal ranks), in this case due to the use of a five-point scale for fourteen aims. In spite of this criticism the mid-rank method used makes no assumptions about the interpretation placed upon the wording of the five categories other than that 'they are ordered', and equalizes the responses of those...
who have been most and least generous in allocating importance. Also this method does not distinguish the cases in which a responder has exaggerated an importance or conversely has attached very little importance in the replies.

Figure 8.3.1 shows the resulting order of aims for the A.P.P.I.L. and CAMOL I.L. teachers, "part a" refers to their actual courses and "part b" refers to an ideal course.

It should be noted that teachers (both A.P.P.I.L. and CAMOL I.L.) coincided in three of the four top aims in both their actual courses and the ideal courses. This would appear to indicate that teachers' aims for lab. work did not depend on the approach used but on the subject taught - Physics.

A detailed study of the results shows some interesting points:

- Teachers thought that it was by reinforcing theoretical knowledge that the lab. work has helped, and could help the students in individualised learning (aim c).

- Although A.P.P.I.L. teachers had the problem of lack of equipment they thought, as the CAMOL I.L. teachers did, that the lab. work in individualised learning should familiarise the students with new apparatus and measurement techniques (aim b). This aim could have been interpreted as a general aim of VIth form lab. work.

- CAMOL I.L. teachers gave more importance than the A.P.P.I.L. teachers to the help the lab. work could give to the students for the exam (aim m).

- A.P.P.I.L. teachers considered that the lab. work should train the students in making deductions from measurements and in the interpretation of experimental data. This aim was considered less important by CAMOL I.L. teachers.
Figure 8.3.1. Teachers' aims of the lab. work in their actual course a

Teachers' aims of the lab. work in an ideal I.L. course b
- The differences in the approaches of individualised learning used, A.P.P.I.L. emphasizing the use of lab. work and CAMOL I.L. not emphasizing this, could be appreciated by the difference in ranking of the aims 1, a, n.

- There was no support for the need for closer contact between teachers and students when using individualised learning.

- Aims g and h were found not to be important by both groups of teachers.

Figure 8.3.2. shows the resulting order of statements related to aims for students, "part a" refers to their actual courses and "part b" refers to an ideal course.

As happened in the case of the teachers, students agreed on some of the top aims, i.e. in two of the three top aims of their actual course and in the three top aims of the ideal course. This is in line with the finding, mentioned above, that the aims of lab. work do not depend on the material used but only the subject studied.

Looking in detail at the results of Figure 8.3.2. some interesting points emerged:

- Students think that it is by making the theoretical part of the course more clear (aim c) that the lab. work has helped them, and could help them, in an individualised learning approach.

- As it is expected in an exam-oriented system, the students would like the lab. work to help them to pass the exam (aim m). Although the CAMOL I.L. students do not have to take a practical examination they felt that lab. work helped them to pass the Physics exam.

- The kinds of skills that students expected to get from lab. work are those which are related to interpretation of data (aim e). The importance of this aim could have been exam-oriented, as it is included in the exam requirements.
Figure 8.3.2. Students' aims of the lab. work in their actual course

Students' aims of the lab. work in an ideal I.L. course
The ability to identify the problem in a new situation and to recognise which method is needed to tackle it (aim k) was found important in the ideal course by A.P.P.I.L. students, but not by the CAMOL I.L. students. This fact could appear to indicate that there is a difference between students who are going to take a practical exam and students who are not going to do so.

As happened in the case of the teachers, there was no support for closer contact between teachers and students when using individualised learning. Aims g and h were found to be the least important by both groups of students.

The differences between the two approaches of individualised learning could be seen in the difference of order the students gave to aims i, b, a, l.

In Figure 8.3.3. (a) it can be seen that A.P.P.I.L. students' expectations, in general, were not fulfilled by the lab. work they were doing. Four aims are very far from the line of coincidence between students' reality and students' expectations and only two aims are on this line. In the case of CAMOL I.L. students (Figure 8.3.3. (a) the contrast between reality and the ideal is not as bad as it is in A.P.P.I.L. Three aims are far from the line of coincidence and 5 aims are on this line. These two graphs support the finding of section 6.4.1, where CAMOL I.L. students had a more positive attitude towards the lab. work than A.P.P.I.L. students.

In the case of the teachers (Figure 8.3.3. (b)), most of the aims are on the line of coincidence of what they were doing and what they thought they should do. Teachers did not feel the necessity to question the value of their present lab. work. They thought that what they were doing was what they should do, as their actions seemed to be effective within the limits of each system.
Figure 8.3.3 Students' aims of the lab work (a)

Teachers' aims of the lab work (b)
For the purpose of comparison, the teachers' order of importance of the four top aims are given in Figure 8.3.4. below alongside the four top students' statements:

<table>
<thead>
<tr>
<th>Teachers APPIL</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Actual course</strong></td>
<td></td>
</tr>
<tr>
<td>e</td>
<td>c</td>
</tr>
<tr>
<td>c</td>
<td>b</td>
</tr>
<tr>
<td>b</td>
<td>m</td>
</tr>
<tr>
<td>n</td>
<td>e</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Teachers CAMOL IL</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ideal course</strong></td>
<td></td>
</tr>
<tr>
<td>l</td>
<td>m</td>
</tr>
<tr>
<td>b</td>
<td>c</td>
</tr>
<tr>
<td>c</td>
<td>e</td>
</tr>
<tr>
<td>e</td>
<td>k</td>
</tr>
</tbody>
</table>

From these four groups it can be concluded that the general aims of the lab. work in individualised learning, according to teachers and students using A.P.P.I.L. material and CAMOL I.L. material are:

"To reinforce theoretical knowledge" (aim c) and
"To train students in making deductions from measurements and in the interpretation of experimental data." (aim e).

8.3.2. Types of lab. work

Having identified the purpose of the lab. work in individualised learning, some information about the type of lab. work used in the two approaches might be helpful in answering the main question of this chapter, that is, "What is the role of the lab. work in individualised learning?"
Five different types of lab. work were presented to students and teachers based on the different types of experiments used by Kerr (1963) and Thompson et. al (1975) in their enquiry. Teacher and students were asked to indicate, on a five point scale ranging from "frequently used" to "never used", the frequency with which they used each kind of experiment and the frequency with which they would like to use each kind of experiment in an ideal course. The five types of experiments included in the questionnaire were as follows:

1. Demonstrations (by the teachers) that verify facts and principles (this might or might not involve the students in discussion).

2. Repetition (by students) of standard qualitative experiments, (e.g. "to show that ..." procedure well defined and clear instructions given).

3. Repetition (by students) of standard quantitative experiments, (e.g. measurement of physical constants procedure well defined and clear instruction given).

4. Discovery experiments designed to answer a question raised in the development of the theoretical work.

5. Project, e.g. problems (new to the student) involving some investigational work and study in depth to reach a solution.

It should be pointed out at this stage that students' interpretation of these terms may have been different from those of the teachers. A discovery experiment done at the end of the unit could have been interpreted by the students as a reflection on standard experiments.

The frequency with which each kind of experiment was used in each approach was estimated and the results expressed in percentages. Figure 8.3.4. shows how much A.P.P.I.L. and CAMOL I.L. teachers used and would like to use the different types of experiments, and Figure 8.3.5. shows the students' responses.
Types of lab. work used (Teachers) □ actual course □ ideal course

Figure 8.3.4
Types of lab. work used (students)

- Actual course
- Ideal course

Figure 8.3.5
From the analysis of these figures the following conclusions, about
the types of experiments, can be drawn:

1) It appears that CAMOL I.L. teachers used the demonstration
type of experiments with more frequency than the A.P.P.I.L. teachers.
Students' responses are in line with this. Teachers and students,
from both approaches, would like to have more experiments that verify
facts and principles in the ideal course.

