LEARNING ENGLISH FOR SCIENCE AND TECHNOLOGY IN BAHRAIN - AN ALTERNATIVE APPROACH.

جامعة البحرين
المكتبة
LIBRARY
University of Bahrain

by

HUSAIN A. A. DHAIF

كلية البحرين الجامعية
المكتبة
LIBRARY
University College of Bahrain

A Thesis Submitted to the

University of London for the

Degree of Ph.D.

1983

University of London Institute of Education

Department of English for Speakers of Other Languages.

LIBRARY
University of Bahrain

ABSTRACT

The thesis considers critically the underlying assumptions and pedagogical implications of current EST materials. It argues that these materials fail to take into account the needs of the local learner from a cognitive point of view, and therefore there is usually a mismatch between the learner and such materials. The thesis suggests that our approach in presenting EST material should be based on the prevalent learning conditions rather than on assumptions about those conditions. This entails investigating the learning style of the learners in the given context.

The thesis puts forward the hypothesis that the strong influence of the cultural and educational variables on the learning process in Bahraini schools results in promoting a type of learning style which is based on learning rules and principles which are carefully explained, exemplified, and then applied. The thesis presents empirical evidence to support this hypothesis using two approaches. Firstly, a classroom interaction analysis is conducted to identify the teaching/learning strategies. Secondly, accepting the notion that learning in general and language learning in particular is a problem solving process, two types of experiments are conducted to compare the learning style proposed in the developed hypothesis with the one usually foregrounded in current EST materials, that is learning through discovery. One type of experiment is based on solving problems in the form of geometrical figures. The other is based on language tasks dealing with certain grammatical and discoursal aspects of EST. In both types of experiments time and recognition of the principle applied are also measured as contributing learning variables.

The results obtained from the interaction analysis suggest that the teaching/learning strategies prevailing in the classes studied take the form of teaching and learning of rules and principles which are throughly explained, consolidated, and then used to develop more data. Also, that learning is conducted in a spiral manner whereby the previously learned data is recycled at different stages during the learning process to ensure maximum retention. The experimental part confirms these findings and shows that in the case of these learners rule and principle learning, as defined in the text, seems to be more effective than any other learning style. It also indicates that less time is usually required for learning in this manner.

CONTENTS

			Page
ABSTRACT.			2
CONTENTS.			4
LIST OF FIGURES.			6
LIST OF TABLES.			7
ACKNOWLEDGEMENTS.			9
INTRODUCTION.			10
CHAPTER ONE:	ENGLISH FOR SPECIFIC PURPOSES (ESP): A THEORETICAL PERSPECTIVE.		20
	1.1	Introduction.	20
	1.2	What is ESP?	20
	1.3	ESP and EST.	24
	1.4	Factors in the Definition of ESP.	27
	1.5	An Historical Perspective of ESP.	28
	1.6	Discourse Analysis and the Current Situation.	36
	1.7	ESP and the Communicative Approach.	40
	1.8	Needs Analysis and Students' Motivation.	46
	1.9	The Use of Authentic Materials.	53
	1.10	Conclusions.	56
CHAPTER TWO:	A CRITICAL ANALYSIS OF SOME BASIC ASSUMPTIONS IN CURRENT EST MATERIALS.		60
	2.1	Introduction.	60
	2.2	The Theoretical Background of Western Science Teaching Methodology.	70
	2.3	The Problem Solving Domain.	72
	2.4	Problem Solving and EST.	78
	2.5	Problem Solving Reconsidered.	87

CHAPTER THREE: THE CASE FOR AN ALTERNATIVE ROUTE TO EST. 95

3.1 Introduction. 95

3.2 Science Teaching in Bahrain. 95

3.3 Hypotheses and Research Design. 100

3.4 Interaction Analysis: A Review. 106

CHAPTER FOUR: INVESTIGATING LEARNING STRATEGIES 1: THE CLASSROOM INTERACTION ANALYSIS. 125

4.1 Introduction. 125

4.2 A Suggested System for Analysing Classroom Interaction. 132

4.3 The Coding and Decoding of Data. 142

4.4 Some Comments and Interpretations. 173

CHAPTER FIVE: INVESTIGATING LEARNING STRATEGIES 2: THE PROBLEM SOLVING EXPERIMENTS. 183

5.1 Introduction. 183

5.2 The Match Tasks Tests. 192

5.3.0 The Language Tasks Tests. 199

5.3.1 The Language (Discourse) Tests. 204

5.3.2 The Language (Grammar) Tests. 209

5.4.0 Results and Comments. 212

5.4.1 The Match Tasks Tests. 213

5.4.2 The Language (Discourse) Tests. 225

5.4.3 The Language (Grammar) Tests. 235

5.5 Conclusions. 248

CHAPTER SIX: THEORETICAL AND PEDAGOGICAL IMPLICATIONS. 252

6.1 Introduction. 252

6.2 Theoretical Considerations of Some Related Theories in Foreign Language Learning. 253

6.3 Implications for Teaching EST in Bahrain. 261

APPENDICES. 278

BIBLIOGRAPHY. 320

LIST OF FIGURES

No		Page
1	Strevens' Taxonomy of ESP Courses.	22
2	The Relationship Between the Domains of ESP.	24
3	Robinson's Summary of ESP Courses.	26
4	Widdowson's Three-way Information Transfer Model.	45
5	Gagne's Hierarchy of Learning Conditions.	73
6	Transition Pathways of Interaction in Episodes A, B, and C.	175
7	The Match Tasks.	186
8	An example of a solution to Match Task 1.	188
9	Exemplification of Conditions for solving the Match Tasks.	194
10	An example of a solution to Match Task 8.	196
11	Exemplification of the Principle for Language (Discourse) Tasks.	207
12	Correlation of the Language (Discourse) Tasks.	208
13	Means of Repeated Measures Analysis by Group for the Match Tasks Tests.	220
14	Sex by Group Interaction for the Match Tasks Tests.	222
15	Means of Repeated Measures Analysis by Group for the Language (Discourse) Tests.	231
16	Sex by Group Interaction for the Language (Discourse) Tests.	232
17	Means of Repeated Measures Analysis by Group for the Language (Grammar) Tests.	241
18	Sex by Group Interaction for the Language (Grammar) Tests.	244

LIST OF TABLES

No		Page
1	Reaction of the Ministry of Education (Bahrain) to the Importance of Aims of Science Teaching in Secondary Schools (from Arrayed, 1980).	97
2	Cell Address in a 20 x 20 Interaction Analysis Matrix.	149
3	Interaction Analysis Matrix for Episode A (Chemistry).	170
4	Interaction Analysis Matrix for Episode B (Biology).	171
5	Interaction Analysis Matrix for Episode C (Physics).	172
6	Summary of the Experimental Design for the Match Tasks Tests.	199
7	Percentages and Means of Time (in seconds) for the Match Tasks Pre-tests.	214
8	Percentages and Means of Time (in seconds) for the Match Tasks Post-test.	215
9	Percentages and Means of Time (in seconds) for the Match Tasks Re-test.	215
10	Means and S.D.s for the Match Tasks Scores.	218
11	Repeated Measures ANOVA for the Match Tasks Scores.	219
12	Means by Sex by Group for the Match Tasks Scores.	221
13	Means and S.D.s of Time Scores (in seconds) for the Match Tasks Tests.	223
14	Percentages and Means of Time (in seconds) for the Language (Discourse) Pre-test.	226
15	Percentages and Means of Time (in seconds) for the Language (Discourse) Post-test.	226
16	Percentages and Means of Time (in seconds) for the Language (Discourse) Re-test.	227

No		Page
17	Means and S.D.s for the Language (Discourse) Scores.	229
18	Repeated Measures ANOVA for the Language (Discourse) Scores.	230
19	Means by Sex by Group for the Language (Discourse) Scores.	233
20	Means and S.D.s of Time Scores (in seconds) for the Language (Discourse) Tests.	234
21	Percentages and Means of Time (in seconds) for the Language (Grammar) Pre-test.	236
22	Percentages and Means of Time (in seconds) for the Language (Grammar) Post-test.	237
23	Percentages and Means of Time (in seconds) for the Language (Grammar) Re-test.	238
24	Means and S.D.s for the Language (Grammar) Scores.	240
25	Repeated Measures ANOVA for the Language (Grammar) Scores.	242
26	Means by Sex by Group for the Language (Grammar) Scores.	243
27	Means and S.D.s of Time Scores (in seconds) for the Language (Grammar) Tests.	245
28	Percentages for Principle Recognition for the Language (Grammar) Tasks.	247

ACKNOWLEDGEMENTS

At this stage I would like to express my gratitude to my supervisor Prof. H.G. Widdowson who helped me to refine my ideas and whose guidance and encouragement was invaluable throughout the stages of my research. I am also grateful to Dr. C.J. Brumfit who showed an active interest in my work and who was always willing to offer his sound judgment in solving some of the problems I faced in carrying out my research.

My thanks also go to the headmasters, headmistresses, teachers, and students of those secondary schools in Bahrain who were kind enough to tolerate my presence in numerous classes, either for filming, observing, or testing during the process of collecting my data. These schools are:

Isa Town Boys' Secondary School

Isa Town Girls' Secondary School

Shaikh A. Aziz Boys' Secondary School

Hoora Girls' Secondary School

West Rafa' Girls' Secondary School.

I would also like to extend my gratitude to University College of Bahrain for offering me a scholarship to follow my research.

Finally, this acknowledgement will not be complete without mentioning my wife, Hussa, and my daughters, Shayma and Bashayer, who suffered the discomfort of being away from me for some time while I was in London. To them I present this thesis.

INTRODUCTION.

It is commonplace for language teachers to pass judgments on the material they use in their classes. Such judgments, however, are usually based only on their experience in teaching that particular material in the context given, and are mostly confined to the practical rather than the theoretical aspects of the material in question. In other words, they are restricted to the type of contexts, structures, and learning activities presented in the material. There is no doubt that a more reliable judgment can be achieved through investigating the theoretical and behavioural basis of that material and weighing them against the learning conditions prevailing in the context given. This obviously lies within the domain of research since teachers in many teaching situations do not have the time, and perhaps the techniques, to carry out such a task. It is through research that one can examine seriously the appropriacy or applicability of certain teaching materials to a given situation.

It would be true to suggest, however, that despite the increasing investigations into the field of language teaching and language learning, and the development of new methodologies and teaching materials, many problems remain unsolved in this field. This is because of the diversity of the learners, their ages, motivations, purposes for learning a given language, and the social, educational, economic and even political situations in which they are learning it. These factors in fact usually decide what is taught and how it is taught. Another equally important reason, which the present study takes its cue from, is that most of our research in language teaching and language learning, and

definitely in the case of foreign languages, seems to be concerned with contrasting teaching methods or suggesting new approaches to producing teaching materials which are based on criticism (of the existing ones) and speculation. There has been comparatively very little research into what the learners have, do, or can do in the learning process. In other words, there is still an acute shortage of research into the behavioural and cognitive domains of foreign language learning. In 1973 Pit Corder wrote " It is as well to admit that at the present time we lack any clear and soundly-based picture of the learning process." [p.109]. A decade later, the picture is still hazy. I believe that until this area is given the attention it deserves, misfits between the learner, the teaching material, and pedagogy will continue to prevail.

In so far as the teaching of English in Bahrain is concerned, my feeling is that research into the learning behaviours and conditions is warranted in the case of English for science and technology (EST). The problem is that students in Bahraini secondary schools using some existing EST materials seem to face considerable difficulties in dealing with those materials. This happens despite the fact that these students have had English tuition for six or seven years, and that the scientific material they are presented with is quite basic. This suggests that some sort of a mismatch exists between the material and the learner above the linguistic level, even after allowing for the low standard among students in general in Bahrain due to the level of teachers' competence and general learning conditions. I would like to suggest that such a mismatch exists between the teaching/learning

strategies prevailing in the Bahraini context on the one hand and the ones pre-assumed by the teaching material on the other. In order to appreciate the need for such research however, it is imperative to consider the social role and status of the English language in Bahrain and to study the factors which influence that status.

In Bahrain, English is the prestige language nowadays. In fact its social status is growing continually as a result of the increasing demand for English in educational, scientific, industrial, and commercial fields. That status has also been influenced by a set of political, economic, social and educational factors. In previous studies [Dhaif 1976 and 1977] I discussed those factors in some detail. I think it would be of benefit to this general background account to reiterate that discussion.

A. The Political Factor:

To study the impact of this factor, a brief account of the political background of Bahrain is essential. Because of its strategic position in the Arabian Gulf, Bahrain drew the attention of both eastern and western powers from as early as the sixteenth century when it fell under Portuguese domination. Then came the Persians who ruled the island for more than two hundred years. In the nineteenth century it was the British who showed a great interest in the Gulf region in general and Bahrain in particular for its position as a staging post on the route to India. This interest led to the signing of what is known as "The Perpetual Treaty of Peace" between Britain and the Gulf

sheikhdoms against any external aggression. Britain in fact went further in its attempt to dominate this strategic area in the Middle East by entering into a number of separate agreements with these sheikhdoms. It strengthened its ties with Bahrain by a set of protection treaties in 1861 and 1892. In the twentieth century, and with the discovery of oil in Bahrain, the Anglo-Bahraini relations developed in such a way that Britain controlled Bahrain's defence and foreign policies and appointed a British advisor, Sir Charles Belgrave, to the ruler of Bahrain in 1926. This episode ended on 15th August 1971 when Bahrain was declared an independent state. The protection treaty was replaced by a new treaty of friendship and co-operation.

This strong political relationship meant that Bahrain was firmly placed within the English language dominance which was encouraged by the British at all levels. Furthermore, throughout the different stages of the political relations between Britain and Bahrain, the British needed a group of mediators, such as representatives, translators, and clerks, in their contacts with the government and the people of Bahrain. This need created a group of bilinguals whose English served them to play such a role. Their knowledge of the English language enabled them to play an influential part in the Anglo-Bahraini relations, and consequently they became very distinguished members in society. It was then that English acquired its status as an influential language in the Bahraini Society because of the superiority enjoyed by its speakers.

B. The Economic Factor:

With the discovery of oil in 1932, Bahrain received a large group of British, American, and other western nationalities who worked in the oil producing industry. This was the first substantial contact between the people of Bahrain and the English language. In fact many Bahrainis, especially those who worked in the oil industry, picked up their English from these agents.

The strong Anglo-Bahraini political relations obviously created various economic links. Bahrain, like any other country under British colonisation, was used as a market for British products. Right from the beginning of this century, Bahrain also received a lot of British economic and educational aid. This aid was either in the form of equipment for industrial, medical, and educational purposes, or in the form of human resources such as administrators, advisors, and teachers. This obviously made a contribution to the status of English in Bahrain. With their products and aid the British exported their language to Bahrain, just as they always did wherever they went. This in fact created a vicious circle. As more people learned English, Britain sold more of her products because people usually buy things they know about, or at least can read about in a language with which they are familiar. This in turn created a further need to learn English.

There has also been a more recent boost to the status of the English language in Bahrain in relation to the impact of certain economic factors. After the collapse of Beirut during the Lebanese civil war as a strong centre for trade and commerce,

most of the international business establishments set their eyes on Bahrain as an alternative centre for their activities in the region, encouraged by the social stability and the excellent communication services which Bahrain offers. This has resulted in a huge increase in trade and commercial activities in Bahrain, especially in the off-shore banking services. With this increase in activity the influence of the English language grew manifold as it is the recognised means of communication.

At the moment English is the lingua franca of commerce and industry in Bahrain, and it is the only foreign language which is used officially in hospitals, airports, factories, banks, supermarkets, and other commercial spheres. It is also widely used in certain official communications. In fact English is used more than Arabic, the official language, in some governmental circles such as the departments of the Post Office, Electricity, Civil Aviation, Public Works, and the Ministry of Health. The recent policy of the government to Bahrainize most of the key posts in the general and private sectors which are occupied by English-speaking personnel has given a further boost to the status of the English language. It is the inevitable tool through which knowledge and skill is transferred from the expatriates to the Bahrainis who will eventually take over.