2) There is no doubt that the kind of experiment most used in
both approaches is the repetition of standard qualitative and
quantitative experiments. In both approaches more than 50% of
teachers and students said that they "frequently used" or "used"
these kinds of experiments. In the case of the ideal course,
A.P.P.I.L. teachers would like to have more qualitative than
quantitative experiments whereas the rest (A.P.P.I.L. students,
CAMOL I.L. teachers and students) would like to have more quantitative
than qualitative experiments. The A.P.P.I.L. teachers' responses
could be interpreted as a solution of the "lack of equipment" problem.

3) The biggest difference between the two approaches of individualised
learning is the use of discovery experiments designed to answer
questions raised in the development of the theoretical work. According
to the students' and teachers' responses, A.P.P.I.L. offered more
experiments of the discovery type than CAMOL. However students and
teachers from both approaches would like to have more experiments
of this type in the ideal course.

4) It is clear that problems involving some investigational work
and study in depth to reach a solution (projects) were not used in
either approach (CAMOL I.L. or A.P.P.I.L.). However A.P.P.I.L.
students and teachers would like to use this type of experiment
sometimes. CAMOL students and teachers did not support this idea.

As can be seen in Figure 8.3.4. and 8.3.5., students and
teachers gave, in most cases, higher scores to the type of experiments
they would like to have in an ideal individualised learning course,
in comparison to the scores given to their actual course. This could be interpreted as a normal tendency to give higher scores to the unknown "ideal situation".

If teachers and students agreed in saying that a particular aim was important in the individualised learning lab. work, it might be assumed that the type of experiment likely to be used to achieve this aim would be "frequently used". Therefore the degree of importance of an aim should be related to the "frequency of use" of the type of experiment which led to the achievement of that aim. Two aims were found to be important by teachers and students in their actual course:

"To reinforce theoretical knowledge" (aim c) and "To train students in making deductions from measurements and in the interpretation of experimental data."

The kind of experiment used, "qualitative and quantitative standard experiments", leads to achievement of these aims. In the case of the ideal course, it seems that teachers and students cannot keep the balance between the aim to be achieved and the way of achieving it. Teachers and students pretend to achieve the two aims mentioned before by doing discovery type experiments. There seems to be a contradiction. In order to reinforce theoretical knowledge, the experiments should be done after the students have met the concepts, principles or phenomena involved in the experiment. The discovery type of experiment implied that the students are going to develop the concept, principles or phenomena through the experiment.

8.4 Conclusions

This chapter has described the Physics lab. work in two different approaches of individualised learning at VIth form level (A.P.P.I.L. and CAMOL I.I.). The most important aspect of the analysis was the considerable degree of similarity found in the responses between the groups of teachers and students. This seems to indicate that the role of the lab. work does not depend on the approach used but on the subject taught (Physics) and the level at which it is taught. This is in line with what Thompson (1975) found in his comparison between Nuffield Teachers' and non Nuffield Teachers' aims of the lab. work.
Teachers and students agreed that the two most important aims of the lab. work were:

"To reinforce theoretical knowledge" (aim c) 

"To train students in making deductions from measurements and in the interpretation of experimental data." (aim e) 

These two aims are very much related to the findings of Kerr in his investigation about lab. work (Kerr 1963). It would appear that the aims of the Physics lab. work at Sixth Form level have not suffered any changes since Kerr’s enquiry. However looking at A.P.P.I.L. teachers’ responses, it can be seen that the importance given to the aim of making the phenomena more real through actual experience (aim n) and the reduced emphasis on discovery method (aim f) are more in line with the findings of Thompson et. al (1975). Thompson found that teachers showed recognition of the need for concrete experience as the basis of meaningful learning.

The importance given by teachers to the aims of familiarisation with standard apparatus and measurement techniques (aim b) could reflect the innovation that "new equipment" has brought. This also limits the use of A.V.A. as a substitute for the experiments.

The considerable agreement among teachers and students about the type of experiments most used (standard experiments) and the type of experiment they would like to do (discovery experiments) shows a lack of consistency between the aims of the lab. work and the way to achieve these aims.

Moreover comparing this inconsistency to what psychologists say about the lab. work I found that Piaget, for example, suggested that:

"Any experiment should not only bear relevance to what the student already knows, but at the same time must be sufficiently novel to present conflicts and thereby produce mental disequilibrium." (Kolodig 1977).
It seems that this kind of balance is what the teachers want to express when they give importance to "reinforce theoretical knowledge" and to use discovery type of experiments.

Demonstration work (done by teachers) was considered by students and teachers to be a desirable type of experiment in individualised learning. Their responses showed that they would like to use more demonstration work in the ideal course of individualised learning.

It was also found that the main problem students had in doing the experiments were related to the time they needed to perform the experiments. On the other hand teachers' opinions about the problems in doing lab. work were influenced by three elements: equipment, school facilities and the emphasis on lab. work made in the material. Students and teachers did not associate the problems they found with the fact of using an individualised learning approach as such.
CHAPTER IX

Discussion and Recommendation

9.1. Introduction

9.2. Individualised Learning in Physics Classrooms

9.3. Guidelines for the training of teachers

9.4. Recommendations for further work
9.1. Introduction

From the idea that human behaviour is influenced by the environment in which it occurs and that understanding of behaviour is derived within the framework in which it takes place, I have discussed different aspects of individualised learning classrooms in Chapters IV, V, VI, VII and VIII.

A school or a Physics Department can support individualised learning in order to improve the quality of teaching or to meet current demands of school administration. In classrooms, teachers will approach it in different frames of mind. He or she will use and modify the material according to his or her own interests, style of teaching and the type of class being taken. This seems to indicate that curriculum research should be carried out in the closest contact possible with teachers. If it is desired that the latest knowledge of any aspect of curriculum be quickly absorbed into the classroom, the outcome of curriculum research should be fed into courses of in-service training.

In this final Chapter I wish, firstly, to discuss as a whole, the aspects presented separately earlier in this thesis, and secondly, to tentatively draw up some guidelines for the training of teachers in the use of individualised learning. The chapter could be considered as the bridge between the research findings and the applicability of these findings. It should be borne in mind that educational research, and particularly curriculum research, cannot produce general solutions or universal panaceas. Indeed, it is always true that the process of teaching and learning is extremely complex, interactive, and highly context-dependent.

9.2 Individualised learning in Physics Classrooms

For the purpose of this discussion, it is perhaps best to begin by repeating the definition of individualised learning used in this study and which is presented in section 4.1.
"Individualised learning involves activities where students' individual differences are taken into consideration."

The study of the terminology used around this idea has been presented and discussed in Chapter II and Chapter IV, coming to the conclusion that teachers very often adapt rather than adopt methods of teaching. The study of the teachers' perception of this terminology showed that the communication of the Physics content is now made mainly through instructional devices and that therefore the classroom becomes more student-activity centred. Although the use of instructional devices does not necessarily imply individualised learning, it does provide the framework in which it takes place. In spite of the difficulties that teachers found in making distinctions between the different terms presented to them, it was observed that the characteristics ascribed to a specific term or approach were concerned with the activities the teacher offered to the students in the classroom. To this must be added: the kind of material used, who decided what was going to be learnt in the class, and individual or group interactions. However, there was no one unique way of restricting these characteristics to a particular approach and label it with a specific name. Teachers' definitions of these characteristics were based on their philosophy and aims of teaching rather than on any particular project or material.

To provide materials individualised for learning by each student is very difficult, maybe impossible, and it makes great demands on teachers. At the operational level, when learning in the classroom tends to become individualised, it does so somewhere on a spectrum of possibilities which range from students' involvement in small and general tasks for a short time, to situations where students decide what task they want to do, where to do it, and from where to obtain information. Right across the spectrum there is a deliberate attempt by materials and teachers to cater for the individual differences of students.

In order to cater for this, all facets of classroom activities must be revised to allow for new work patterns. A view of teachers
as simply direct one-way transmitters of Physics concepts and knowledge was found to be inadequate to deal with the problems raised by students, or to take advantage of the opportunities offered by this new situation. Much has been said and written about the new role of the teacher, and this has been discussed in Chapter V. One general principle that emerged was that teachers' general classroom roles are very deeply influenced by the aims of education at school and society level. Since time and circumstances modify these aims in particular ways (e.g. the idea of education for all) teachers' specific roles in the classroom are a balance between their own ideas of education and what is expected from them by the society (students, parents, head teachers, examiners, employers, etc.). In trying to achieve this balance in the new situation, the teacher plays a 'changing role'.

According to the teachers involved in this research, there are four areas where changes in the teachers' behavioural role take place. I have called these areas: preparation, control, interaction and motivation.

When the teacher is performing the role of purveyor of a predetermined quantity of established knowledge to the students, the scope of the "preparation area" is narrow. This implies little more than the breakdown of the subject matter into a sequence of topics presented to the students during the academic year. On introducing individualised learning, the teacher produces and looks for appropriate resources of knowledge and skills. In this way the teacher becomes the creator of a series of environments more favourable to individual students and because of that the "preparation area" is extended: it has suffered radical changes. In the case of the Physics Classroom, where resources of different kinds are usually available for any teaching method (due to the fact that Physics is an experimental science) teachers and students agreed that the aim of performing experiments in an individualised learning course should be to reinforce the theoretical knowledge learned through written material. It was also to enable the students to take greater advantage of practical activities through selection and use of knowledge rather than by its inert absorption. This agreement seems to imply the socializing role of the teacher into the discipline of Physics.
When the teacher is selecting the right experiment, the real life example, and in general the most appropriate learning resources, he is performing the role of motivator. He looks for and provides those situations which could motivate the student to learn Physics. In this way the teacher is involved in a very active role as a motivator of learning.

Teaching techniques often consist of strategies where the teacher's performance and control of the class are intertwined and emphasized. This implies that a passive non-developing role is assigned to the students. When students become more active, looking for information, communicating their interests and needs, teachers need to maintain a different kind of control in the classroom. Instead of seeking to subjugate the students to the teacher's interests, the area of concern moves more towards students' development and interests. This new way of control calls for sensitivity and skills in interpersonal communication. The strong "teacher-to student group" interaction is replaced by "teacher-to individual" and "individual to teacher". As a consequence of this, the effectiveness of the different kind of interaction performed by the teacher depend on his/her capacity to adapt himself/herself to different individuals and classroom environments created for the students. That different roles are performed by the teacher when interacting with various individual students is both desirable and inevitable. On the other hand, students in such individualised learning classrooms have a greater opportunity for interaction with their peers using the language of science. This enables them to create a new social order in the classroom. Students' perceptions of the teacher become, in such situations, more concerned with the personal qualities that the latter demonstrates to the students. The nature and extent of students' mutual interactions depend on the style of work followed and the "resources status" of individuals each participant, including the teacher, has been able to achieve in the classroom. This research has revealed that the changes which take place in Physics classrooms using individualised learning are far from being exclusively influenced by the expectations of the
material used. The teacher's personal and intellectual capacity and willingness to change are the key elements.

In this study my intention has not been either to argue the case for or against individualised learning, or to present it as the solution to educational problems, but to portray it as it actually takes place, and to study the changes that take place when it is introduced. It should be borne in mind that these changes are influenced by external factors, which in the near future could decide the use of individualised learning in this country. Comparing the elements which influenced the disappearance of the Dalton Plan from English schools (see section 2.4.2.) in the first half of this century with the situation that the schools are facing at the moment (October 1979), some points of coincidence can be seen:

- The lack of central support in the production of material. Teachers start producing and using material by trial and error; without any training. Teachers' centres and teachers' organizations cannot cover all aspects of individualised learning without support.

- The pressure of external exams: There is a great concern with the qualifications that the school can give, i.e. education is oriented towards exams. Teachers' effectiveness is measured by the number of 'O' level and 'A' level passes.

- The financial problem. The cuts in finance for education affect the production and acquisition of material needed for individualised learning.

From the methodological point of view the approach used in this research was adopted in the belief that, by studying the problems that teachers face in the classroom, all teachers could be aware of the different difficulties that they could encounter when using individualised learning.
9.3 **Guidelines for the training of teachers**

In this study teachers' reactions towards the idea of individualised learning were particularly significant and relevant in its use, and the range of their reactions are probably typical of those found in respect of many innovations. Some teachers were enthusiastic, others tolerant, others were sceptical. The decision to adopt individualised learning for any reason, e.g. as a philosophy of teaching, as a curriculum reform or innovation, or in a trend towards greater humanization in education, is that of each individual teacher. Whatever the intention may be, no teacher is fully prepared by prior experience to become part of an individualised learning classroom. As I have said earlier (Chapter II), how teachers do their job depends to a large extent on their attitude towards teaching. This is far more extensively influenced by their own prior experience of education than by any materials available to them. Teachers using any individualised learning approach are almost always engaged in a series of activities in which they do not have previous experience, either as a teacher or as a student. Their performance in the classroom is limited to their own intuition on how they should act. In the school visits I found teachers who were 'feeling their way' in using individualised learning. At the same time I did find teachers who were quite bewildered about how constructively to use it, or simply by what they should do physically. As individualised learning will, in the future, be used by teachers of widely varying abilities and knowledge, an increase in teacher's in-service training in this area will be called for.

Mounting successful in-service courses is difficult. Usually they are criticised for being too limited or unrealistically grandios. According to Bailey and James (1978) the failures of science in in-service are due to: lack of relevance of content to the participant, a lack of substance in terms of the immediate usefulness of the ideas presented and an inconsistency between the practice advocated and the method of presentation. To accomplish the difficult task of training teachers for the use of individualised learning we must help teachers to acquire and understand the idea involved in it, to relate their own perception
to the 'ideal' use of individualised learning. Only then can we ensure that individualised learning will actually take place, as teachers will only use it well if they believe in it. The first requisite for use of the approach is a commitment to the idea, as without such commitment efforts become thoughtless and superficial.

The experience gained by the teachers involved in this research has suggested four areas for training: preparation, control, interaction and motivation. Too often it is assumed that an individualised learning training course should be based on how to prepare written materials or produce A.V.A., or simply on a discussion of the subject content presented in the material. An undue emphasis is laid on the preparation area. Although these aspects may be found to be important by some teachers, they are not enough for most teachers who want to use the idea in the classroom. Teachers have to be thoroughly familiar with the way the content is presented, or will be presented in the different material to be used, in order to be able to quickly pinpoint students' difficulties. They should be aware of the type of problems or difficulties they and their students are likely to face and be prepared to take advantage of any situation which could facilitate the learning process. Thus more emphasis is needed on the control area.