Proficiency in English is also a passport to better jobs, both in the general and private sectors. It is commonplace nowadays to read in any job advertisement in the local press the condition that "The applicant must read and write English". School leavers who have a reasonable mastery of English are usually picked up by the commercial and industrial establishments

where salaries are high and prospects are good. The rest usually find jobs in the government ministries where salaries are comparatively low but knowledge of English is not essential. In most of the large commercial and industrial establishments proficiency in English is a key factor in promotion.

C. The Social Factor:

As the Anglo-Bahraini political and economic relations grew stronger so did the social status of the English language in Bahrain, mainly through the influxes of British and other English-speaking nationalities, such as Indians, who came to Bahrain in search of employment. And as more British took up jobs in governmental circles (as directors, advisors, etc.) and in the private sector (as managers, engineers, supervisors,etc.), and with the increase of English-speaking Indians in hospitals (as nurses, doctors, etc.) and in the private sector (as clerks, shop assistants, etc.) the English language spread rapidly in society and made more contacts with the people. Nowadays, the increasing number of Sri-Lankan nannies and housemaids, who have become a'household commodity', has meant that the English language is being introduced at the moment right from infancy in certain homes. In fact it is amazing these days to hear old grandmothers in Bahrain, most of whom are absolute illiterates, using some basic English words and phrases in their attempt to communicate with their housemaids. Other unskilled and semi-skilled Sri-Lankan men are currently abundant in both the general and private sector, and despite their success in picking up a workable amount of Arabic, they nevertheless represent an added strength to the existence of the English language in the Bahraini society.

D. The Educational Factor:

Although the Arabic language has remained the official language of the State and the medium of instruction in all the state schools, English is taught as a compulsory foreign language in these schools and is considered a first class subject. Students learn it from the fourth form in the primary school until the completion of their secondary education. This means that all those who attend school learn English for an average of five hours a week for eight years. Moreover, they must pass an English language test every term and/or in the promotion examinations at the end of each academic year. Failing such a test could mean the repetition of the year.

English is also the medium of instruction in most private schools, and for most subjects at the Gulf Polytechnic, College of Health Sciences, and University College of Bahrain, all of which offer tertiary level education. The increasing demand for technical education, as a result of the recent expansion in industrial enterprises in Bahrain and the government's plan to meet the shortage of skilled personnel in certain fields, has also strengthened the dominant role of the English language in the educational system. This is because English is not only a key subject in the selection process for this type of education, but also the medium of instruction for the technology subjects in technical schools.

The nature and strength of these factors, then, indicate that the English language has a dominant role to play both at school and

in society at large. That role is even more evident in the case of tertiary education where, as mentioned above, most subjects, particularly in science and technology, are taught through English. The present study, however, concerns itself with the teaching of EST at the secondary stage. This is because I believe that it is at this stage that we should start to prepare students to deal with the main features of EST discourse which they will be facing in learning science at the tertiary level. The fact is that there are always constraints imposed on EST courses offered within a college course structure. Colleges are always reluctant to 'give away' the sufficient number of hours for English courses since this would usually be on the expense of the time allocated for what they see as their prime concern, i.e, the science courses. As far as science departments are concerned, English is only a service subject, not a speciality, and therefore it should occupy only a fractional proportion of the semester. The problem, however, is that since science courses are taught through English, those courses cannot be taught efficiently until students have acquired an adequate and workable mastery of English.

The other reason for focusing on the secondary stage, as far as the situation in Bahrain is concerned, is that students by then would have had six years of general English and therefore this would be an optimum time to introduce them to a relevant ESP course. Furthermore, they are required to choose their specialisation at this stage and follow either a scientific or literary type of education.

Before leaving this introductory account, it is essential to make it clear from the outset that the investigation of general strategies in science teaching/learning in Bahrain which is included in this study is purely analytical and not evaluative. In other words, although the teaching/learning conditions prevalent in the Bahraini context might not be considered ideal, they are nevertheless the ones we have to deal with and accommodate in our EST pedagogy at the moment if we are to establish any meaningful relationship between the learning context and EST. Finally, all the empirical data, which includes video recording of a number of science classes in four different secondary schools in Bahrain as well as students' answer sheets for all the experimental tests which were conducted, are available for any further consultation.

CHAPTER ONE

ENGLISH FOR SPECIFIC PURPOSES (ESP): A THEORETICAL PERSPECTIVE.

1.1 Introduction:

The scene of English language teaching has been inundated with teaching materials whose aim is to help the learner with uses of English for specific disciplines, especially science and technology. The preparation of these materials have been influenced by different trends ever since the need for specialist materials was recognised in the early 1920s. These trends have been different, even contrasting, in nature and have reflected the influence of development in adjacent disciplines, namely applied linguistics, sociolinguistics, psycholinguistics, and pedagogy. The current situation is undoubtedly the result of those trends in one way or another. In order to consider the validity of some of the underlying assumptions in ESP, and how those assumptions are reflected in the production of teaching materials, it is essential to study the developmental stages of ESP and to consider their implications. But before doing so, it is important, perhaps, to study some definitions of ESP and its boundaries.

1.2 What is ESP?:

Definitions of ESP are abundant in the literature of English language teaching. Mackay (1975), for example, writes that "It (ESP) is generally used to refer to the teaching/learning of a foreign language for a clearly utilitarian purpose of which there is no doubt." [p.24]. A somewhat similar definition is provided

by Strevens [1977a] who states that "ESP courses are those in which the aims and the contents are determined, principally or wholly, not by criteria of general education (as when 'English' is a foreign language subject in school) but by functional and practical English language requirements of the learner." [p.90].

The basic issue in these definitions is that the learner's specific purposes should represent the focal factor in deciding what to teach. It is important to point out here, however, that although it is currently assumed that it is the purpose of the learner which is specific rather than the language he should learn, this was not the case in the early stages of ESP as we shall see later in this chapter. Thus, the specificity of the purposes in current ESP definitions is related to the communicative needs of the learner as defined by his field of specialisation and the communicative situations he is expected to be engaged in. ESP, in this sense, focuses on the pragmatic rather than the formal aspects of language. In other words, ESP is more concerned with the teaching of those communicative acts required by the learner in his specific field rather than the linguistic properties of a certain register.

In these definitions, ESP is usually contrasted with what is known as "General English" courses which are normally culturally and literary oriented, and in which language is the means and the end at the same time. Thus, a general English course, unlike an ESP one, is non-specific in the sense that it is not directly related to any discipline or type of learners. Naturally there are always measures which are applied in choosing what is to be

taught in any given situation. In the case of general English, this means the teaching of a set of vocabulary, structures, and perhaps communicative acts which are considered as having a high frequency rate in everyday use of the language in situations typical of everyday life. ESP, on the other hand, is more geared to the learner and is therefore directly related to his communicative needs.

From these general definitions two main areas seem to stand out; English for Academic Purposes (EAP) and English for Occupational Purposes (EOP). In his Taxonomy of ESP. Strevens [1977a], however, favours the term "educational" as opposed to "academic", which he uses only when he talks about ESP in higher education. He develops the following diagram which characterises different ESP courses not only in relation to the situation in which those courses are offered but also the stage at which they are offered.

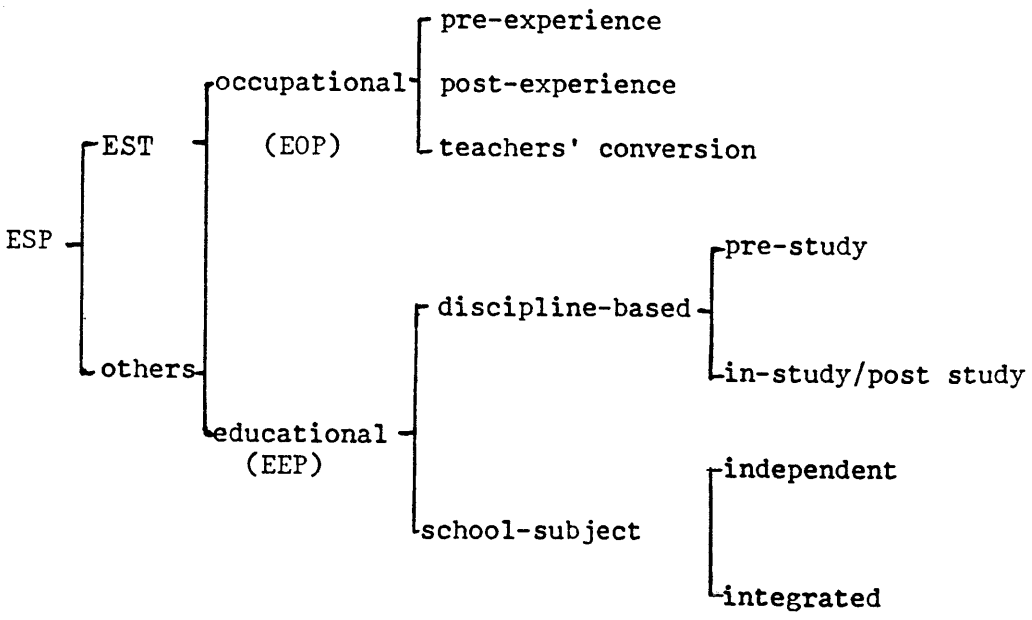


Fig. 1

[From Strevens, 1977a, p.92]

A number of points need to be discussed in relation to this diagram:

i. The use of the term "educational" instead of "academic" is perhaps intentional since the term "academic" suggests a higher and more technical level of employing the language, eg. in conferences, in writing papers for publication, or in research, and in which the focus is not on developing a basic linguistic ability but rather on the techniques of organising and presenting one's thought and arguments.

ii. The inclusion of the area of "teachers' conversion" in the diagram is inappropriate since the type of courses which Strevens has in mind here (i.e. retraining courses for teachers of French, for example) surely should be placed under 'occupational/post experience'. This is not an English language course per se but a course in linguistics and methodology.

iii. The area of 'EEP as an independent school-subject' is rather misleading. Does it refer to the general type of English courses, and in this case should it not be represented on the ESP spectrum? Or does it refer to the teaching of study skills as opposed to the subject matter and in this case we are dealing with a different level of definition that could be applied to all other categories on the diagram? The essence of ESP is that "considered as communication language ceases to be a separate subject, but becomes 'an aspect of other subjects'." [Mackay et al, 1978, p.18].

1.3 ESP and EST:

Another major, and possibly the most influential, area in ESP is that of the teaching of English for Science and Technology (EST), which contains certain features from both EOP (as in 'English for Nurses') and EAP/EEP (as in 'English for Chemistry'). The strong influence of EST is also manifested by the amount of research which this area has witnessed throughout the seventies in fields such as discourse analysis, rhetorical functions, and rhetorical structure (eg. the conceptual and physical paragraph). Robinson [1980] observes that "Although the largest number of ESP textbooks is in the general area of commerce, the largest number of articles refer to EST." [p.8]. If one considers ESP courses in relation to the communicative functions as well as the skills which these courses are to develop then an interactive relationship must exist between the three domains; EAP, EOP and EST. This relationship could be represented, in relation to General English, as follows:

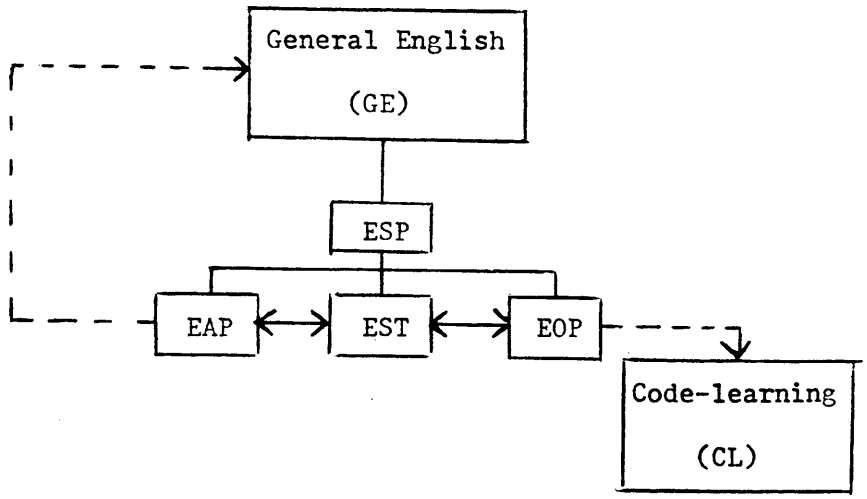


Fig. 2

Perhaps it is worth pursuing this discussion a bit further to

consider certain theoretical implications which may influence the content of EAP and EOP courses. Since the central issue in defining an ESP course is the learner's specific purpose and the type of language functions and skills to be developed in using a particular type of language, I would like to suggest that ESP courses can be presented on a continuum with EAP at one end and EOP at the other. Other types of ESP could be placed along the continuum (e.g. the intensive listening comprehension course in Japanese run by the armed forces of Britain and the United States in the Second World War for their air force personnel). Since the principal aim of any ESP course is to cater for the specific needs of the learner, an ideal EAP course will have to be so comprehensive in fostering language functions and skills that it may be classified as a general language course. (This explains the dotted arrow leading to GE 'General English' in the diagram above). On the other hand some EOP courses could be set up to teach a very restricted type of language use because the language functions are highly predictable and very precise as in a course for civil airline pilots or air traffic control staff or even international telephone operators. However, many socio-linguists would classify the type of language use generated in such situations as 'language-like behaviour' and not actual language use, since there is no real active and free use of language. Also, since the communicative acts are highly predictable in those situations, there is no negotiation of meaning which is an essential feature of any real communicative act. In this case language learning is in fact reduced to 'code learning'. (This explains the dotted arrow leading to CL 'code learning' in the diagrama above). Since an EST course is usually discipline oriented, and since it can be related to both EAP and

EOP, I think it would be more appropriate to talk about an offshoot of EST which is geared to academic purposes (ESTAP) as in 'English for Biology', with emphasis on aspects of scientific discourse and rhetorical acts as well as related skills. Similarly, another offshoot of EST would be geared to occupational purposes (ESTOP) as in 'English for Mechanics', with emphasis on communicative functions required in fairly definable communicative situations.