One of the aspects of which a teacher should be aware when using individualised learning materials, is the total context in which his/her own teaching is taking place. To get to know how each student acts and reacts is undoubtedly necessary but it is also necessary to know to what and why they act and react. Teachers have to learn to interact more extensively and effectively with the students either in small groups or with individuals, for long enough to guide and stimulate their ideas, but not so long as to bore the students. Students could have difficulties with a part of the material, some would like to have direct, quick, and simple help, a long explanation could distract and reduce productivity and learning effectiveness. Others would like to have the opposite. When the teacher interacts with an individual student he/she may be doing what he/she used to do in a teacher-centred group. As a consequence the effort and productivity of the interaction may be wasted. In training experienced teachers in respect of
individualised learning it is important that they realise that their specific skills of interaction and motivation are even more necessary than ever before.

It is not possible to tell the individual teacher how to select the best materials, how to select resources for all kinds of students, how to develop a teacher-student relationship, how to interact with a particular student or how to teach the least motivated. This certainly cannot be done through a course based on traditional patterns of expository lecturing because the theory of so-doing is currently inadequate and classroom practice is incapable of being communicated in such a way. It is only by providing the teacher with a general understanding of the possible situations in which they will be involved in the classroom, in order to enable them to make their own decisions according to their classrooms and schools, that such a training could be both useful and successful.

For example the proposal for in-service training presented in Appendix G tries to adapt an in-service training course to the needs of the teachers willing to use the A.P.P.I.L. project. The first activity suggested is to determine through a very open questionnaire the participants' needs and interests, for in many cases these two ideas overlap in people's mind. At the same time the level of concern with individualised learning is determined as a measure of the participants' commitment to the idea of individualised learning and the heterogeneity of the group to whom the course is addressed. This enables the sessions of the course to be designed at the right level and with the elements which are needed. The approach also provides opportunities for interchanging ideas on the difficulties to be met in the use of the project by suggesting that the course be seen during the first weeks of the first term of individualised learning use. This is made from the view that teachers without any experience in using individualised learning do not know what their personal limitations are in respect of the skills demanded by its use.

Teachers using individualised learning need the range of skills mentioned earlier, but I do think that it is more important to gain an understanding of these skills. It is only by understanding them that teachers can apply them in their classrooms.
9.4. Recommendation for further work

This research began with the idea of identifying the elements which change in the classroom when individualised learning is used. The approach followed allowed an identification of some general elements in a variety of classrooms. The analysis, however, suggests future research in two major areas: classroom interactions and teacher in-service training.

This study looked at the teacher and student interactions in VIth form classrooms using individualised learning material. The resulting description raises several questions. Do students of different ages produce the same models of initiation of interactions? Do the sexes interact in a different way when the class is mixed? Could the models of initiation of interaction developed be adopted for larger classes? Is the new social order found in small classes present in larger classes and for younger students? Research of this nature requires more than one researcher in the classroom. The use of recording equipment could be useful only if it is used as support for participant observation.

The second area for research suggested by this study is that of teacher-training. The teachers involved in this research, who had some kind of training in individualised learning, were trained only in the area of preparation. Future research should look at the effects of the training of teachers in the other areas, as suggested in this study, in order to answer the following questions: How far does the self-perceived role of the teacher influence the interaction? How far could in-service training help the teacher to interact more effectively with students? How could the teacher develop the role of motivator in the classroom? How many different kinds of control should and could the teacher establish in the classroom and under what circumstances could they be used? What is the relationship between the new way of control in the classroom and the self-perceived role of the teacher?
I hope that the results of this research will stimulate different organizations to produce in-service courses for teachers who are willing to use individualised learning and at the same time that other researchers may carry out further study in such classrooms.
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APPENDIX A

THE INTERACTION GUIDE
No. Students

Diagram of the classroom

Comments about the beginning of lesson

Comments about the lesson.

<table>
<thead>
<tr>
<th>S ← T</th>
<th>Explaining</th>
<th>Asking some questions</th>
<th>Informing of correctness</th>
<th>Telling what to do</th>
<th>Inhibiting the student</th>
</tr>
</thead>
<tbody>
<tr>
<td>S → T</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Requiring some material</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asking what to do</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Checking correctness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seeking explanation of a point</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seeking conceptual understanding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>S → S</th>
<th>1 2 3 4 5 6 7 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seeking explanation of a point</td>
<td></td>
</tr>
<tr>
<td>Seeking conceptual understanding</td>
<td></td>
</tr>
<tr>
<td>To check the questions</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>T → S</th>
<th>1 2 3 4 5 6 7 8 group 1 group 2 group 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>To see what is happening</td>
<td></td>
</tr>
<tr>
<td>To check the questions</td>
<td></td>
</tr>
<tr>
<td>To give conceptual understanding</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX B

REPERTORY-GRID INSTRUCTIONS
Repertory Grid on Students' interactions
in Individualised Learning

The aim of this form is to determine the nature of students' interactions in a classroom where individualised learning is taking place.

You will find two forms: FORM X and FORM Y.

Please read the instructions overleaf FULLY FROM 1 to 6 BEFORE COMPLETING FORM Y.

After filling form Y read instruction 7.

Your time and effort is greatly appreciated.

THANK YOU

Greta M. de Gonzalez
Institute for Educational Technology.
1. Start with the FORM X. Write your name in the space "a".

2. Write the first name of the following people in the space indicated (on the FORM X).

   b. your Physics teacher
   c. the student you ask most about Physics in the classroom
   d. the student who asks you most about Physics in the classroom
   e. the student you talk to most either in the class or outside.

   Choose a different student for c, d and e. DO NOT REPEAT THE SAME NAME TWICE.

3. Line up FORM X so that the letters a to e correspond to letters a to e in FORM Y (see the diagram below).

   REMEMBER "CONTINUING READING BEFORE ACTUALLY FILLING IN THE FORM Y"

4. Think about the people who are represented by the circles in row i.e. you, your Physics teacher and the student you ask most about Physics in the classroom, and DECIDE:

   "In what important way do you see two of them alike and in contrast to the third with respect to TALKING AND DISCUSSING YOUR WORK AND GENERALLY WORKING IN THE CLASSROOM WITH THEM. Please think carefully and consider any factor which you think is relevant.

   WHAT MAKES TWO OF THE PEOPLE ALIKE? Briefly write this in Column A. Please say which two you are referring to.

   WHAT IS THE CONTRAST TO COLUMN A THAT MAKES THE THIRD DIFFERENT?

5. The diagram below is an example of what I am asking you to do. In this example, you, your Physics teacher and the student you ask most about Physics in the classroom were being considered and the student decided that, he and the student he asks most about Physics were alike because both of them use the same text book but the teacher differed from them because he used a different text-book.
Now consider each of the persons you have written in FORM X, for each person ask yourself:

**DOES COLUMN A DESCRIBE THIS PERSON OR DOES COLUMN B?**

**LIKE A**
- Is the person described exactly by Column A? If yes put a 5 in the box below.
- Is the person fairly like Column A? If yes put a 4 in the box below.
- Is the person described by Column B? If yes put a 1 in the box below.