Finally, to summarise ESP courses it may be helpful to adopt Robinson's diagram [1980, p.13]:

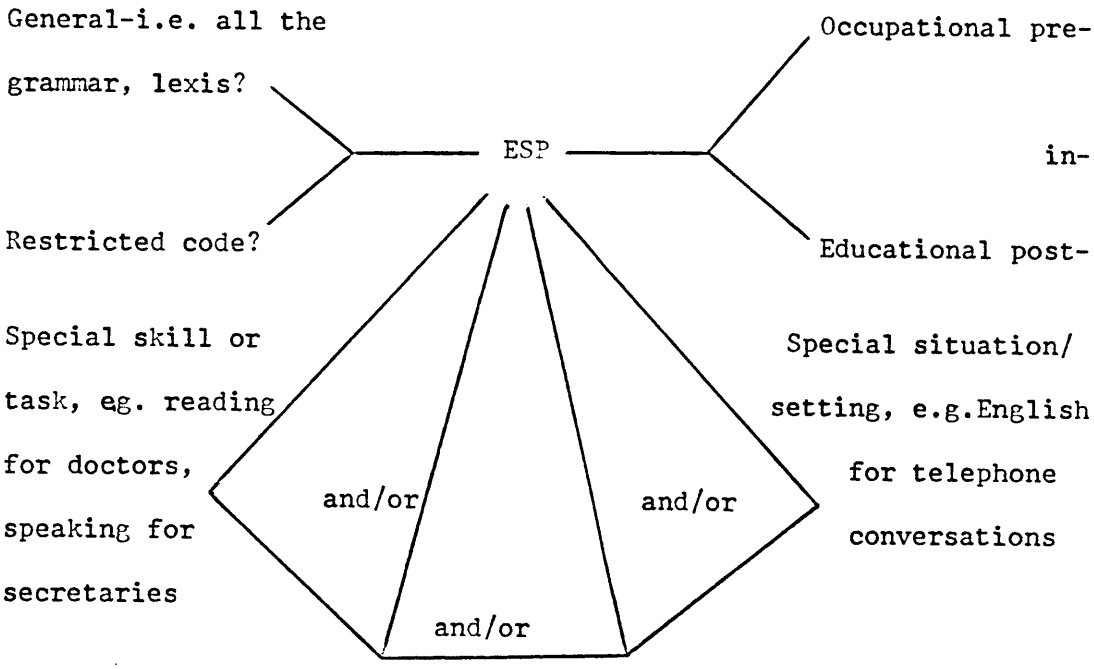


Fig. 3

1.4 Factors in the Definition of ESP.

Robinson [1980] suggests that any definition of ESP is affected by four factors:

i. The time factor: Most ESP courses acknowledge time constraints, especially in the case of EOP , which create a necessity to select which skills or communicative functions are to be developed in the given time. Perren [1974] writes: "In 1968 it was assumed that teaching a language to adults for special purposes often implied an intensive course. This still applies... The customer is often in a hurry, has little time at his disposal, and wishes to acquire particular skills related to his vocation or profession." [p.7]

ii. The age of the learner: Most ESP courses assume that the learner is an adult or near adult not only within EOP, during pre-service or in-service courses, but also EAP where the bulk of language courses are geared to tertiary education. However, recently there has been a tendency to consider secondary school students as the need for preparing them for higher education is increasingly recognised.

iii. Level of attainment: Since the assumption is usually made that the learner is an adult it is also assumed that he is a post-beginner. In fact, in his introduction to "The English We Use for Science" Close [1965] insists that students should first learn general English then English as used in science in general and lastly the type of English related to their specialist field. A similar view is held by Trim, and Hartley [in Perren, 1969]. The implication of the level factor is

that many ESP courses offer remedial English within the specific objectives, having recognised the inadequacy and inappropriateness of the preceeding general course [e.g. Bates, 1978], or redirect the use of the type of English the student has achieved at the previous stage [e.g. Widdowson, 1974a, Allen, 1975, and Allen and Widdowson, 1974].

iv. The ability to express learning purposes by the learner: This implies that both the learner and the teacher should be conscious of those purposes and thus the ESP course is, by definition, learner-centered. Strevens [1977b] notes that this learner-centeredness is significant "in demonstrating the existence of major 'tide' in educational thought" since ESP "can be seen as responding to the new educational requirement to study the learner, to analyse his needs and aims, to define his contribution to the learning/teaching situation." [p.152].

1.5 An Historical Perspective of ESP:

Although much of the development in ESP took place mainly in the last two decades, ESP is not a recent innovation and has a much longer history than is assumed especially in the area of Scientific English. The importance of focusing on the specific needs of the learner, a central issue in ESP, has long been recognised by textbook writers, although with a varying degree and nature of application. In his 'Basic English' C. K. Ogden [1932] recognised the learner's desire to apply the system developed in "Basic English" to his special field when he tried to answer the learner's question "Of what use is Basic to me in my special field?". Ogden's answer, however, was to show how

original scientific texts could be rewritten [in 'Basic English Applied: Science', 1931, and 'Basic for Science', 1942] using an extra 150 specialist words in adition to the initial 850 words which Ogden believed would do the work of 20,000 and would facilitate international communication. The distinction between science as a discipline and the different specialist subjects in science was also marked by the fact that "100 of these words are general science words (for which there may be parallels in other fields), of value in the discussion of any branch of knowledge which comes under the heading 'science'. The other 50 are made up from the narrower field in which special interest is taken." [Ogden, 1932, p.171]. Palmer and Harman on the other hand, in writing "The Teaching of English to Soldiers" [1940), which was written for African soldiers, acknowledged the importance of relating the teaching material to the particular difficulties of the learner. They wrote in the preface:

> "It seemed clear that the best solution of the problem would be an entirely new book prepared by those with a knowledge, not only of how English should be taught, but of the type of pupil to receive instruction." [p.7].

However, there is no evidence in this course to suggest that this aim was actually catered for. Whereas Ogden's application of the learner's needs is in the simplification of authentic scientific texts, Palmer's application is entirely situational, attempting to apply a general course of English to the military training situations of African soldiers. Both of them, however, turn to the provision of specialised vocabulary as a solution. Yet, the most interesting feature of Palmer's course is that it employed

an approach which runs contrary to most current ESP approaches in deciding what to teach since it was written "in such a way as to include most of the elements that are the more general and to exclude those that are more particular." [p.8]. These courses, however, cannot be considered seriously within the ESP spectrum, and nor can traveller's phrase-books of the type mentioned by Strevens [1977b, p.150], for they were not based on any serious investigations of the learner, his needs, or the linguistic characteristics of the specialist field. Strevens [1977b] suggests that "Language courses of the type 'German for science students' can more properly be regarded as the earliest form of SP-LT (special purpose language teaching)" [p.150-151). However, a close investigation of the linguistic components of books such as "Science German Course", [Moffatt, 1961] and "German for Science Students", [Rosenberg-Rodgers and Horwood, 1966] reveals that no restriction or selection (two of Strevens' major criteria for determining SP-LT content) was practised in presenting language data, since they introduce almost the whole corpus of the German patterns. The books offer exercises on sentence manipulation and passages for translation as exemplification of the general patterns rather than as distinct features of the German scientific register.

In so far as EST is concerned, however, a big surge had already started in the 1920s with a number of statistical investigations of science textbooks of the type exemplified by the work of Pressey [1924], Powers [1925] and later by Curtis [1938] and Cole [1940], and which resulted in compiling lists of vocabulary peculiar to different science subjects. The criteria used to

determine such vocabulary, as illustrated by Cole's work, were:

1. Frequency counts which were conducted and cross-checked by a number of people.
ii. Importance rate in teaching situations which was determined by consulting 'expert teachers'.
iii. Social usefulness estimated by the value of each vocabulary in life outside the classroom.

A significant outcome of the vocabulary frequency count in EST was the belief that specialised uses of language were exclusively a matter of lexicon. This in fact characterised the first stage in ESP.

The next stage in ESP came with the massive intensive courses which were run by the armed forces of Britain and the United States during the Second World War to train their air force personnel to understand the type of spoken Japanese used by Japanese pilots talking to their ground control stations. These courses used a restricted form of language (air force spoken Japanese) and had a restricted aim (listening comprehension).

Since the 1950s the theoretical background and preparation of EST teaching material has been influenced by four areas, which Macmillan [1976, p.41] lists, chronologically, as being:

i. Literature.
ii. Logic.
iii. Linguistics.
iv. Language in use.

He notes that in the early 1950s the feeling in some British universities was that science undergraduates suffered from 'narrowness of outlook' which was engendered by early specialisation within the school system. Interestingly, however, the distinction was not made between native students and those who came from overseas, but between arts and science students. The feeling was that science students needed more exposure to humanistic disciplines such as literature and logic. When analysing the problem of the undergraduate science students at Cambridge, Henn [1951] quoted Professor Lawrence Bragg, the Cavendish Professor of Experimental Physics, as saying:

> "They do not learn to write clearly and briefly, marshalling their points in due and aesthetically satisfying order, and eliminating inessentials. They are inept at those turns of phrase or happy analogy which throw a flying bridge across a chasm of misunderstanding and make contact between mind and mind. They do not know how to talk to people who have had a very different training from them, and how to carry conviction when decisions or plans for action of vital importance to them are made. Those are arts which our humanists have studied, and I feel very strongly indeed that a Cambridge education for our scientists should include some contact with the humanistic side. The gift of expression is important to them as scientists; the best research is wasted when it is extremely difficult to discover what it is all about." [p.142].

Thus, to Bragg the teaching of literature to science students was a means to achieve 'good style in thought' and to improve their presentation of scientific knowledge which he considered as "an art akin to poetry and literature." [in Henn, 1951, p.IX]. Henn also told the science students that "The qualities of good writing, clarity of thought, the justness of words, the judgment implicit in imagery, must come from you... and the only way of incorporating them in your own writing is by the enlargement of your sensibility, by your experience of literature of every kind." [p.141].

However, in the late 1950s a move towards a different type of material was generated. This move was based on a new development in linguistic theory, and was the result of two factors:

i. The recognition of the shift in motivation among language learners. West [1956] wrote about "the gap between the very general conversational and literary vocabulary taught in the schools and the realistic vocabulary which the learner demands for his earning life", indicating that "The dominant motive is no longer literary and social (interest in the British way of life) but commercial, technical and scientific."[p.153].

ii. The recognition of the difference between literary and scientific English. Brookes [1959] noted that "Literature and science are wholly separated; there is at best a coolness between them" [p.137], and demanded that the difference between these two areas should be recognised in teaching

> English to science and engineering students. He urged the need "to take a warmer interest in the characteristics which differentiate scientific from literary writing, and to study the problems of communication which are peculiar to the scientists." [p.138].

It is worth noting that although both Bragg and Brookes were concerned with improving students' ability in writing scientific English, Bragg turned to literature and logic for a solution while Brookes turned to linguistics via register analysis.

Macmillan [1976] notes that Brookes, in effect, pointed to two different but related areas in ESP. His first demand to take an interest in "the characteristics of science writing" pointed to the domain of linguistics and marked the shift towards the study of register, while the second demand "to study the problems of communication" pointed to the domains of sociolinguistics and psycholinguistics and marked the move to study communicative acts. Investigations into these two fields, however, did not start at the same time.

The concept of register was developed in the fifties and sixties by a number of British linguists [e.g. Halliday, Catford, Strevens] as a reaction to the traditional belief "that specialised uses of language are marked only by lexicon, and that words have a stable 'life-style'." [Spencer, 1973, p.38]. Investigations into register were based on studies of textual features of language in order "to produce a more systematic 'model' for handling the type of variability in language use which appear to correlate with differences of topic, rhetorical

function, medium, and participant relationship." [Spencer, 1973, p.38]. Halliday et al [1964] categorically defined the realm of register analysis when they stipulated that "It is by their formal properties that registers are defined. If two samples of language activity from what, on non-linguistic grounds, could be considered different situation-types show no differences in grammar or lexis, they are assigned to one and the same register." [p.89]. Register analysis focused on verb frequencies, sentence-types, and lexis in relation to specialised uses of language. The results of those analyses were then used to decide what to teach.

One result of register investigations with regard to EST was, for example, the belief that scientific English contained more passives than the normal use of the language and that certain verb tenses were more prominent in scientific English than in other uses. This, however, was not without conflicting results. While Swales, for example, in "Writing Scientific English" [1971], suggested that "In Scientific English the main verbs of sentences are usually in the Present Simple tense", [p.1], Close in "The English We Use for Science" [1965] emphasized the 'continuous tense' when he advised students reading scientific English to "observe the emphasis on activity in Progress, or on the process, or on the duration of the activity or process, which is expressed in the 'continuous' form of the verb, **e.g.** is rising, is being examined, have been heating." [p.14]. These investigations, nevertheless, led to more precise specifications of the linguistic needs of certain learners.

It must be pointed out here, however, that the move towards

register analysis did not dismiss the earlier vocabulary statistical investigations, but rather widened it to include syntactic features of the samples in question. Halliday, for example, believed that although frequency counts of words or structures would not yield accurate characteristics of 'special language' (register), they nevertheless, "do provide an important component of the total picture." [In Perren, 1969, p.24]. Implicit in the concept of register was the recognition of language as a code and the 'special languages' (or registers) as sub-codes. Also, the study of register gave primacy to written texts, as opposed to spoken conversations, for descriptive and comparative reasons. Thus the preparation of EST teaching material was based on the linguistic description of the lexical and syntactic properties of written scientific texts.

Finally, given the dominance of register analysis in the 1960s, one can rightly conclude that the second stage in ESP was characterised by the view that the 'S' in 'ESP' stands for a 'special language' rather than a specific learning purpose, and consequently ESP courses were subject, rather than learner, oriented. Writing EST textbooks was a matter of:

i. deciding the linguistic features of scientific English, and

ii. selecting, adapting or writing specific teaching material to illustrate those features.

1.6 Discourse Analysis and the Current Situation:

Since the 1970s the situation has changed considerably. Many linguists and applied linguists have rejected the concept of register in describing specialised uses of language since it is

based on the traditional linguistic theory which is accused of focusing on language as a referential code and ignoring its functional role. Register analysis is then guilty of focusing on the textual, rather than the contextual, features of language. In other words, it is criticized for being confined to the formal properties of language as exemplified at the sentence level and thus being unable to take into account the communicative purpose of the text.

The current belief is that a more appropriate way to study the characteristics of language registers is "to discover what rhetorical acts are commonly performed in them, how they combine to form composite communication units, and what linguistic devices are used to indicate them." [Widdowson, 1971, p.40]. What Widdowson is advocating here is the study of a sample of language not as an exemplification of language usage (register analysis) but rather as an exemplification of the communicative acts of language use (discourse analysis).

It is worth noting that Widdowson, one of the most influential thinkers in ESP, is taking Austin's notion of "speech acts" a step further to consider other aspects of language use, especially the relationship between the utterance and the context. Austin [1962] rejected the assumption in philosophy then that to say something is always to state or describe something, and therefore any utterance ought to be verifiable, i.e. it could be true or false. Instead he argued that to say something is to do it, i.e. to perform an act of some kind. He then tried to establish a grammatical relationship between the

utterance and its performative force, or what he called 'illocutionary act'. He pointed out that every utterance has an illocutionary act which could be made explicit by the use of a performative verb. He summarised his criteria grammatically as follows:

> "... any utterance which is in fact a performative should be reducible, or expandible, or analysable into a form with a verb in the first person singular present indicative active... Thus 'out' is equivalent to 'I declare, pronounce, give, or call you out'. 'Guilty' is equivalent to 'I find, pronounce, deem you to be guilty'. 'You are warned that the bull is dangerous' is equivalent to 'I, John Jones, warn you that the bull is dangerous'." [p.62].

Although Widdowson [1971] recognises the validity of Austin's insight in establishing a relationship between what is now known as surface structure and deep structure, he nevertheless objects to Austin's criteria on three grounds:

i. Although sentences like 'Come here' and 'I order you to come here' have the same illocutionary force, the circumtances in which each of them is used would be different.

ii. In most cases it is difficult to specify the illocutionary act if a context is not provided. Thus 'I'll come tomorrow' may serve as a promise, a threat, or a confirmation, and 'You sound just like your mother' may be an insult or a compliment.

iii. The problem is further complicated by the fact that "Just as one linguistic form may fulfil a variety of rhetorical functions, so one rhetorical function may be " fulfilled by a variety of linguistic form." [Widdowson, 1971, p.38].

However, notions such as 'speech acts' and 'rhetorical functions' has led to a growing interest in the study of the social functions of language and the investigations into discourse. Thus, linguists and applied linguists have begun to look beyond syntax to pragmatics in language analysis and to investigate the rhetorical acts, rather than linguistic features, of language use.

The shift in orientation in linguistic theory has led to fresh outlooks in applied linguistics to establish new approaches, especially in the analysis of a particular discourse, which in turn has resulted in new insights into pedagogy. One prominent area which has received considerable attention in this respect is that of EST. In fact Widdowson [1971] demands that "applied linguistics should be concerned with EST because it happens to bring into prominence, as 'general' English teaching does not, a question which is one of the principal issues in linguistics at the present time: that is to say, the nature of language as communication." [p.31].

Thus, investigations into discourse analysis have had strong impacts on the study of the main features of English for science and technology. The most important one, perhaps, is the rejection of frequency counts of tenses and vocabulary as a base for describing language properties peculiar to EST discourse,

since such counts do not reveal the communicative value of that discourse. As Allen and Widdowson [1974] point out "People who talk about 'scientific English' normally give the impression that it can be characterized in formal terms as revealing a high frequency of linguistic forms like the passive and the universal tense in association with specialist vocabulary. But to characterize it in this way is to treat scientific discourse merely as exemplification of the language system, and does little or nothing to indicate what kind of communication it is." [p.4]. The other important point is that scientific English usually uses a substantial amount of non-verbal devices, such as graphs, tables, and formulae, which represent an important element of scientific communication but which cannot be accounted for by the frequency lists. It follows then, that the concern with teaching ESP in general and EST in particular is very much related to the teaching of communicative English.