**LIKE B**
- If the person is neither like A and B then put a 3 in the box below.

REPEAT INSTRUCTION 7 ABOVE FOR EACH PERSON NAMED IN FORM X FOR ROW i to x.
Now go to instruction 7
Repertory Grid on Teachers' activities in Individualized Learning

The aim of this form is to determine the teachers' views about the activities they have to perform in a course in which individualised learning is taking place.

You will find two forms: FORM X and FORM Y.

Please read the instructions overleaf FULLY FROM 1 to 7 BEFORE COMPLETING FORM Y and ensure that you understand what to do before commencing.

After filling form Y read instruction 8

Your time and effort is greatly appreciated.

THANK YOU

Greta M. de Gonzalez
Institute for Educational Technology.
therefore please start in space 2).

4. - Line up Form X so that the number 1 to 5 correspond to number 1 to 5 in Form Y (see the diagram below).

REMEMBER "CONTINUE READING BEFORE ACTUALLY FILLING IN THE FORM Y"

5. - Think about the methods that are represented by circles in row i.e. the teacher's activities in 1, 2, 3 and DECIDE:

"In what important way with RESPECT TO THE ACTIVITIES YOU HAVE TO PERFORM IN THESE TEACHING METHODS are any two of them alike and in contrast to the third. Think about the activities you have to do before the lesson, during the lesson and after the lesson.

Please think carefully and consider any factor which you think is relevant.

WHAT MAKES TWO OF THE ACTIVITIES ALIKE? Briefly write this in Column A. Please say which two you are referring to.

WHAT IS THE CONTRAST TO COLUMN A THAT MAKES THE THIRD DIFFERENT? Briefly write this in Column B.

6. - THE DIAGRAM BELOW IS AN EXAMPLE OF WHAT I AM ASKING YOU TO DO.

In this example the teacher's activities in normal teaching, Independent Learning and Work-sheet were being considered and the teacher decided that in Independent Learning and in Work-sheet he is required to sit all the time and that is what makes them alike in contrast to normal teaching which required him to walk constantly around.

<table>
<thead>
<tr>
<th>FORM X</th>
<th>BIPOLAR SCALE</th>
<th>FORM Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>COLUMN A</td>
</tr>
<tr>
<td>Normal Teaching</td>
<td>Independent Learning</td>
<td>Work-sheet</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>i</td>
<td>0</td>
<td>0.5</td>
</tr>
<tr>
<td>ii</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>iii</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>iv</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Note: The values in Form Y are illustrative and do not correspond to the values in Form X.
7. - Repeat instruction 5 for each row, from row i to row x, 
    considering in each case the three methods circled in each row. 
    "DO NOT WRITE THE SAME THING IN COLUMN A OR COLUMN B MORE THAN ONCE"

    NOW: PLEASE GO BACK TO INSTRUCTION 5 AND COMPLETE FORM Y ACCORDINGLY.

8. - What you have now is 10 pairs of contrasting statements, what you 
    have written in Column A is the opposite of Column B. 
    In row i think of Column A as being an end of a scale and 
    Column B as being of the other end, i.e.

    i  Column A -------------------------Column B
    scale  5  1

    Now, consider each of the methods you have written in FORM X, 
    for each method ask yourself:

    DOES COLUMN A DESCRIBE THIS METHOD OR DOES COLUMN B?

    Is the method described exactly by Column A?  If yes put 5 in the box below.
    LIKE A  Is the method fairly like Column A?  If yes put 4 in the box below.
    Is the method described by Column B?  If yes put 1 in the box below.
    Is the method described fairly by Column B?  If yes put 2 in the box below.
    LIKE B  If the method is neither like A or B then put a 3 in the box below.

    REPEAT INSTRUCTION 8 ABOVE FOR EACH METHOD NAMED IN FORM X FOR ROW i 
    TO x.
Now go to instruction B.
APPENDIX C

LABORATORY WORK QUESTIONNAIRES
The Use of the Lab-work in Individualised Learning

The purpose of this questionnaire is to gather information about how you think the Lab-work\(^1\) is and how it should be used in individualised learning\(^2\).

The questionnaire consists of five parts: for most questions you are asked to ring a number.

Please be as frank as possible. This questionnaire will be treated as totally confidential.

Thanking you very much for your time and help.

Greta M. de Gonzalez
Institute for Educational Technology,
University of Surrey, Guildford.

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\(^1\) Lab-work (Laboratory-work): Refers to any work of a practical nature done in a Physics Laboratory

\(^2\) Individualised learning: Refers to those situations where the students have direct access to learning materials and resources, e.g. study guides, worksheets.

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**PART I**

The following comments on lab-work have been made. In order to find how far these statements reflect your views, I would like you to ring the number on the right which indicates how you feel about each statement.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Without Lab-work physics is not physics</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>2. Teachers are compelled to teach mainly facts, so lab-work is not used</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>3. Lab-work can give a student a deep appreciation of physics</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>4. Lab-work is largely a waste of time</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>5. Learning physics without Lab-work is like learning to swim without water - nearly impossible</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>6. Lab-work raises students' interest in physics</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>7. If you do much Lab-work you cannot cover the syllabus</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>8. Lab-work tends to become a cooking exercise</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>9. Lab-work makes physics very real and understandable</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>10. School experiments are not related to physics theory</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

Please add and rate any other statements.

11.                                                 | 5              | 4     | 3         | 2        | 1                |

12.                                                 | 5              | 4     | 3         | 2        | 1                |
## PART II

The following list includes a series of selected statements relating to Lab-work in a physics course. Please rate, by ringing a number on the right for each statement, how much you think each particular statement reflects:

(a) your actual physics course;
(b) what you think should happen in a physics course in which individualised learning is being used.

<table>
<thead>
<tr>
<th>Statement</th>
<th>(a)</th>
<th>(b)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The Lab-work:</strong></td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>1. Gave me training in manipulative skills</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Acquainted me with new apparatus and measurement techniques</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Made more clear to me the theoretical part of the course</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Taught me to think more scientifically</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Trained me to make deductions from measurements and interpretations of</td>
<td></td>
<td></td>
</tr>
<tr>
<td>experimental data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Led me to find out facts and principles of which I was not previously</td>
<td></td>
<td></td>
</tr>
<tr>
<td>aware</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Helped me develop the necessary language to communicate about physics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Gave me the opportunity to exchange my ideas about physics</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The Lab-work:

- Provided me with a break from theory work
- Enabled me to understand experimental error
- Gave me practice in seeing problems and seeking ways to solve them
- Helped me to bridge the gap between theory and practice
- Prepared me for a practical examination
- Made the phenomena studied more real and interesting
### PART III

Please ring a number on the right in each case to indicate how frequently you have used each of the following kinds of lab-work in your actual course (Column A), and how frequently you think they should be used in a physics course using individualised learning (Column B).

<table>
<thead>
<tr>
<th></th>
<th>Column A Actual Course</th>
<th>Column B Individualised Learning Course</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequently Used</td>
<td>Occasional Use</td>
</tr>
<tr>
<td>1. Demonstrations (by the teachers) that verify facts and principles. (This might or might not involve the students in discussion)</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>2. Repetition (by students) of standard qualitative experiments, e.g. &quot;to show that ...&quot; procedure well defined and clear instructions given</td>
<td>5</td>
<td>4</td>
</tr>
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<td>3. Repetition (by students) of standard quantitative experiments, e.g. measurement of physical constants procedure well defined and clear instruction given</td>
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</tr>
<tr>
<td>4. Discovery experiments designed to answer a question raised in the development of the theoretical work</td>
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</tr>
<tr>
<td>5. Projects, e.g. problems (new to the students) involving some investigational work and study in depth to reach a solution</td>
<td>5</td>
<td>4</td>
</tr>
</tbody>
</table>

Please add and rate additional kinds of lab-work.