1.7 ESP and the Communicative Approach:

The focus in discourse analysis on the communicative acts of language, which characterises the current stage in ESP, has meant a shift in pedagogy as well as in language description. In general, language learning is now considered as performing a communicative role. Consequently, the emphasis in pedagogy is on developing the communicative competence of the learner to meet the communicative requirements of the specific situations in which he is expected to play that role. Communicative competence in this sense means the ability to produce and understand utterances which are not only grammatically correct but also contextually appropriate [Campbell and Wales, 1972, p.247]. This

ability includes rules of use as well as rules of usage. Hymes [1972] makes a strong link between these two types of rules when he stipulates that "There are rules of use without which the rules of grammar would be useless." [p.278]. The implication is that if we are to achieve communicative competence in the learner, rules of use need to be given as much attention as rules of grammar, since communicative competence is not derived directly from grammatical competence. As Widdowson [1972] puts it "... it is a radical mistake to suppose that knowledge of how sentences are put to use in communication follows automatically from a knowledge of how sentences are composed and what signification they have as linguistic units." [p.17].

Given this, textbooks which are communicatively based usually contain language data which teaches the rules of use and the appropriate utterances the learner should use in certain communicative contexts as in the following example:

> " Notice these different ways of asking a person to do something:
>
> (Just type this letter for me), will you please?
>
> Will you _____ please?
>
> Would you _____ please?
>
> Do you think you could_____ ?
>
> Would you mind _____ing?
>
> Notice that the last two forms are often used in situations where you are asking a favour."

[From Byrne, D., and S. Holden, 1976, "Insight", Longman, p.15].

In EST textbooks, those rules are related to the communicative acts of EST discourse as in the following example:

" The same information can be presented in three different ways:

as a set of directions + statements of results, or as an observation, or as a description.
Which way is chosen depends on the purpose of the writer.

Directions + statements of result are used when the writer wants to give details of how an experiment is to be carried out.
Descriptions are used when the writer wants to describe an experiment as a process.
Observations are used when the writer wants to refer to the results of an experiment in order to make a deduction or induction, or in order to illustrate a generalization.

Each of these ways of expressing information is a different kind of communication."

[From Allen, J., and H. Widdowson, 1974, "English in Physical Science", Oxford University Press, p.72].

The strong relationship between ESP courses in general and the communicative approach is summed up quite effectively by Brumfit [1977] who writes:

" First, it is clear that an ESP course is directly

> concerned with the purposes for which learners need English, purposes which are usually expressed in functional terms. ESP thus fits firmly within the general movement towards 'communicative' teaching of the last decade or so." [p.71].

As far as EST is concerned, the current stage has had pedagogical implications in the preparation and teaching of EST materials. Although admitting that certain grammatical features have a high frequency of occurrence and definable use in scientific discourse, current EST textbooks deal with these features through the treatment of the communicative acts peculiar to scientific English. The focus in learning EST is currently on how to use language forms appropriate for realising communicative acts such as descriptions, definitions, instructions, results, and so on.

Teaching EST as communication also entails the teaching of language as discourse, and as such "we have to shift our attention from sentences in isolation to the manner in which they combine in text on the one hand, and the manner in which they are used to perform communicative acts in discourse on the other." [Widdowson, 1973, p.69]. This means that attention must be given to the inter-sentential relationships of the scientific text. In the 'English in Focus' series, for instance, this is achieved through language data under the section 'Contextual reference' in each unit.

Widdowson, then, bases his approach to the teaching of EST on two principles:

i. The teaching of grammatical cohesion of text, i.e. the manipulation of formal devices to create a scientific text, such as the use of connectives like 'however', 'thus', 'therefore', and so on, and the use of the impersonal passive.

ii. The teaching of rhetorical coherence of discourse, i.e. the communicative acts peculiar to scientific discourse, such as defining, classifying, drawing conclusions, and so on.

He also suggests a theoretical model to develop the learner's communicative competence in learning EST [1974a and 1975]. This model is based on three assumptions:

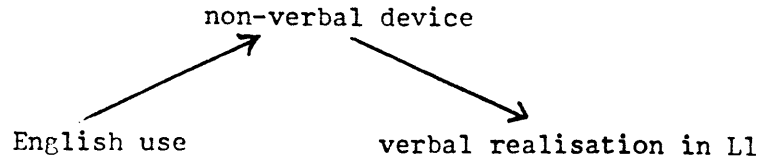
i. That scientific discourse deals with a universal set of communicative acts,

ii. That scientific discourse is partially realised through a universal set of non verbal-devices,

iii. That the EST learner is familiar with (i) and (ii) above in his own mother tongue and has a basic linguistic competence in English.

Thus, the process of developing the learner's receptive and productive communicative competence in EST is a matter of establishing a three-way 'information-transfer' process which can be diagrammatically presented as follows:

Comprehension:



Composition:

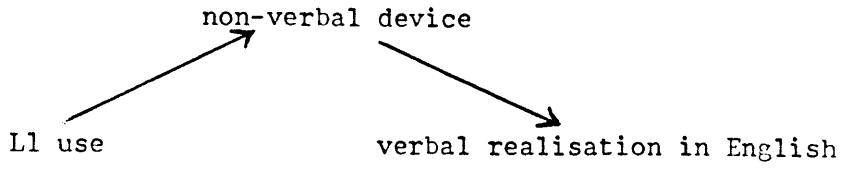


Fig. 4

[Adapted from Widdowson, 1975, p.9]

As for the selection, grading, and presentation of the language data to be taught, Widdowson [1972] advocates that these should be dealt with in terms of the communicative acts of scientific English. Thus, our selection of language items will have to be related to "those communicative acts which the scientist must of necessity most commonly perform... When grading, we might consider ordering such acts according to the manner in which they normally combine to form larger communicative units... (and) in presentation, we can make appeal to the kind of cognitive process which learners as students of science must develop anyway." [p.18]

The limitation of such an approach lies in the presentation process which assumes that, by definition, all students of science possess a uniform set of cognitive capabilities, regardless of their socio-cultural backgrounds, and that our EST pedagogy should be based on exploiting those capabilities. This point is going to be discussed in some detail in the next chapter

in relation to science teaching methodologies. Suffice it to say at this stage that the universality of scientific discourse does not necessarily imply a universal set of cognitive processes and strategies in dealing with that discourse, and that the cognitive style which learners employ in dealing with a certain subject is strongly dependent on the manner in which that subject is treated in the primary culture. Consequently, our approach in presenting EST materials should be strongly linked to those cognitive processes identifiable in the learning context. Otherwise, the result will be frustration for both the teacher and the learner.

1.8 Needs Analysis and Students' Motivation:

It was suggested earlier that the central issue in deciding what to teach in an ESP course is the consideration of the learner's needs which suggests a learner-centred approach not only in selecting the type of communicative acts and skills to be taught, but also in presenting those acts and skills in language contexts which are related to the learner's discipline. The underlying assumption is that by closely relating what is to be taught to the learner's specialisation and immediate needs, we can sustain his motivation. And motivation is undeniably the most influential factor in achieving success. Thus, a proper ESP course requires a rigorous analysis of the learner's needs. Munby [1978] provides a detailed sociolinguistic model of needs analysis which aims at specifying the target level of the learner's communicative competence by building up a communicative profile of the learner's needs and by converting these needs into syllabus contents.

One drawback of Munby's model, however, is that it is not cost-effective. Many practitioners have felt that the same output could be obtained by using a more simple technique than going through the sophisticated set of parameters included in Munby's model. Thus, what Munby offers us is a model which, as Swales [1980] puts it, "has the serious disadvantage of offering a poor return on investment of time, energy and mental effort." [p.69]. Furthermore, the massive and accurate information it requires is normally difficult to obtain since in most ESP courses the learner is still a student or a trainee and does not know what sort of communicative acts he is going to be engaged in, or what the job specifications are. If the teacher or course planner provides that data then there is no guarantee that these needs are actually what the learner would want to achieve, especially when we consider the learner's change of attitude, change of job, modification of his objectives due to progress in the course, or lack of it. The question of needs and demands is in fact a delicate one which needs elaboration. The point is that although many researchers, Munby included, have given a lot of attention to the study of learner's needs, they have ignored their demands, or perhaps have been led to believe that the two are one and the same thing. I believe they are not. The identification of the learner's needs, as applied and discussed in most studies and articles, usually takes its cue from the type of language situations and communicative acts the learner is expected to be engaged in, and thus are arrived at through analyses of those situations in isolation from the learner. That is to say, he is told what his needs are and what is good for him to have. Those needs, however, may not be his demands, i.e. what he wants to use his language for. Dissatisfaction with some teaching materials

may stem not only from the fact that those materials do not take the learner's needs into consideration, but may also come from the imposition of certain needs on him by wrongly assuming that needs are the same thing as demands. Perren [1974] makes the remark that " Identifying the learner's needs is a tricky business and we must beware of foisting on him needs which we think he should have but of which he is unaware." [p.8]. This is perhaps what Candlin et al [1978] had in mind when they wrote "We are perhaps in danger of producing a course for an audience which does not exist" [p.203]. The problem then seems to hinge on the question of "Who provides the data?"

Another limitation of Munby's model is that it attempts to produce target syllabuses rather than pedagogical syllabuses. In other words, it specifies what the learner is supposed to achieve but does not tell us how to achieve it, and thus falls short of being a practical tool for deciding what is actually to be taught in the classroom. Munby admits that "The profile is a detailed description of communication needs without containing any specification of the actual language forms that will realise those needs." [1978, p.40]. But the profile does not tell us how to produce those language forms either. Munby also ignores the question of grading and presentation. There are no suggestions in the two examples offered in Example A, Part 10, on the application of the instrument to show how a learner who has 'very elementary' command of English may develop a native-like competence as exemplified in the linguistic realisation of the suggested micro-functions. [p.200-204]. Nor does it suggest a time span for the achievement of the target level. We should remember

that time constraint is a significant factor in drawing up any ESP course and undoubtedly would influence the language content and even the target level.

Another pedagogical aspect which is ignored in Munby's model is the cultural and social factors such as learning strategies, cultural attitudes towards the target language, and cultural differences between L1 and the target language in the way communicative functions are specified and expounded. Munby [1978] in fact admits that he has not dealt with socio-political, logistical, administrative, psycho-pedagogic , or methodological variables of course design, and which he nevertheless acknowledges of being "significant in the modification of syllabus specifications and production of materials." [p.217]. This last point perhaps needs elaboration. Since Munby claims that his model "starts with the learner and ends with his target communicative competence" [p.3] to develop a profile of communicative needs, it seems to me that one important input to that profile should be the communicative strategies the learner has already developed in his mother tongue, especially as we are dealing with an adult learner. This, incidentally, is also one of the serious drawbacks attributed to the communicative approach in the sense that as the communicative functions produced so far are related to a Western European context with its unique set of communicative norms, it is questionable whether they are applicable in other learning contexts. The danger is that by teaching these communicative functions in the way the foreign culture presents them, i.e. to apologise or invite in a certain manner, bearing in mind that the communicative approach gives primacy to 'appropriateness' over 'grammaticality', we might be

imposing on the learner certain social behaviour which may not be in harmony with his cultural norms. The point is, each language has a unique pattern of interaction which is reflected in its speech acts and rules of speaking. Wolfson [1981], for example, investigated the use of complimentary expressions by English speaking Americans and other speakers and found that in one case what was taken by an American person as a compliment was considered by a French person as an insult. She concluded that "Speech acts differ cross-culturally not only in the way they are realized but also in their distribution, their frequency of occurrence, and in the functions they serve." [p.123]. Halliday draws attention to this fact in relation to ESP when he writes:

> " I would underline the point that we could not assume the same 'special-purpose' language varieties for all languages. It is clear that different language communities distribute their language functions in different ways, and I feel that one of the things we should take cognizance of here is that we cannot expect a single framework to be valid for all." [In Perren, 1969, p.25-26].

At this stage I would like to reconsider the assumption which was mentioned at the beginning of this section, one which seems to be the basis of almost all ESP courses and which simply states that immediate relevance of the teaching material to the existing or target communicative contexts would yield higher motivation in the learner. Allen, for example, the co-editor of the 'English in Focus' series indicates to this particular assumption by suggesting that "... the student's interest is maintained because

he can readily appreciate the relationship which is established between the English class and what goes on in the engineering workshop or physics laboratory," [1975, p.29]. Motivation, as viewed and applied in most ESP teaching material, is considered as an extrinsic element which is injected into the teaching situation through the choice of subject-relevant material. The assumption is that relevance will create a desire to learn. I think motivation should be considered as an intrinsic pre-condition of learning which should be brought about by conditioning the learning tasks rather than the content. In ESP learning situations, and indeed in any learning situation, the learner will be more successful if he has acquired achievement motivation. That is to say, his desire to learn will be generated by the feeling that he is achieving success in mastering novel tasks. Thus, motivation in this case becomes a natural by-product of successful learning. One way of achieving success in the learning task is perhaps by exploiting the cognitive style which the learner is familiar with, since the appreciation of that style has a lot to answer for in the process of creating successful learning conditions. Thus, the teaching material will have to be presented in a manner which highlights the learning strategies typical of the learning situation we are concerned with. The use of subject specialisation in presenting language data is only significant in so far as it offers the learner familiar contexts. But even this familiarity is not always a good thing, especially when it is too excessive that the language data becomes contrived. In fact, many students find the subject oriented material unstimulating. This is because by insisting on having the content closely related to the subject

matter most EST textbooks end up with presenting trivial scientific knowledge to advanced students. The following two paragraphs on "Magnets" is an example of how a basic concept is over-stated:

> " A magnet is a substance which attracts certain other substances. A substance which is attracted by a magnet can itself be made into a magnet. Generally speaking, there are three substances which are attracted by a magnet: iron, cobalt and nickel.
>
> Substances which are attracted by a magnet are known as magnetic substances, and those which are not are referred to as non-magnetic substances. Iron,cobalt and nickel are magnetic substances. They are attracted by magnets and they can themselves be magnetized."
>
> [From Allen, J., and H. Widdowson, 1974, "English in Physical Science", Oxford University Press, p.53].

Given this type of material, one may rightly argue that just as traditional EFL textbooks are guilty of presenting contrived language data which simply exemplifies linguistic rules (language usage), some EST textbooks are guilty of presenting contrived language data which exemplifies the linguistic realisation of certain communicative acts (language use), and therefore fail to introduce natural discourse.

Finally, the strong relationship between relevance and motivation, which once used to be taken for granted, should be considered in the light of the cognitive style prevailing in the learning situation. Nevertheless, the question of creating a

balance between interest and specialisation is equally important. Perhaps one way of sustaining interest would be through synchronisation of what is taught in the science class and the EST class to ensure that what is dealt with in the EST class is new or at least fresh.

1.9 The Use of Authentic Materials:

Many ESP course writers advocate the use of authentic material, i.e. real instances of language gathered by recording language activities in certain situations, or by using texts which have not been originally written for use in language classes. The argument behind this approach is that since the learner will be required to cope with the type of language used in the 'real' world, the language course should present him with just that.

The control of syntax and lexis which is usually practised in writing teaching material is criticised for achieving simplicity at the expense of distorting the structure of discourse. It is argued that the specially created texts inhibit the transfer of the learner's communicative ability to real life situations since, as Phillips and Shettlesworth [1978] have found out, "...the gap between classroom discourse (in any normal classroom) and the target discourse of the learning objectives is perhaps surprisingly wide" [p.23]. Thus, they advocate the exploitation of authentic material which is adopted from the learner's field of study, but offer two ways in which the content of this material can be controlled:

i. by grading the material in terms of accessibility, taking

into account the length of the text, the new information presented,and the supportive graphic features.

ii. by grading the tasks required from the learner.

They find this approach most economical in terms of time, effort, and money, and thus fit most typical ESP projects. The use of authentic material also bears some relevance to the pedagogy of ESP, as it is suggested that ESP methodology should offer some involvement in real life communicative activities since the ultimate goal of an ESP course is to prepare the learner for such activities.

Widdowson [1976], however, rejects the concept of authenticity as a "quality residing in instances of language". Instead, he suggests that authenticity is "a quality which is bestowed upon them, created by the response of the receiver. Authenticity in this view is a function of the interaction between the reader/hearer and ... the writer/speaker. We do not recognize authenticity as something there waiting to be noticed, we realize it in the act of interpretation." [p.263]. Thus, he advocates the use of specially constructed material which would match the learner's competence. In his view, pedagogy aims at guiding the learner towards his target behaviour not confronting him with authentic texts which he would fail to understand and would consequently confuse his target behaviour. Allen and Widdowson [1974], the editors of the "English in Focus" series defend their decision to use created texts on two grounds. "Firstly", they write, "we are able to avoid syntactic complexity and idiosyncratic features of style which would be likely to confuse students... (and secondly), we are able to 'foreground' features

of language which have particular communicative value." [p.4-5]. Robinson [1980] comments that although Widdowson's justification is persuasive "the problem still often remains of how to bridge the gap between such constructed texts - even if graded in terms of difficulty - and the frequently untypical, idiosyncratic texts of the real world. Jumping in at the deep end is not the answer, but neither is the wearing of water wings for ever." [p.37].

I find Allen and Widdowson's argument for creating texts more convincing. In addition to the point about the gradual guidance of the learner towards his target behaviour,and the foregrounding of certain communicative features of scientific discourse, there is the difference between teaching science as a discipline and science as a subject. The organisation of discourse in the two cases undoubtedly differ. Since EST courses are concerned with teaching science as a subject, and are consequently aimed at a scientifically unsophisticated reader, certain discourse features are usually given prominence. Those features include repetition of information, frequent rephrasing and control of vocabulary. Such features do not exist in texts dealing with science as a discipline. On the other hand, the argument for training the learner to cope with discourse as presented in real scientific texts (i.e. as a discipline) is highly hypothetical, since in many learning situations the rise of such a need is a remote possibility, at least until the learner has acquired an advanced linguistic ability. However, the concept of authenticity should also incorporate a behavioural dimension. In other words, the constructed texts should be recognised as being authentic in the sense that they foreground a set of learning strategies which

are familiar to the learner.

1.10 Conclusions:

ESP has become fashionable and has introduced a bandwagon in ELT. This has strongly influenced the production of teaching material but has had very little influence on methodology. ESP has witnessed a shift in focus during the last two decades. Traditionally, ESP courses were based on the notion that different subjects used special types of language. ESP was, in that sense, subject-oriented. Current ESP courses, however, are geared to the communicative acts required by the learner in his specific specialisation, and are therefore learner-oriented.

ESP remains as an approach to provide the leaner with the minimum communicative competence, usually under time constraint in varying degrees, since it always reduces the language contexts to the minimum. It is not surprising, therefore, to see that ESP courses are usually evaluated in relation to the degree of specificity in identifying the purposes and requirements of the learner. Halliday, however, is sceptical about the degree of specificity of those requirements when he declares that "in some cases I feel they are formulated in a way which is too specific, and unrealistically so." [In Perren, 1969, p.30].

ESP has witnessed a number of swings in focus over the past fifty years or so. One swing has been from total preoccupation with the subject matter through lexical and syntactic counts to the total concern with the sociolinguistic domains of the discipline, or, in other words, from teaching 'special languages' to teaching

'specific communicative acts'. Another swing has been in the restriction of language skills in ESP courses, for although earlier work aimed at developing certain skills (e.g. "A First Technical Reader", "Writing Scientific English"), the belief now is that the traditional four skill division is no longer appropriate. Listening to lectures, for example, requires understanding, writing, and even reading to rearrange ideas. Another swing has been the total rejection of students' literary background which was once considered to be essential in developing their scientific writing. This rejection is expressed by Hitchcock [1978] who writes "The reason we have so many who cannot write lucid technical prose in either their mother tongue or a second language might be because their composition teachers stressed literary technique." [p.47]. What has been missed out, however, is the serious consideration of the behavioural and socio-cultural aspects of the learning situation. That is to say, ESP courses have so far failed to take into account what the learner contributes to the learning situation, i.e. his learning strategies and his cultural and educational background.

The current approach to ESP is based on three main strands:

i. Discourse analysis to identify the type of communicative acts performed in a given discipline and how those acts are realised through linguistic devices.

ii. Needs analysis to specify, and in relation to discourse analysis, the communicative events and communicative acts the learner is expected to be engaged in.

iii. A communicative approach to language teaching to create

learning contexts which highlight those communicative acts.

The strong emphasis on satisfying the learner's needs means that even textbooks which teach general English could be said to be of a specific purpose, namely to help the student pass a certain examination, and similarly those which aim to teach spoken English or reading comprehension. This strong emphasis may also suggest that a true ESP course should cater for one learner (one-to-one classes), since each individual learner has certain needs or purposes which may not be shared by another learner. ESP courses, however,presuppose identifiable group needs and purposes rather than different individual needs. A compromise approach, advocated by Kirkman [1978], suggests that ESP courses should be designed locally for specific target audiences with any register analysis confined to the particular set of text-books for the special subject that a particular class employs.

The success of any ESP course seems to hinge on three elements:

i. A proper and co-ordinated analysis of needs and demands to identify the communicative acts required by the learner for his specific language use.

ii. Developing favourable motivation in the learner by presenting him with interesting and challenging teaching materials and tasks.

iii. The use of authentic communicative tasks and materials which are graded in terms of accessibility and learning tasks, and which correspond to the learner's cognitive behaviour.

Finally, I think the 1980s will witness a more scrutinizing insight into ESP in relation to the learner's behavioural, linguistic, and cultural background, and more appreciation of the contribution he makes to the learning process. This is because more and more crucial issues within ESP (e.g. reading, comprehension, coherent writing, learning strategies) are being considered in the light of the influence of socio-cultural factors on the learning process.

CHAPTER TWO

A CRITICAL ANALYSIS OF SOME BASIC ASSUMPTIONS IN CURRENT EST MATERIALS.

2.1 Introduction:

There has been a tendency to produce EST teaching materials which are intended to be globally applicable. The underlying assumption seems to be that since science is a universal area of enquiry with identifiable rhetorical acts which are neutral to any specific language, it is possible to produce teaching materials that will be suitable to any EST group of learners irrespective of their learning contexts and/or cultural backgrounds. The springboard of such materials is the discipline and its communicative acts rather than the learner and what he brings with him to the learning situation. Current EST teaching materials, therefore, are based on the assumption that what the learner needs to know to achieve success in his science course is how communication is organised in scientific discourse and how language is used to realise those communicative acts peculiar to that discourse. Since the ultimate aim of EST is to help the learners to cope with their science courses, it (EST) should take its cue from the methodology of science and the type of cognitive processes which that methodology promotes. In other words, EST, as Widdowson [1975] puts it, should involve "an exploitation of science teaching methodology" and "must be conducted not as a separate operation but as an extension from science education." [p.10]. Although very few people would dispute this contention, the question is which type of science methodology should our EST

model be based on? Clearly current EST textbooks do not necessarily exploit the science teaching methodology employed in the situations where those textbooks are supposed to be used. Rather, they all seem to be firmly rooted in a Western model of science teaching. In other words, EST textbook writers tend to exploit a set of learning conditions and strategies typical of Western, and more particularly British, science classroom conditions, and as science material is prepared and presented to native learners. Thus, they assume certain shared rhetorical conventions and learning strategies which are derived from Western methodology of science teaching. Therefore, since discovery learning is a marked feature of Western science methodology, EST textbooks usually contain language exercises which drill the learner in acquiring language data by making judgments and finding things for themselves. The problem, however, occurs when the science teaching methods in the primary culture differ from that presupposed by the EST textbook and do not make provision for such learning behaviour and therefore do not promote those strategies which will make learning in this manner possible. In fact the opposite may be the case, where rote memorising is the norm. A typical example is provided by Trowbridge [1974] when he discusses the conflict between Western scientific thinking and the traditional thought in Nepal, and its influence on science education. He writes:

> "The child of Nepal, a Hindu, Buddist, or Muslim has a cultural heritage poles apart from that of the Western scientific heritage, and this gives him a completely different world view. Unlike an American child who will see the situation in terms of 'dealing' with it and

> 'coming up' with a solution, a Nepal child has been brought up to 'accept' a situation by making reference to some traditional problem. Instead of 'inventing' a solution he will be 'remembering' a solution." [p.26].

Trowbridge here illustrates the fact that in many learning situations, culture is to a large extent responsible for the type of cognitive style the learner develops. Chiu [1972], for example, in his cross-cultural studies of cognitive styles between American and Chinese children found evidence which suggest that "Chinese, in contrast to Americans or Western people, lack intense interest in the imaginary and abstract reasoning. Their way of thinking is concrete, is confined solely to the realm of the immediately apprehended", and that "The inferential-categorical response mode was the most dominant for the American subjects." [p.241] He concluded that this contrast in cognitive style is attributed to differences in attitudes, values, and ways of thinking between the two cultures. Earlier Bruner [1966] suggested that "There are differing attitudes towards intellectual activity in different social classes, the two sexes, different age groups, and different ethnic groupings. These cultural transmitted attitudes also pattern the use of mind."[p.43].

The other relevant point which has to be made here is that the cultural domain also plays a dominant role in deciding the way the educational process is conducted. The fact is that school subjects are defined in relation to the primary culture and that such a definition influences the teaching methods of those subjects. In other words, different cultures treat different

subjects in different manners and that subsequently influences the manner in which those subjects are presented, taught, and learned.

In so far as EST is concerned, although the terminal aim may be identical in most teaching situations, i.e. to develop an awareness of the conventional communicative acts peculiar to science and how they are realised and organised in scientific discourse, the route will undoubtely differ as long as there are different methodologies for teaching science, some of which may bear no resemblance to the Western method of learning about science. The general framework of current EST approaches seems to focus on what the learner has to achieve at the end but fails to account for the different learning conditions and strategies in science education which are inherited from learning variables and cultural milieu and which usually influence the learning process and therefore affect the route to get to that ultimate end. EST material in this respect has been guided by the neutrality of the scientific discourse and not by the variables of the learning situation. Thus, if one may adapt Widdowson's comment [1976, p.266] about the importance of establishing adequate means for achieving established ends, one may rightly argue that current EST textook writers seem to have established ends which are adequate but have chosen inappropriate means for achieving them.

Widdowson [1976] has suggested that meanings "are recovered by negotiation with the aid of shared conventions" [p.264], and that "Some of those conventions are linguistic and relate to the shared knowledge of the language code; others are rhetorical and

relate to the shared knowledge of how the code is used in particular kinds of discourse." [p.263]. Given the importance of the cultural and educational background of the learner in the learning process, I would like to suggest that in addition to Widdowson's linguistic and rhetorical conventions a third input is required here to achieve what Widdowson [1976] calls an "appropriate response" [p.266]. That third input is the learning conditions and the developed learning strategies of the learner. This is because if we agree with Widdowson [1976] that in EST learning situations we are concerned with the teaching of "the discourse of science as a subject whose rhetorical conventions derive from the methodology of science" [p.265], then surely the strategies fostered and consolidated in the science teaching situations in the first language have a substantial influence on how that "appropriate response" is achieved when learning about science in a foreign language. This is what Hutchinson and Waters [1980] mean when they suggest that "The factor that should determine the ESP programme is not the subject itself but the way in which that subject is received by the student." [p.9]. The implication here is that when a certain subject is re-introduced in a foreign language, cultural variables as applied to the methodology of teaching that subject must be taken into consideration. In teaching English for science to Bahraini students, for example, we have to take into account how science is taught in Bahrain, since that will define the behavioural input to the learning situation and will provide the basis for presenting and negotiating meaning in learning about science. Since the springboard of most EST materials is the Western science methodology with its social and psychological

implications, one can rightly argue that as a result such materials are usually based on false assumptions as far as the learner and the learning situation in many countries are concerned. It will also be right to say that such materials will present the local learner with all sorts of learning problems since the starting point and learning strategies fostered by the primary culture will certainly differ from those presupposed by the material.

The significance of the cultural variables and learning modes in developing EST teaching materials hardly needs documenting. However, it is highly relevant to cite the reaction of course planners who have been involved in writing courses in two different parts of the world, namely the Middle East and Africa. Reporting on the British Council project "Communication Skills in English" devised for first year medical students at King Faisal University, Dammam, Saudi Arabia, Chamberlain and Flanagan[1978] noted that "materials must take specific account of the available information relating to the learner's exact language attainments, his background at home and society.... That pattern of such factors in any given institution is likely to be unique even if in particular respects analogies can be drawn with ESP programmes elsewhere. The controlling factors in an Arabic-speaking society are at any rate certain to differ substantially from those which govern EFL programmes devised for learners at universities in America or Britain." [p.37]. Edwards [1974] also, in designing specialist teaching materials for nurses and midwives in Nigeria, commented that "a fairly wide knowledge of the cultural and educational background is useful if not imperative; otherwise many of the assumptions, conscious or subconscious, on which

teaching material is based may prove to be false." [p.247]. Finally, Swales [1980] expresses his objection to the use of imported ESP materials and pedagogy quite forcibly when he writes "I have yet to be convinced of the general efficiency — and certainly the cost-effectiveness — of an approach that relies heavily on curriculum design models, experience from other educational settings, pre-planning and preparatory materials writing, rather than one that attempts a maturing and organic response to the actual educational environment in which the programme is to operate." [p.61]

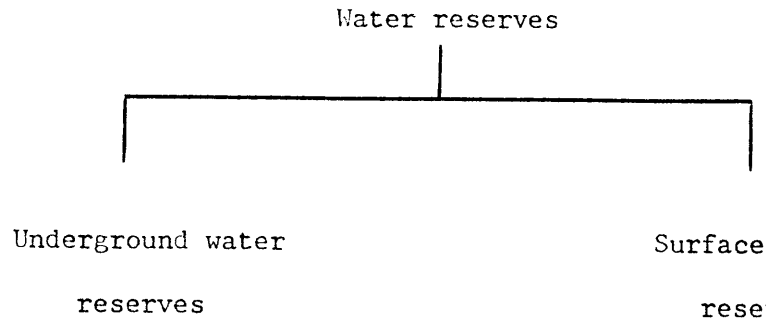
Selinker et al [1976] in fact touched on the importance of considering the educational background of the learner when they studied the problem of reading comprehension of EST discourse in the case of second language learners. They suggested that a non-native learner usually suffers from "the inability to comprehend the total discourse in a paragraph even when he may understand all the words in each sentence and/or all of the sentences in that paragraph." [p.281]. The problem, in their opinion, is caused by the inability of the non-native learner to extract and reorder implicit presuppositional rhetorical information in EST discourse. They reported, as an example, that their non-native students fail to capture the simple and complex implicit classification presented in the following paragraphs and the relationship between the two levels of classification presented in paragraph (b) where the sub-division becomes a main class:

IMPLICIT CLASSIFYING INFORMATION: SIMPLE AND COMPLEX

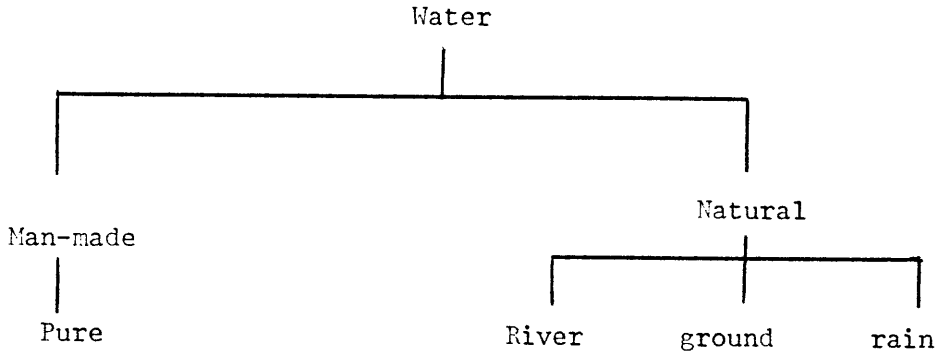
A. Underground water reserves are much larger than those on the surface, but as they are unseen we tend to underestimate them. It is vitally important that we make use of these underground reserves, but never haphazardly. For example, where does the water come from which we find in one or another of the underground water-bearing layers ('aquifers')? How does it move? How is it renewed? And if this water is used, what effect will it have on the discharge and the future level of the water table? What are the laws of hydrogeology? Despite the immense progress of recent years, all these questions have still not been fully answered.