### PART IV

Difficulties in doing physics lab-work stem from several causes, e.g. lack of equipment, time, technical help, the loading of laboratory timetables, the size of classes.

Which difficulties are important in your present course?

Why?

In which way do you think the use of individualised learning increases or decreases the problems of lab-work?
**PART V**

Please indicate, by ringing the appropriate number in Column A, the response that you think is the most appropriate for each statement in your actual physics course, and by ringing the number in Column B the response that you think is the most appropriate for each statement in a physics course using individualised learning.

<table>
<thead>
<tr>
<th>Column A</th>
<th>In your actual course</th>
<th>Column B</th>
<th>In a course based on individualised learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGREE</td>
<td>DISAGREE</td>
<td>UNDECIDED</td>
<td>AGREE</td>
</tr>
<tr>
<td>5 4 3 2 1</td>
<td>5 4 3 2 1</td>
<td>5 4 3 2 1</td>
<td></td>
</tr>
</tbody>
</table>

1. Some experiments are replaced by films, film-loops, videos, computer exercises

2. Experiments are explained by using film-loops, videos, films

3. Films, videos or film-loops are used to show how to use some sophisticated apparatus

4. Experiments which require very sophisticated apparatus are replaced by films, film-loops, videos

5. Experiments are set up by a teacher on film, video or film-loop and the students then set up the same experiments by themselves

6. Dangerous experiments are replaced by films, film-loops, videos

If you wish to make any comments in addition to these ratings, or on any other aspects of Lab-work, please do so below.
The Use of Laboratory-work in Individualised Learning

The purpose of this questionnaire is to gather information about how you think the Lab-work\(^{(1)}\) is and should it be used in Individualised Learning\(^{(2)}\).

Please be as frank as possible; it will be treated as totally confidential.

Thanking you very much for your time and help.

\[\text{Greta M. de Gonzalez}\]

Institute for Educational Technology
University of Surrey.

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## PART I

The following comments on lab-work have been made. In order to find how far these statements reflect your views, I would like you to ring the number on the right which indicates how you feel about each statement.

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1. Without Lab-work physics is not physics
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4. Lab-work is largely a waste of time
5. Learning physics without Lab-work is like learning to swim without water - nearly impossible
6. Lab-work raises students' interest in physics
7. If you do much Lab-work you cannot cover the syllabus
8. Lab-work tends to become a cooking exercise
9. Lab-work makes physics very real and understandable
10. School experiments are not related to physics theory

Please add and rate any other statements.

11.

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\(^{(1)}\) Lab-work (Laboratory-work): Refers to any work of a practical nature done in a Physics Laboratory.

\(^{(2)}\) Individualised Learning: Refers to those situations where the students have direct access to learning materials and resources, e.g. study guides, work-sheets.
PART II

The following is a list of possible aims for the Lab-work in a physics course. Please rate each one on the scale depending on how much you think that particular aim is:

(a) An aim of your actual physics Lab-work where you are using individualised learning.

(b) How much you think that particular aim should be an aim of Lab-work in a physics course which uses individualised learning.

<table>
<thead>
<tr>
<th>(a)</th>
<th>(b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOT AT ALL</td>
<td>NOT IMPORTANT</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
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<td>1</td>
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</tr>
<tr>
<td>1</td>
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</tr>
</tbody>
</table>

1. To develop specific manipulative skills
2. To familiarise students with important standard apparatus and measurements techniques
3. To reinforce theoretical knowledge
4. To promote a logical, reasoning method of thought
5. To train students in making deductions from measurements and in the interpretation of experimental data
6. To enable the students to find facts and arrive at new principles by investigation
7. To develop an ability to communicate in physics
8. To provide closer contact between students and teacher through discussion of experiments

9. To stimulate and maintain students' interest in physics
10. To develop critical attitudes towards experimental work rehabilitation, accuracy, interpretation
11. To give practice in seeing problems and seeking ways to solve them
12. To help the students to bridge the gap between theory and practice
13. To prepare the student for a practical examination
14. To make phenomena more real through actual experience
### PART III

Please indicate how frequently you use each of the following kinds of Lab-work in your actual course (Column A), and how frequently they should be used in a physics course using individualised learning (Column B).

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</tr>
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<td>5</td>
</tr>
<tr>
<td>Used</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Occasionally Used</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Rarely Used</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Never Used</td>
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1. Demonstrations that verify facts and principles (This might or might not involve the students in discussion)

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2. Repetition (by students) of standard qualitative experiments, e.g. "to show that ..." procedure well defined and clear instructions given

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<td>3</td>
</tr>
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</tr>
<tr>
<td>Never Used</td>
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<td>1</td>
</tr>
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4. Discovery experiments designed to answer a question raised in the development of the theoretical work

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5. Projects, e.g. problems (new to the students) involving some investigative work and study in depth to reach a solution

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<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Never Used</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

6. Please add and rate additional kinds of Lab-work.

<table>
<thead>
<tr>
<th></th>
<th>1 2 3 4 5</th>
<th>1 2 3 4 5</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
<tr>
<td>Used</td>
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</tr>
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7. Please add and rate additional kinds of Lab-work.

<table>
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</tr>
<tr>
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</tr>
</tbody>
</table>

### PART IV

Teachers have found that the difficulties in doing physics Lab-work stems from several causes, e.g. lack of equipment, time, technical help, the loading of laboratory timetables, the size of classes.

Which difficulties are important in your present course?

Why?

In what way does the use of individualised learning increase or decrease the of Lab-work compared with those found in the traditional method of teaching?
 PART V

Please indicate, by ringing the numbers in Column A and Column B, the response that you think is the most appropriate for each statement.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Column A In your actual course</th>
<th>Column B In a course based on individualised learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Some experiments are replaced by films, film-loops, videos, computer exercises</td>
<td>5 4 3 2 1</td>
<td>5 4 3 2 1</td>
</tr>
<tr>
<td>2. Experiments are explained by using film-loops, videos, films</td>
<td>5 4 3 2 1</td>
<td>5 4 3 2 1</td>
</tr>
<tr>
<td>3. Films, videos or film-loops are used to show how to use some sophisticated apparatus</td>
<td>5 4 3 2 1</td>
<td>5 4 3 2 1</td>
</tr>
<tr>
<td>4. Experiments which require very sophisticated apparatus are replaced by films, film-loops, videos</td>
<td>5 4 3 2 1</td>
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</tr>
<tr>
<td>5. Experiments are set up by a teacher on film, video or film-loop and the students then set up the same experiments by themselves</td>
<td>5 4 3 2 1</td>
<td>5 4 3 2 1</td>
</tr>
<tr>
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<td>5 4 3 2 1</td>
<td>5 4 3 2 1</td>
</tr>
</tbody>
</table>

If you wish to make any comments in addition to these ratings, or on any other aspects of Lab-work, please do so below.
APPENDIX D

LIST OF TEACHERS' ACTIVITIES

IN INDIVIDUALISED LEARNING
TEACHER'S ACTIVITIES IN I.E.

IN A STUDENT-CENTRED SITUATION ...