B. A similar need for scientific research exists in the branch of hydrology that deals with the quality of water. In nature, there is no water like the pure water defined by chemists, made up of only hydrogen and oxygen. River water, ground water, and even rainwater always contain other dissolved or suspended elements, and these, even when present in small quantities, play an important role.

Paragraph A: Example of "simple implicit classification";



Paragraph B: Example of "complex implicit classification", two levels of generality:



[From Selinker, et al, 1976, p.288]

It is clear that the reason why non-native learners are unable to extract and order such information is attributed to the fact that these learners are not trained in making inferences, a learning strategy required here to solve the problem, which Western science methodology exploits and which, according to Selinker et al, native learners do possess and share with the writer. Therefore, the problem, it seems to me, is not related to the implicitness or explicitness of the rhetorical information, since that information is there in both cases, but rather to the type of learning strategy required for extracting it, one which is presupposed by the text and which is derived from the method of teaching science.

With regard to EST, it is perhaps interesting to note that one area where the influence of learning strategies fostered by the primary culture is mostly felt is in developing reading skills. Research conducted in this area [Dudley-Evans et al, 1976; Cowan and Sarmad , 1976; Selinker et al, 1976; Mage, 1978] has shown that foreign students are usually influenced by their previously acquired learning strategies in their task to retrieve meaning form scientific texts which have been initially written for native speakers and which foreground a typical Western science methodology. Dudley-Evans et al [1976], for example, found that the learning strategies their Iranian students had acquired during their educational experience (rote learning in this case), and which were basically cultural in nature, often came into conflict with the inductive and deductive strategies which are peculiar to the methods of science. In connection with the teaching of reading to these students they had this to say:

> " It should perhaps be recognized that in teaching efficient reading one is doing more than teaching just language, and that one's methods, or at least the approach drawn from Western scientific methods, may well be alien for many non-European students." [p.164].

Since most EST materials are, as mentioned earlier, based on a Western model of science teaching, to consider the validity of such materials to a situation like Bahrain, it is imperative to identify the theoretical basis of that model and its pedagogical implications, and to see how such a pedagogy has fed into current EST teaching materials. This, as well as identifying the

learning strategies employed by the Bahraini student, should lead to establishing some parameters for the modification of those materials to suit the Bahraini situation. The following section will deal with the first part of the proposal, i.e. the theoretical and pedagogical basis of Western science methodology and its implication in the preparation of world-wide EST teaching materials.

2.2 The Theoretical Background of Western Science Teaching Methodology:

Reports on the development of science education in Britain acknowledge the fact that methods of teaching science have always been influenced by certain psychological and sociological models of learning theories. Throughout the 1960's and 1970's the teaching of science in Britain witnessed a number of curriculum development projects generated by the Nuffield projects and the Schools Council Integrated Science Project (SCISP). These projects were based mainly on certain behaviouristic approaches in learning. The ASE Document [1979] indicates that "Both Science 5/13 and SCISP are based on psychological models of human development. The former project relies on an interpretation of the work of Piaget on the intellectual development of children, while the latter is linked to Gagné's concept of learning hierarchies." [p.57]. The most significant outcome of these projects is the current model of methodology which is based on the concept of teaching science by enquiry and discovery through question-and-answer teaching techniques and through learning by doing. In fact the drive towards a teaching model based on the act of discovery became notably the main feature of most

curriculum development projects, including those of the social sciences, in America and Europe in the late fifties and throughout the sixties and the seventies. As Professor Kelly [1978] puts it, "this aimed to encourage pupils to find and think out things for themselves rather than just being told about them. Questions are presented to pupils who are then asked to carry out, and possibly even design, investigations by which they might find the answers to the questions." [p.2-3]. The aim is to make students work like scientists, and thus the current model of science teaching employs a progression of identifying the problem, to generating hypotheses, to conducting experiments, to noting results, and finally to deducing conclusions. This framework is illustrated in the following paragraphs:

> " If gravitation were the only attractive force there would be no solids; everything would be a gas! There must be some other forces of attraction. You know of one straight away - magnetism. But not all substances are attracted by a magnet - copper certainly is not - and so we have to rule this one out.
>
> Do you know what happens if you rub a plastic ball-point pen on your coat sleeve and then put it near some small pieces of paper or some chalk dust. Try it and see. What force is this?
>
> As this is the only other force of attraction we know about at present it seems likely that it is this that holds particles together. Thus, we believe that the force which keeps a solid rigid is an electric force."
>
> [From Mee, A. J., et al, 1973, "Science for the 70's", Pupils' Book One, Second Edition, Heinemann, p.60].

The enquiry behaviour in this model is consolidated by promoting inferential learning strategies. This is manifested by the frequent insertion of questions at different positions in the text as in the following example:

> " Preserving sugar has much larger crystals than castor sugar. How do you think the methods of making the two kinds of sugar differed? The same is true of salt. Salt used for preserving or for putting on icy roads has larger crystals. Table salt has tiny cristals. Why do we not use large crystals for table salt? Would it be more or less expensive to make large crystals?"
>
> [Ibid, p.81]

It is perhaps true to suggest that the current method of science teaching is the outcome of the concept of "problem solving" as a learning behaviour which was developed by Gagné in his psychological model of learning hierarchy published for the first time in 1965 in his work "The Conditions of Learning". The strong influence of the problem solving concept on the teaching of science on the one hand and on the current approach in producing EST materials on the other makes it essential to study this concept in some detail.

2.3 The Problem Solving Domain:

Gagné [1970] categorically rejects Thorndike's view that all learning is basically the same. Instead, he argues that there are different forms of learning, and that each form "begins with a different state of the organism and ends with a different capability for performance." [p.65]. This means that each form of

learning requires certain conditions, or prerequisites, in order to take place. Gagné suggests that the process of learning is controlled by eight types of learning conditions which characterise the learner's thinking behaviour. These conditions represent a learning hierarchy in which each level, except the first, acts as a prerequisite to the one above it. Thus, the relationship between these types of learning could be presented in the following diagram:

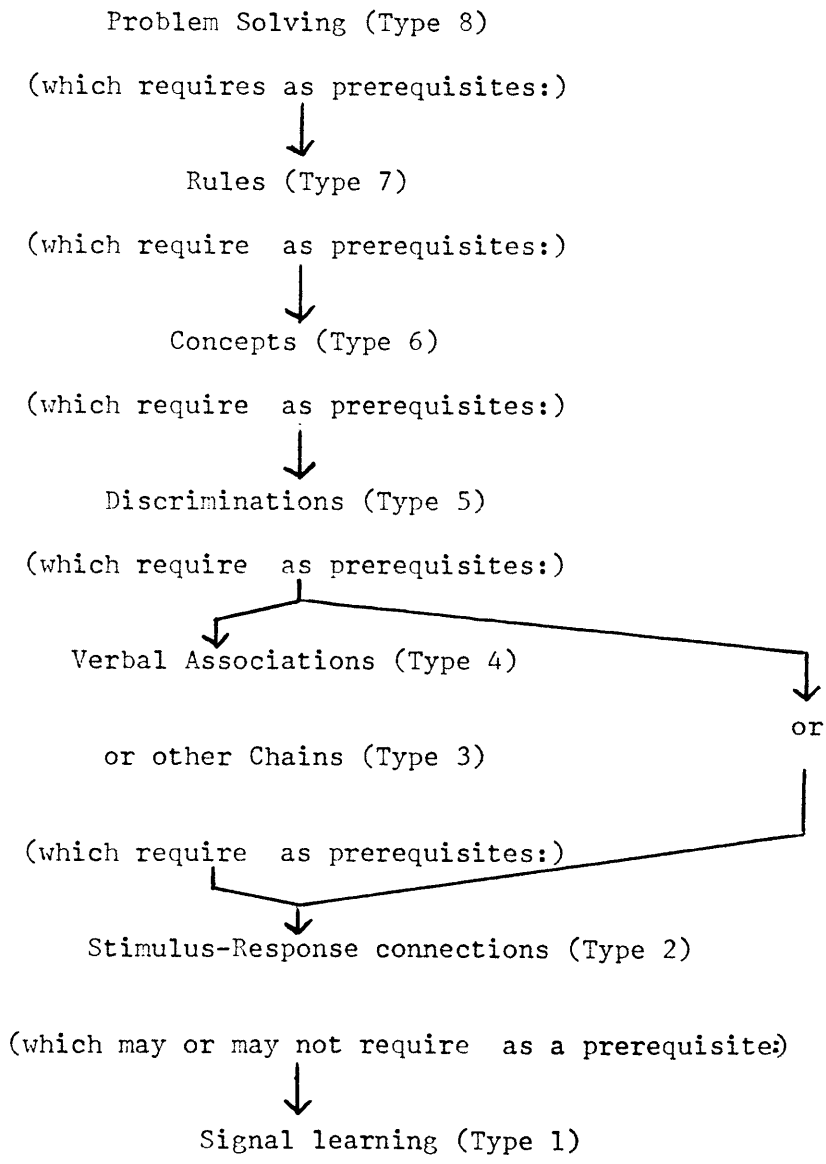


Fig. 5

(Adapted form Gagné, 1970, p.66)

According to this hierarchy, problem solving represents the highest form of learning, one which is frequently called upon in various events in everyday life. Gagné [1970] defines problem solving as "a process by which the learner discovers a combination of previously learned rules that he can apply to achieve a solution for a novel problem situation." [p.214]. The result of learning in this manner is that after solving the problem the learner will have achieved a new entity, which Gagné calls "a higher-order rule", and which the learner adds to his repertoire.

An important condition in problem solving, however, is that the learner must have a prerequisite knowledge of the subordinate rules and a strategy for organising and applying the relevant rules to discover the solution.

Because of the close relationship between problem solving and rule learning, in the sense that the former is dependent on the latter, it is important to make some distinction between the two types of learning conditions. According to Gagné [1970] the difference lies "in the nature and amount of guidance provided by verbal instructions." [p.224]. In problem solving situations this guidance is minimal and aims at stimulating the recall of the relevant rules and guiding the learner's thinking in a certain direction. In other words, problem solving is a form of guided discovery process in which the prerequisite rules are not overtly taught but rather hinted at. The implicitness manner in recalling previously learned rules is considered to be vital for the development and the activation of new higher-order rules, i.e. the capability for solving new problems. Rule learning, on

the other hand, concerns the explicit presentation of the rules for solving the problem faced in the learning process. Evidently, in order to learn a rule, the learner must have acquired the component concepts of that rule. Thus, rule learning is more apparent, and perhaps more effective, in the case of adult learners.

The implication of the problem solving through discovery in science teaching is that the learner is expected to proceed by defining the problem (i.e. recalling the previously learned rules), formulating hypotheses (i.e. finding the required combinations which may solve the problem), and finally verifying those hypotheses (i.e. trying out those combinations until a solution is reached). Learning science in a problem solving manner, therefore, is conducted through an investigatory behaviour as in the Nuffield courses. As mentioned earlier, in such courses the learner is encouraged to discover the solution by verbally directing his thinking and stimulating his recall of previously learnt rules. This can be demonstrated in the following example:

> " You found out that when a mixture of hydrogen and air is burnt it made a particular squealing noise. This is a slight explosion. If you get the proportion of air just right you can get a very violent explosion. You know already that gases are present in the air, and you know what burning really is. Which gas in air combines

with hydrogen when it burns? To get the loudest explosion would you use air to mix with hydrogen, or only part of the air? Which part?"

[From Mee, A. J., et al, 1974, "Science for the 70's", Pupils' Book Two, Second Edition, Heinemann, p.11]

It is perhaps interesting to note here that the discovery method in science teaching was soon exported to other countries, especially in the third world, without much consideration for the learning strategies and conditions prevailing in individual learning contexts. A reflection on the exportation of British science teaching programmes to the third world is, in my opinion, both interesting and useful in providing an analogy to the current trend in EST teaching materials. Since the 1960's, and with the help of international assistance programmes, many developing countries have adopted the Western science education programmes which were developed for use mainly in Britain as a response for a pressing demand for curriculum development in science teaching. The adoption of those programmes by the developing countries was the result of three factors:

i. The developed countries provided not just the financial funding for educational development but also the human resources in the form of experts and teachers who brought with them the Western model of science education.

ii. Since those programmes were successful in the countries where they were initially developed and used, the developing countries believed this success could be transferred with minor adaptation of content to suit local situations.

iii. The imported programmes offered a ready-made package of science teaching materials when time was a fundamental factor in the curriculum development projects of these countries.

Now, with regard to the production of EST materials it is interesting to note that a somewhat similar situation exists. Most of the published materials or projects taking place in different countries for writing such materials are the product of Western writers and thus reflect the Western model of science teaching. Also, the success of certain materials in a certain part of the world has led writers and publishers to assume that such success is attainable in different parts of the world. And finally, a similar time constraint, intensified by the rapid development in science and technical education in these countries and the dominant role of English in this type of education, has led to the adoption of these teaching materials despite the difference between the learning strategies assumed by those materials and those actually acquired by the learners as a result of the type of educational system they pursue and its underlying objectives and philosophy. The problem, as Swales [1980] points out, is that these materials "may have been planned to a varying degree of detail and inflexibility in an environment quite different to that in which it is supposed to function, thus importing contemporary western pedagogical approaches that may be inopportune and counter-productive. There is 'educational shock' just as much as 'cultural shock'." [p.63].

2.4 Problem solving and EST:

Since current EST materials are, as mentioned earlier, based on a Western model of science methodology, these materials view the teaching of English for science as a problem solving activity. EST textbook writers have abundantly made reference to this view when defining their approach in presenting language data. Mackay and Mountford [1978], for example, in considering the most appropriate approach to cater for science students stipulate that "what appears to be required is an approach that focuses attention on the learning of the language as a communicative instrument from the learner's point of view. This approach emphasises the 'problem solving' role of the learner as a participant in the interpretation and composition of discourse." [p.9]. In writing the 'Nucleus' course, the problem solving approach was promoted, according to Bates, [1978], through "completing descriptions, carrying out simple calculations, answering Why? questions about new situations using previously learned items, etc.", and that the course also contained "an open-ended aspect to many of the activities involving problem-solving, inference. etc." [p.91]. Similarly, Allen and Widdowson, the co-authors of 'English in Focus' series, state in their paper on the theoretical background of the series [1974] that the approach they adopt "is based on the assumption that the students will be people whose minds are directed towards rational thought and problem-solving." [p.12].