1. I need more preparation before the lesson, in normal teaching I need rather less possibly without disaster.

2. I rarely do class discussion.

3. I deal with individuals, not with the whole class.

4. I do not deal with the whole class, I deal with individual.

5. There is less need of teacher direction.

6. There is less dealing with the class as a whole.

7. I don't teach the class as a whole.

8. I need more pre-planning for the lesson.

9. I am more a consultant rather than a director.

10. I am more an organizer rather than an expositor.

11. I allow the students to work at their own pace, in normal class teaching is required and the students keep up with each other.

12. I encourage the students to find out information for themselves.

13. I have time for individual tuition.

14. I prepare the material myself rather than follow other people's ideas.

15. There are lots of practicals for the students rather than copying and writing.

16. There is lots of marking for me to do.

17. Students do different work, it is much harder for me to mark.

18. I do not use the traditional sequence of topics, heat, light, sound, etc. I use a concept based approach.

19. I know exactly work covered.

20. I can lose track of who's done what with large group.

21. I can make pupil work at his/her maximum rate.

22. There is a greater emphasis on teacher preparation rather than relying on lab. technicians.

23. I have storage problems due to lack of control with the material.

24. There is individual work rather than class teaching.
25. I allow the students to have their own rate of progress.
26. I work with individual all the time.
27. I teach individually.
28. I control the lab. work.
29. I control individual work.
30. I need a range of apparatus.
31. I follow my own ideas, no in-service courses.
32. There is no class discussion between teacher and students.
33. I use written material instead of the blackboard.
34. I manage structured practical work.
35. I want a lot of written work.
36. I rely a lot on prepared resources to stimulate interest.
37. I do less talking to the class as a whole.
38. There is interaction between pupil and material rather than between teacher and pupil.
39. I allow the students to work at their own pace.
40. I provide a range of reference material for the student to use.
41. I do not need to give detailed instructions for pupil activity.
42. I allow the children to work on their own in order to find out the information rather than receive the information.
43. I move around the classroom a lot.
44. I talk to individual pupil rather than to the class.
45. I allow the students to do different work in class.
46. I allow the students to work individually rather than teaching them in groups.
47. I allow the children to work on their own, teacher in advisory capacity.
48. I organize the experiments or activities individually.
TEACHER'S ACTIVITIES IN I.L.

IN A STUDENT-CENTRED SITUATION ...

49. I demand work from the pupils through written material.
50. I orientate the work of individuals.
51. It is hard to prepare the material before lesson.
52. It is easier to organize because there is less demand on A.V.A. hardware.
53. It is more interesting because of the use of a variety of teaching methods.
54. I use material prepared by other people, I do not have control of the material.
55. I give the instructions of the course by written material.
56. I allow more variety in homework, therefore more interesting to mark.
57. I can sit and manage groups rather than talk up front to a great extent.
58. I give the notes in written form rather than dictate them.
59. I move between students rather than being static.
60. I am a consultant as a resource.
61. I am mainly a "problem solver" rather than a knowledge purveyor.
62. I prepared the information in written form.
63. I allow the students to pace the lesson.
64. I am an adviser who helps with the pace of the activities.
65. I am an assessor and motivator, more important to establish pattern of approach rather than impose my pattern of approach.
66. I allow the students to investigate aspects under their own initiative at the level they want.
67. I am mostly adviser in short term sense rather than having a range of roles.
68. I am a resource in the long term rather than dominating the teaching-learning situation.
69. I am mostly in one place rather than moving about.
70. There is less marking to do, in normal teaching I have to mark sets of books.
71. I spent a lot of time in the preparation of the lessons.
72. The class behaviour is good, the discipline is less difficult.
73. I talk to individual or small group rather than to talk to the whole class.
74. I allow the students to do different experiments.
75. I spent little time in introducing the lesson.
76. I spent a lot of time clearing up the classroom.
77. I am free of teaching from the blackboard, in normal teaching I use the blackboard continuously.
78. I pre-prepare course material (soft and hardware) to be used by the students.
79. I allow a student to teach him/her self.
80. I check the student's work while he is using the material.
81. I allow the students to take active role in the classroom.
82. All my effort goes into preparing material, and not teaching it rather than to teach poorly prepared material.
83. I allow the students to use the hardware rather than me using it for demonstrations.
84. I allow the students to have a wide area of study rather than limit it.
85. I allow the student to learn by experience, emphasis in practical.
86. I spent more time in the preparation of the material.
87. I move around more rather than stay in one place.
88. I allow the students to work in different things.
89. I supervise students' work individually.
90. There is great difficulty in setting homework as each student is doing something different.
TEACHER'S ACTIVITIES IN I.L.
IN A STUDENT-CENTRED SITUATION...

91. I have to hook a lot of equipment for each lesson.

92. Marking is more difficult but I can do some in class.

93. I allow the students to work from resources other than me.

94. I talk most of the time to individual or small group rather than to the whole class.

95. I allow the students to do the experiments by themselves and independently of each other.

96. I plan the course according to the need of individual.

97. I give the students experimental work to do which is relevant to the theory they are learning.

98. I am an adviser, consultant, course planner rather than an information giver.

99. I have to mark different homework.

100. My activities are uniform from lesson to lesson.

101. I spend much time going around from group to group rather than being in front of the room.

102. I allow an element of student choice according to interest/needs of my students.

103. I develop close personal relationship with the students.

104. I spend more time talking to individual or small group than in normal teaching.

105. I allow the students to find most answers to questions on their own from books, etc.

106. I have to work the instruction sheets.

107. I allow the students to work independently for a relatively long time continuously.

108. I allow the students to write most answers on blank sheets of paper rather than in allotted spaces.

109. I work with well defined units of material.
110. I allow the students to carry out a relatively large number of short-duration experiments rather than being demonstrated by me.

111. I prepare lessons in large blocks rather than lesson by lesson.

112. I monitored the pupils' work through multiple-choice tests.

113. I allow the students to work at different speeds.

114. I am a consultant instead of being in direct control of the learning.

115. I react to pupils' problems rather than carry the class with them.

116. I allow the pupils to work at their speed over a long period.

117. I allow the pupils to vary their rate of work.

118. I allow the students to dictate the speed of work.

119. I use the computer to help me with the marking.

120. I allow the students more freedom.

121. I re-write the material.
APPENDIX E

LIST OF TEACHERS' CHARACTERISTICS

(student perception of the teacher)
STUDENT PERCEPTION OF THE TEACHER

The teacher ....
1. already knows and understands the material.
2. does not know the students so well.
3. does not have any problem with the Physics.
4. explains things better, he knows more.
5. knows the answers already.
6. is involved with others when a question arises.
7. does not have the same problems as the s's.
8. is interested in Physics.
9. is older and wiser.
10. is extremely gifted at explaining problems.
11. is more sensitive and refined.
12. is interested in Maths.
13. is more sensitive.
14. is conscientious.
15. is a teacher.
16. works out the problems.
17. does not like people mucking about.
18. does not have problem in Physics.
19. gives or sets the work.
20. goes into his office and has a rest.
21. works hard but relaxes.
22. is a teacher.
23. understands the lesson.
24. is older.
25. does not fill up the worksheets.
STUDENT PERCEPTION OF THE TEACHER

The teacher ....