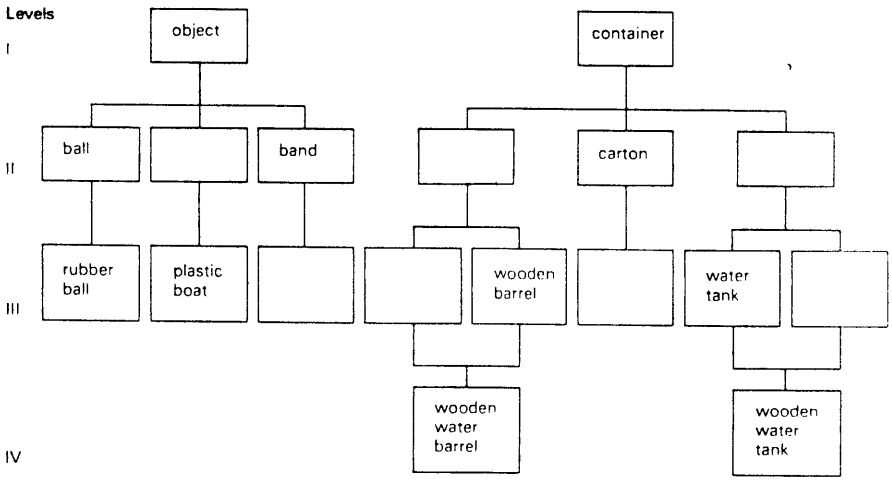
Consideration of the basic assumptions of most EST materials also reveals that these materials adopt the view that learning in a problem solving manner should be based on developing discovery

learning strategies. These strategies in turn are developed through making inferences from given examples and minimum hints about principles for solving language problems.

The influence of the problem solving technique through discovery and inferential learning strategies in current EST materials is evident in the fact that the language exercises are designed in such a way "to allow some scope for the student to exercise his own judgement." [Allen and Widdowson, 1974, p.18] and that "the student is largerly left to work things for himself within the controlled specification of the problem." [Widdowson, 1975, p.11]. The exploitation in these materials of the discovery and inferential learning style within the problem solving domain is carried out through different types of language tasks. The student may, for example, be asked to fill in a diagram or a table with or without reference to a text. The following is a typical example of the problem solving exercises which appear in the 'Focus' series:

EXERCISE D: Classifications and generalizations

1. Draw the following diagram and complete it by filling in the spaces.



[From Allen J. & H.Widdowson,1974, "English in Physical Science",Oxford University Press, p.42-43]

He may also be asked to write statements based on diagrams.

The following example is taken from the same book:

5. Consider the following statements:

(a) All substances, except those which decompose when heated, can be changed from one state to another.
(b) A solid substance can be changed into a liquid substance.

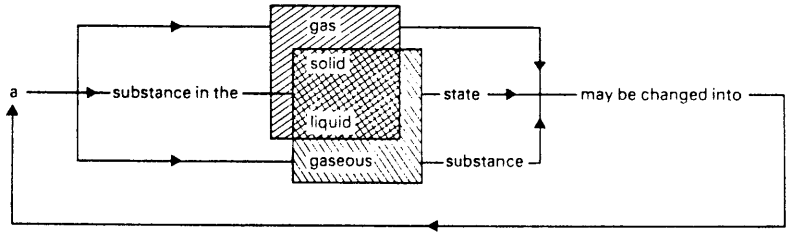
Statement **(b)** follows logically from statement **(a)**. If **(a)** is true then **(b)** must also be true.

Both statements are generalizations, but **(a)** is a higher level generalization than **(b)**.

(i) Use the following diagram to write out as many lower level generalizations like statement **(b)** as you can.

EXAMPLE

A solid may be changed into a substance in the liquid state.
A substance in the solid state may be changed into a liquid.
A gaseous substance may be changed into a liquid substance.*

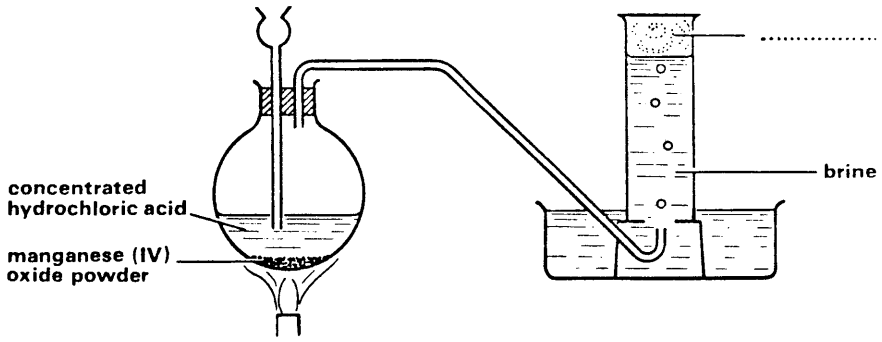


[Ibid, p.28-29]

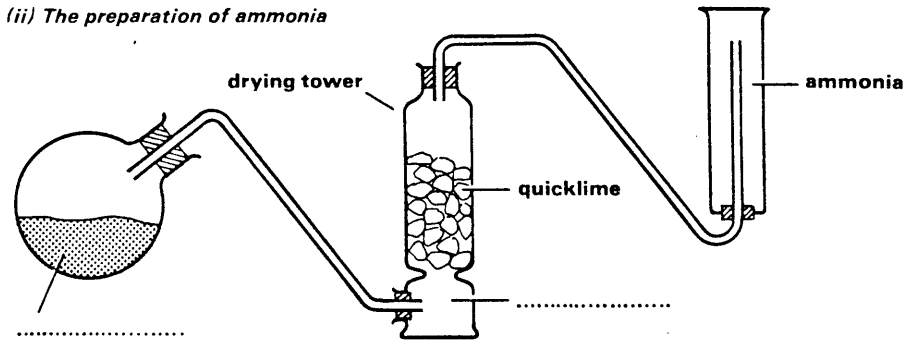
Or he may be asked to write a description of a scientific process based on a diagram, as in the following example:

C. Provide descriptions for the processes which are illustrated by the following diagrams:

(i) The preparation of .....



(ii) The preparation of ammonia



[Ibid, p.75]

Finally, he may be asked to write a paragraph using given key words, phrases and an assortment of sentences, as in the following exercise:

Join each of the eleven groups of words below into one sentence, using the additional material at the beginning of each group. Omit the words underlined. Number your

sentences and begin each one with a capital letter:

1. TURN/RED/AND/IT/, /GIVING

   an acid will affect litmus

   an acid will react with washing soda

   it will give off carbon dioxide

2. AND

   the metal disappears

   hydrogen is liberated

3. SPECIAL/, /, /AND/WHICH/TURN/BLUE

   a class of bases is called alkalis

   they will disolve in water

   they will form solutions

   they will affect red litmus

4. _ _ _ _ _ _ _

   _ _ _ _ _ _ _

[Ibid, p.20]

Clearly then, the problem solving approach adopted by most EST materials is derived from a Western model of science as an area of enquiry requiring rational thinking and reasoning strategies. The tendency to adopt such a technique is also reinforced by two beliefs. Firstly, that scientific discourse, as Widdowson [1975] argues, is realised by a communicative system neutral to different languages, and that the best way of teaching that system is through the exploitation of science methodology and the development of those cognitive processes peculiar to science. Secondly, that students studying science in English have to read

textbooks which highlight such a cognitive style. However, considered in the cultural perspective discussed earlier, this has usually meant confronting the student with language data which employs a type of cognitive style alien to him. It is perhaps interesting to note that, given his firm conviction in the universality of scientific discourse and the related cognitive processes, Widdowson [1975] argues that there is even a universal type of science methodology when he writes "I think that it is likely that scientific textbooks written in different languages express essentially the same methodology." [p.7]. This claim seems to me to be rather extreme and may only be true when a textbook in a certain language is a literal translation of the same material from an English textbook. Widdowson in fact over-estimates the concept of the universality of scientific discourse on the expense of playing down the influence of the cultural variable on how school subjects are treated. I believe that school subjects, just like teaching methods, are by-products of the primary culture. They, therefore, tend to reflect the manner, and consequently express the type of methodology, in which any given subject is dealt with in that culture. That is to say, if science, for example, is considered as a body of knowledge in a given culture, science textbooks will tend to present the subject in that manner. This has in fact been the case in the Arabic culture. To verify this claim one only has to compare the technique used to present scientific concepts and phenomena in a British textbook with that used in its Arabic counterpart. In dealing with the expansion and contraction phenomenon for example, "Science for the 70's" (Book One, 1973) introduces the topic by first discussing three experiments using a metal, a

liquid, and a gas. In each case the investigatory behaviour is constantly encouraged by posing questions which require making observations and studying findings as in the following experiment:

> " Heating a metal rod:
> Set up a retort stand and a wooden block as shown in Fig.4.19. On the top of the wooden block is a cotton reel with a straw or a piece of wire stuck on it with a piece of plasticine. Heat the rod of the retort stand. What happens to the pointer? What must have happened to the rod? What happens to the pointer when the rod cools down?" [p.61]

After dealing with two other experiments in the same manner using a liquid and a gas, the textbook concludes:

> " You will find that in all these cases the substance — solid, liquid, or gas — gets bigger when it is heated. We say it expands. When it cools down again it goes back to its original size; it contracts on cooling." [p.62]

After more experiments,the textbook then poses more investigatory questions on the application of such phenomena, among them are:

> "Why are the ends of metal bridges supported on rollers rather than on rigid mountings? Why does a thick glass bottle or jar crack when boiling water is poured into it? Why are sections of concrete roadway separated by thin strips of tar (or sometimes wood)?" [p.63]

If, on the other hand, we examine an Arabic science textbook of the same level, we find that the topic is dealt with in a strikingly different manner. The following excerpt, and its English translation, show how this phenomenon is dealt with in one of the textbooks used by students in Bahrain:

تمدد الأجسام الصلبة :

معظم الأجسام الصلبة تتمدد بالحرارة وتنكمش بالبرودة ويمكن بيان ذلك عمليًّا بإجراء تجربة الكرة والحلقة أو تجربة الساق والمؤشر .

والأجسام الصلبة المختلفة تتمدد بمقادير مختلفة فإذا أخذت ساق مكونة من صفيحتين متماثلتين وملتحمتين إحداهما من النحاس والأخرى من الحديد وسخنت تقوست الساق وذلك لأن صفيحة النحاس تتمدد بمقدار أكبر من تمدد الحديد .

وإذا حال دون تمدد الأجسام الصلبة أو انكماشها حائل تولدت قوة عظيمة تؤثر فى الحائل ولهذا تتخذ عند بناء المنشآت المعدنية احتياطات للسماح للقضبان والأنابيب التى تتركب منها هذه المنشآت بالتمدد والانكماش ، فمثلا تترك مسافات صغيرة بين أطراف قضبان السكك الحديدية وكذلك تترك مسافات صغيرة بين أطراف القناطر الحديدية والمبانى التى ترتكز عليها وتجعل هذه الأطراف مطلقة بحيث ترتكز على عجلات تتحرك فوق قضبان.وفى تركيب السيقان الحديدية المستعملة داخل الأفران يراعى أن تثبت عند أحد طرفيها وتترك مطلقة الحركة عند طرفها الآخر .

"Expansion of solids:

Most solids expand by heating and contract by cooling. This can be shown practically by conducting the metal ball and the ring experiment, or the rod and the pointer experiment. Different solids expand by different measures. So if you take a rod made of two plates of copper and steel of equal lenght and welded together and heat them, the rod bends because the cooper plate expands more than the steel plate.

> If the expansion or contraction of solids is obstructed, a great force is generated which affects that obstruction. For this reason certain measures are taken when building metal constructions to allow for the expansion and contraction of the rods and pipes used in those constructions. Small spaces are left, for example, between the ends of the rails on railways. Small spaces are also left between the ends of metal bridges and the mountings supporting them, and these are supported on rollers moving on rails. Also, steel rods in cookers are fixed at one end and left free at the other."
>
> [From Al-Sayed Eshary, A.M., 1975, "Physics: The Properties of Matter and Heat", Daar Al-Márif, p.70]

In fact there is abundant evidence in the two books showing a remarkable difference in dealing with different scientific concepts, but the example given above should suffice. Whereas the English textbook leads the learner through a technique of enquiry and making inferences before making any generalizations, its Arabic counterpart teaches facts, principles, and formulae, offers ready-made explanations, and suggests experiments as a confirmatory device.

Given this, it is perhaps not surprising to see that even the seemingly acceptable notion of universality of scientific and technical discourse has frequently come under attack. Hitchcock [1978] argues that "It is profoundly incorrect to say that technical English is culturally neutral. ... Frequently the notion of the 'objectivity' of technical prose is put forward,

but such 'objectivity' is in-and-of-itself a cultural reflection of Western scientific traditions." [p.36]. Earlier Kaplan [1966] exemplified the influence of the cultural domain on our thinking by quoting Peirce's assertion that "if Aristotle had been Mexican, his logic would have been different; and perhaps, by the same token, the whole of our philosophy and our science would have been different." [p.2]. Hutchinson and Waters [1980], in discussing the relationship between technical English and the Western culture, write, "We should not lose sight of the fact that the language of modern technology is a development of Anglo-American culture. It is not an artificial, cultureless code, but an adaptation of the existing resources of the English language and the culture this reflects." [p.14]. They go on to illustrate the significance of the learner's unfamiliarity with cultural concepts in negotiating meaning in technical discourse by arguing that the foreign student, who is unfamiliar with, for instance, the words "tail", "stock", and "saddle", would be at a disadvantage in trying to understand the terms "headstock", "tailstock", and "saddle" on a lathe. The native student, on the other hand, would simply have to widen the application of known concepts, i.e. the "head" and "tail" concept and the "saddle" concept.

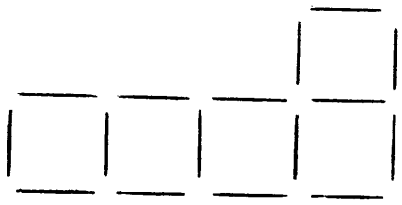
2.5 Problem Solving Reconsidered:

In this section I would like to consider some of the basic issues in the problem solving domain in general and in relation to current approaches to teaching EST in particular. Gagné [1970] considers problem solving as a method of learning congruent to discovery learning in the sense that in problem solving the

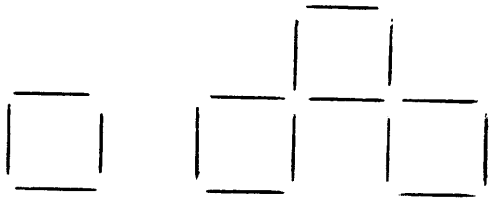
learner is supposed to discover the solution, the higher-order rule. In order to do that, the learner is given some guidance varying in amount and nature, but that guidance never states explicitly the rule or principle for solving the problem. Although Gagné presents problem solving in his suggested learning hierarchy as a higher level type of learning which requires rule learning as a prerequisite, he in fact discusses problem solving as a type of learning parallel to rule learning. He stipulates that "In a fundamental sense, the capability learned by problem solving (type 8) is no different from that which may be learned by combining subordinate rules in the manner described as rule learning. Both learning types result in the establishment of higher-order rules. The two kinds of learning appear to differ only in the nature and amount of guidance provided by verbal instructions. In rule learning, the instructions include a sentence or question that verbally cues the solution, but in problem solving they do not." [p.224]. He also cites various experiments in which the comparison is clearly made between discovery and rule learning. I think Gagné's model presents a confusing relationship between the three notions: problem solving, discovery learning, and rule learning. Given this, I would like to suggest that any learning situation could be considered a problem solving situation in the sense that the learner is faced with the problem of learning or acquiring new knowledge. To solve the problem, i.e. learn or acquire that knowledge, he can follow various routes. His choice, however, is restricted by his cognitive repertoire and the nature of the problem. Thus, problem solving should be considered as a learning process which could be attained either throught discovery of the rule to solve the problem or by learning that rule and then

applying it. Evidently, arriving at a solution to the problem, i.e. the higher-order rule, is in both cases dependent on previously learned simpler rules, or what Gagné [1970] calls "lower-order rules" [p.208]. To illustrate the relationship between the two types of rules, let us consider the following problem:

Problem



Solution



Move 3 sides to make 4 squares.

[N. B. This is one of the problems used in Katona's study, 1940, which is going to be discussed later.].