26. never asks for help.
27. does not sit around a table.
28. teaches Physics.
29. is older.
30. works with all the pupils.
31. is noisy.
32. does not get on well with all the pupils.
33. is not our friend.
34. does not share answers.
35. teaches us.
36. is good in Physics.
37. has experience.
38. has an answer to every problem and question.
39. helps the student.
40. teaches us.
41. is a teacher.
42. helps all the students.
43. knows the answers.
44. talks about Physics.
45. sets the questions.
46. talks a lot.
47. does not talk to us outside the classroom.
48. does not write a lot.
49. answers the questions.
50. can answer the questions easily (quickly).
STUDENT PERCEPTION OF THE TEACHER

The teacher ...

51. finds Physics easy.
52. explains Physics.
53. knows what he is talking about.
54. works on his own the problems (Physics)
55. is easy to understand.
56. is regarded as a last resort and is only consulted when the s's cannot work out the problem.
57. supervises calculations and marks.
58. has a higher social standard in the classroom.
59. moves about the class from person to person discussing problems.
60. knows everything, anyway he is the teacher.
61. uses basically Nelkon and Parker.
62. is teaching Physics.
63. does not need to study.
64. is not a student.
65. is involved in A.P.P.I.L.
66. is a teacher.
67. hasn't a sense of humour.
68. is not at the same level.
69. does not contact the student so much.
70. lectures us.
71. teaches Physics.
72. is only seen during Physics lesson.
73. treats us as students.
74. has got Physics 'A' level.
STUDENT PERCEPTION OF THE TEACHER

The teacher ...
75. knows about the work we do in Physics lesson.
76. only deals with one subject.
77. has to be talked to in a respectful manner.
78. is a teacher.
79. lectures us.
80. teaches Physics.
81. deals with one subject.
82. has less contact with the students.
83. asks questions to stimulate student's mind.
84. leaves out minor details in working (calculations).
85. asks questions to which he himself knows the answer.
86. is not seen outside the school.
87. asks questions to check if s's know.
88. works the questions for himself.
89. answers our questions.
90. asks questions that he can answer himself.
91. likes to leave some questions out.
92. has an overall picture of the subject/he is the teacher.
93. has more understanding of Physics.
94. is far more advanced than the pupil.
95. is older than we are.
96. has already completed his University course.
97. does not need to go to maths lesson.
98. knows more Physics than the s's.
99. teaches the students.
100. does not need to pass.
STUDENT PERCEPTION OF THE TEACHER

The teacher ...

101. is older than the s's.
102. is ahead in the subject.
103. is consulted by the s's because he is the teacher.
104. is consulted when s's have problem.
105. understands better Physics.
106. solves the s's problem.
107. has a degree.
108. is in the Physics line.
109. has a clear concise way of explaining.
110. does not discuss much.
111. explains and states facts.
112. understands Physics at a more advanced level.
APPENDIX F

ONE-TO-ONE INTERACTIONS
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APPENDIX G

PROPOSAL FOR TRAINING

TEACHERS USING A.P.P.I.L.
The need:

It seems that any 'innovation in teaching' is introduced because it is thought to show great promise and is judged to be valuable and effective. A few years later the so called 'new method' has either been assimilated or is thought not to be so valuable. In the latter case, a decade later will find it not used at all. It was demonstrated in Chapter VI (Individualised Learning in the classrooms,) that the way that the A.P.P.I.L. material was used in the schools was very much dependent upon the educational values of the teacher. A very important conclusion which can be drawn from this Chapter is that in future the degree of congruence between the philosophy and the aims of the teacher and those implied by A.P.P.I.L. will affect the acceptability of the project in the schools.

The idea of more independent or individual work in the classroom has been generally accepted by teachers (e.g. the popularity of work-sheets) but too many teachers are still "wondering how to use it effectively" in terms of implementation strategies. There is a very strong relationship between the teacher's type of concern for the project (how much he knows about it in terms of material needed, activities to do, new roles, time involved in planning, marking, interactions, organization, students' achievement, etc.) and the way of using the project.

Most of the A.P.P.I.L. teachers are involved in traditional teaching for 80% of the school time and they are usually relatively alone in using A.P.P.I.L. in their schools. The opportunities that the teachers have for answering, by themselves, all the questions which usually arise when the project is used for the first time, of solving both the small and large problems, is minimal. Teachers are often puzzled at the outset about what to say or ask a student or
even more whether to say or ask anything at all. In classrooms where the teacher is not well prepared for work with the project, the range of materials needed are often not available in time and the teacher is unable to quickly pinpoint students' difficulties and deal with them. It is not enough for a teacher who wants to use individualised learning to know the content of the material. He has to be thoroughly familiar with the way the content is presented in the innovation and should be aware of the types of problems he and his students are likely to face. He should also learn to interact with the students (in small groups or with individuals) long enough to guide and stimulate their ideas but not so long as to bore the student. 'No interaction' does not mean that the student will learn more with the material. The teacher should learn to share the teaching with the material.

The Evaluation of A.P.P.I.L., which aimed to study the impact and effect of A.P.P.I.L. on the classroom situation, demonstrated once more that curriculum development means teacher development, that the teacher has a vital role to play in the classroom where student-centred material is used and that there is no such thing as teacher-proof curriculum.

What to do.

As in any year there will be many teachers using A.P.P.I.L. for the first time, it seems to be necessary that some kind of training be provided in order to help them in the implementation of the project. The kind of training I am proposing does not intend to tell the teachers how the units should be used, but to reveal and fulfil the needs of individual teachers. In other words, to apply individual/independent and resource based learning to the teachers.

Bearing in mind that:

(1) The first month is the most important time in the adaptation of the project in the schools.
(2) The A.P.P.I.L. Teacher's Handbook is not enough to know how to work with the project as it presents only the general information of the project,

(3) Teachers cannot attend a Residential Course at the beginning of the first term (due to administration problems),

(4) Teachers on Residential Courses are divorced from the classroom, which is their reality,

(5) Teachers without any experience in using A.P.P.I.L. do not know what their personal limitations are in respect of the skills demanded by its use.

I propose that a course should be designed as follows:

(a) The course should be in weekly sessions for a minimum of 4 weeks.

(b) The sessions should be after the normal school day or when the teacher, by common agreement, can attend them.

(c) A session should not be longer than 2 hours.

(d) The Advisory Teachers could run the sessions, working with different small groups.

(e) Teachers with experience in the use of A.P.P.I.L. should be invited to run small group discussions such as: on managing lab. work in large groups, one-to-one interactions, L VIth and U VIth together, preparation of the material, managing different activities, how to create a science environment, etc.

(f) There should not be a session in the first week of the term in order to give an opportunity for the teacher to feel the needs of the course.
(g) At the end of the first week a questionnaire will be sent to them where the needs and interests will be identified and the levels of concern in the project will be determined.

(h) With the information gathered in the questionnaire, needs and interests will be classified and divided into at least three sessions.

(i) The first session will be divided in two parts: in the first part information about the course in general and how it has been planned, getting feedback from the teachers about it and modifying it if required.

(j) Books and A.V.A. used in the starting units should be around and some experiments should be set up, in each session.

(k) The group should be divided into small groups of 4 or 5 according to the types and levels of concern in the project.

(l) In every session written feedback from the teacher should be asked for in order to modify future sessions if required.

(m) A session on lab. work should be designed in such a way that the teachers have enough time to work through all the experiments of one starting unit, and in some cases, ideas of how to do the same experiment with different apparatus. This should be discussed with small groups.

(n) Extra written material could be available in case the teachers want to know more about any specific point.

(o) An evaluation of this in-service training should be done.

I offer my full co-operation and time in the design and preparation of these sessions.

Greta M. de Gonzalez