A lower-order rule in this case would be that in order to create 4 squares out of the given 5, we must lose one square. Another lower-order rule could also be that we have to destroy two squares and create one. A higher-order rule, on the other hand, and which in fact represents the solution to this type of problem, would be that we have to create holes between the squares and loosen the figure.

Since learning rules seems to be a vital prerequisite for solving problems, either through discovery or applications of those rules, it is imperative that we consider some aspects and

implications of rule learning as a cognitive behaviour. Rules, whether used to define concepts or relate a set of concepts, are important in organising intellectual capabilities. As Gagné [1970] states, "They operate to guide the individual's behaviour in meeting a host of particular situations and solving a variety of particular problems." [p.190]. He also makes a distinction between learning a rule as "an inferred capability" and as "a verbal statement" [p.193] in the sense that one does not assume the other. In other words, knowing the verbal statement of a rule does not necessarily entail the understanding or the ability to apply it, and vice versa. Learning a rule, therefore, does not necessarily correspond to the act of stating that rule but more importantly to showing the ability to use it in solving problems, i.e. demonstrating its application. This can be achieved by making sure that the learner understands the component concepts of the rule and by exemplifying its application in dealing with appropriate problems.

Another important point which has to be considered here is the relationship between the learning situation and the type of learning strategy applied in that situation. Since different problem solving situations, and sometimes even one given situation, would require the use of different strategies, it would be more appropriate to think of the relationship between the two domains as an interactive one whatever strategy we consider to be overriding in solving a particular problem. That is to say, the learner always, within limits, discovers some rules and principles for himself but those rules and principles have to be learned, or rather confirmed and consolidated, before

they become a part of the learner's repertoire. Bruner [1961] in fact goes even as far as suggesting that "the process of memory, looked at from the retrieval side, is also a process of problem solving: how can material be 'placed' in memory so that it can be got on demand?" [p.32]. We should recognise the fact that just as different learning situations require different forms of learning strategies, different learners posess different types of capabilities and may perform differently under the same learning conditions. Dienes [1959] sums up this state of affair quite effectively when he writes:

> " Apart from differences in individual emphasis..... we must consider the possibility that there are ways which are objectively better or more efficient for acquiring a given concept.... because of the inherent nature of the concepts in question. It has, in fact, been shown that certain concepts are just not amenable to learning by certain forms of mental organization." [p.10].

Gagné [1970] discusses different experimental studies, such as Katona's match tasks [1940] and Maier's pendulum [1930], in which results suggested that problem solving through the discovery method resulted in a higher level of transfer and retention of the acquired higher-order rules, i.e. the capability to solve novel problems. However, he notes that such evidence "does not demonstrate that higher-order rules must be learned by discovery. In much adult learning, for example, the guidance provided by verbal instructions may be so complete that the rule to be learned is stated verbally during the course of learning. The key to achievment of a higher-order rule does not lie solely in

the discovery method." [p.225]. Gagné and Brown [1961] in an earlier study considered the question of learning effectiveness in relation to transfer of the learned principles to a novel problem solving situation. Using three learning programmes, namely "Rule and Example", "Guided Discovery", and "Discovery", they concluded that although their findings revealed significant learning effectiveness in favour of the Guided Discovery programme, those findings emphasized "the importance of 'what is learned' rather than 'how it is learned' as the crucial factor in learning effectiveness." [p.320].

In so far as EST is concerned, although it is reasonable, and even well-founded, to argue that learning EST is basically a problem solving exercise, the problem lies in determining the most effective technique to be employed in a problem solving-based language learning situation with regard to specific learners. Current EST approaches seem to be based, as has been exemplified earlier, on what has been identified as discovery and inferential learning strategies with the assumption that all EST learners have acquired these strategies through their science learning. This assumption is not always justified, especially where science methodology differs in principle and practice from the Western method.

The other point is that problem solving through discovery, as discussed above, is dependent on the acquisition of subordinated rules. As Gagné [1970] points out "To be successful, problem solving must be based on the prior attainment and recall of the rules that are combined in the achievement of the solution, the higher-order rule." [p.226]. The problem with regard to learning

EST is that even in situations where students have a reasonable competence of the grammatical rules of English, they, as Selinker et al [1976] found out, are usually unable to "gain access to the total informational content of the discourse." [p.282]. This, as suggested earlier, is due to the fact that current EST materials employ a set of learning strategies which students are not familiar with. If, therefore, we interpret Gagné's notion of subordinate rules as a pattern of acts which governs the learner's cognitive behaviour and which eventually leads him to the solution of the problem, we can legitimately argue that the learner's failure here is attributed to the fact that he does not possess the "proper" subordinate rules for solving such a problem. Given the fundamental condition in a discovery problem solving approach that minimum verbal instructions are given, this technique makes the task of learning a foreign language that much more difficult especially in the case of adult learners where full explanations are usually needed, and in situations where such explanations are expected by the learner. Robinson [1980] has reported that students find some of the material in the "Focus" books difficult because it is "insufficiently guided and explained.... and thus requires much more contextualized practice than is provided." [p.48].

The final point I would like to make here is that Selinker et al, as well as many of those who have been concerned with the problem of foreigners learning English for science and technology, seem to believe that the solution lies in discovering ways which would facilitate the task of launching the learner into the established Western route of dealing with EST materials. I would like to

suggest that a more practical and realistic approach would perhaps be to find a different and more appropriate route, one which is geared to the cognitive behaviour and learning strategies which the learner has already developed through his learning experience. This is because, given the fact that those strategies are the natural outcome of the learner's interaction with the educational process and cultural milieu, they tend to be deeply rooted in the learner's cognitive repertoire. It would, therefore, be more practical to activate those strategies and use them in the learning process rather than develop a new set which has no grass root in the learner's cognitive repertoire. As Bruner [1966] points out, "A theory of instruction concerns itself, rather, with the issue of how best to utilize a given cultural pattern in achieving particular instructional ends." [p.43]. Consequently, I would like to conclude that our EST methodology should be based not on the set of learning strategies underlying a foreign model of science teaching but rather on those actually prevailing in the learning situation where that EST material is to be used. To define those strategies and test their effectiveness in relation to transfer and retention the following research design is suggested:

i. To form hypotheses about the existing learning strategies based on observation of the learning/ teaching process in science teaching classes.

ii. To test those hypotheses experimentally in relation to learning abstract principles using geometrical-figure tasks.

iii. To test correlation between the figure tasks and language tasks based on some current EST material.

CHAPTER THREE

THE CASE FOR AN ALTERNATIVE ROUTE TO EST.

3.1 Introduction:

In the previous chapter we accepted Widdowson's view that our EST methodology should be approximated to that employed in science teaching, and thus we should draw on the same teaching and learning strategies which are activated in dealing with science as a subject. However, I have argued that our definition of science teaching methodology ahould be that which is actually employed in the context under study, and not a universal type which may exist only in our assumptions. Thus, we should take our cue from what actually goes on, not what should go on, in the classroom. In this case the starting point should be the analysis of classroom interaction from a behavioural perspective to identify the cognitive behaviour which prevails in the classroom and consequently governs the learning process. This, however, has to be conducted against a formulated hypothesis about the teaching and learning behaviour in the context given as manifested in science classes and other learning situations.

3.2 Science Teaching in Bahrain:

Before setting out to outline the thesis of the present study and the research procedures employed to find evidence in support of that thesis, it is imperative to consider the general framework of science teaching in Bahrain. This should serve as a background against which the problem will have to be viewed. This is because, as mentioned earlier, the influence of these learning

conditions has a crucial impact on the process of learning in general and any EST programme to be devised for the Bahraini situation in particular.

In general, the teaching of science in Bahrain is regarded as the teaching of knowledge, principles, and facts with no real personal involvement on the part of the student. The emphasis is on acquiring, and even memorising, science as a body of knowledge. Students are presented with a set of scientific facts, observations, principles, and formulae which they are supposed to assimilate. Consequently, the methodology applied by science teachers is exclusively concerned with the teaching of science as a 'content' rather than exploration and application of scientific knowledge in everyday life. The focus being on the practical use of that knowledge either immediately, such as passing examinations, or later in life, such as career purposes. This is illustrated in the following table which shows the reaction of the Ministry of Education in Bahrain to a questionnaire on the importance of different aims of science teaching in secondary schools, [Arrayed, 1980], using the score 1 for the least important aim and ranking the others up to 10 as the most important one.

Table 1: Reaction of the Ministry of Education (Bahrain) to the Importance of Aims of Science Teaching in Secondary Schools.

Aim	Lower Secondary	Upper Secondary
a. Observation	2	1
b. Scientific thinking	4	3
c. Examination	10	10
d. Career decision	8	7
e. Career preparation	9	8
f. Useful information	3	4
g. Curiosity	1	2
h. Interest	5	5
i. Intellectual enjoyment	7	9
j. Significance of science	6	6

It is quite clear from this table that the educational system places almost exclusive emphasis on what Arrayed refers to as 'utilitarian values' (aims c, d, e, and f) in science education. Experiments, on the other hand, are mainly conducted by the teacher and are illustrative or confirmatory rather than investigatory. Arrayed also makes some useful inferences, based on information obtained from teachers and inspectors of science in Bahrain, among them is that "The methods most regularly used were teacher-led discussion and teacher lectures and explanations, and to a much lesser extent teacher demonstration with equipment", and that "Laboratory work carried out was mainly to verify known facts and illustrate known results." [p.102]. He goes on to make the folowing conclusion about science teaching in

Bahrain based on the analysis of that information:

> "The problems and processes of science were not stressed; and the activities set were not challenging or provocative. The attitudes of teachers did not encourage the students to pose problems, or try to find out for themselves. The students were not helped to realize that the learning of science is more than just memorization of facts; they were not given any opportunity to try to formulate their own hypotheses and to design and perform their own investigations. Instead, they were told everything they were supposed to know." [p.104].

Science teaching in Bahrain could, therefore, be appropriately labelled as a "non-problematic" and "non-negotiable" exercise. The result is that no problem solving strategies of the type of formulating hypotheses, learning by discovery, and making inferences are required by the students. This perhaps is the direct result of the elite connotations attached to science in the primary culture on the one hand and the role of the school as a provider of knowledge on the other. The former factor has created a vicious circle whereby science courses are regarded as elite subjects which only bright students manage to master and, in turn, those courses have to live up to this expectation by presenting science as a complex set of knowledge and facts. The latter factor has resulted in the belief that access to scientific knowledge is only possible through the teacher.

A third influential factor is the examination system which is closely content-oriented and which therefore promotes factual

recall skills. The significance of such a factor is reinforced by the educational policy of the Ministry of Education which considers the passing of examinations as a top priority in ranking the aims of science education in schools (see Table 1).

A fourth factor which undoubtedly influences the learning behaviour is the format of science textbooks used by the students. These books usually present scientific knowledge in the form of facts, laws, formulae, or definitions which are then confirmed by experiments. The following text and its translation, which is taken from one of the textbooks students study in Bahrain, should serve as an illustration:

درجة الصوت ونوعه

Pitch and Quality of Sound

العوامل التى تميز الأصوات أو النغمات بعضها عن بعض ثلاثة هى : الدرجة ، والشدة ، والنوع .

أولاً ـ درجة الصوت Pitch :

هى الخاصية التى تميز بها الأذن الأصوات أو النغمات المختلفة من حيث الحدة أو الغلظة ودرجة الصوت تتوقف على تردده .

ولتوضيح ذلك تجرى التجربة الآتية : خذ مشطاً عادياً من أمشاط الشعر وأمرر قطعة من الورق المقوى على أسنانه فتهتز قطعة الورق عند انتقالها من سن لأخرى ويصدر الصوت وإذا كان إمرارك لقطعة الورق بطيئاً فإن الصوت المسموع يكون غليظاً ودرجته منخفضة ، وإذا كان سريعاً فإن الصوت المسموع يكون حاداً ودرجته مرتفعة .

Pitch and Quality of Sound

"The factors which differentiate sounds or tones are three: pitch, loudness, and quality.

First: Pitch: It is the characteristic by which the ear recognises different sounds or tones as high or low. The pitch of the sound depends on its frequency of vibration. To illustrate this we conduct the following experiment. Take a hair comb and pass a piece of cardboard on its teeth. The carboard vibrates as it moves from one tooth to the other and produces a sound. If your movement of the cardboard is slow, the sound is low-pitched, and if the movement is quick, the sound is high-pitched."

[From Al-Shathly, A.F., 1976, "Physics:Sound", Daar Al-Márif,p.77].

It is perhaps imperative to make the point here that although these might not seem to be ideal learning conditions under which science should be taught, the fact remains that our EST methodology should be adapted to the cognitive behaviour postulated by those conditions and should appreciate the teaching and learning strategies which prevail in the Bahraini context.

3.3 Hypotheses and Research Design:

Against this background, the central hypothesis of this study is that, given the above learning conditions, Bahraini students learn better by being exposed to explicit rather than implicit rules, principles, and information, and by means of applying learning strategies based on REFERENCE and APPLICATION rather

than INFERENCE and DISCOVERY. By reference and application learning strategies I mean a method of learning which is based on explicit exposure to rules, principles, and procedures which are then applied in solving problems in any learning situation. This is in constrast with the frequently upheld view that learners in general learn better through inference and discovery strategies, whereby they are not given any explicit rules or principles to draw upon in their task to solve problems but rather offered minimum guidance to discover those rules and principles by themselves. The fact is, learning by discovery will take place only within limits and is dependent on the perception of the underlying rules. Furthermore, learning in this manner requires time since it is governed by a trial and error technique. This also means that learning can happen by chance and therefore is somewhat uncontrollable.

Even when divorced form the practicalities of the prevailing learning conditions, the case for learning through application of rules and principles can theoretically be consolidated by the argument that awareness of rules and principles is fundamental in assisting transfer and building a solid base on which other learning can take place, and in creating a productive type of thinking. I have already quoted Gagné [1970] who asserts categorically that discovery of a solution in a problem solving situation depends upon the recall of previously learned rules, and thus "The person who has a greater variety of rules, on which to draw... will have a greater chance of arriving at a solution." [p.233]. Earlier, Taba et al [1964] discussed the significance of learning through application of principles with regard to the type of thinking it promotes and in contrast with two other

cognitive tasks. They had this to say:

> "Application of principles invites a greater degree of divergence than either of the preceeding cognitive tasks (i.e. grouping and classification of information, and interpretation of data and the making of inferences). Each condition presented as data invites a divergent line of predictions. For this reason, this process contains opportunities for creative and divergent use of knowledge.... The operations involved in applying principles are quite crucial to developing productive patterns of thought. This process is the chief vehicle for transfer of knowledge. This is the chief process on which the transfer of knowledge depends, and therefore a crucial one for getting mileage out of what little the students are able to acquire directly during their schooling. It is a chief means for creating new knowledge by logical processes, and a way of acquiring control over wide areas of new phenomena." [p.34-35].

Although evidence obtained from a range of studies and experiments in favour of "learning through inference and discovery" may tempt us to quickly discard the claim for "learning through application of rules and principles", experience has often shown that one should not be so quick in jumping on the bandwagon. The fact remains that most experiments are relative and cannot be viewed apart from a common cultural and educational context. They usually include a cultural and educational element which influences the results of those experiments. The point is that results of certain studies and

experiments concerned with learning and teaching and conducted in certain learning conditions are sometimes over-generalized and over-exploited. The result is that pedagogical implications are drawn and then applied in situations with a markedly different set of behavioural, educational and cultural variables. I believe that these variables have got a lot to answer for in the way students form their concepts, solve problems,and learn languages, among other cognitive and social behaviours. In the Bahraini situation, learning through awareness and application of rules, principles, and procedures is congruent with the type of learning strategies fostered by the educational and cultural settings.

Against this background the task of testing the formulated hypothesis aimed at investigating the cognitive behaviour of students in Bahrain in the light of the influence of the science teaching methodology applied. It is hoped that the findings would then form the basis for establishing certain parameters for producing and presenting EST materials for Bahrain. The task was carried out in two simultaneous types of investigations:

i. A study of the behavioural characteristics of science methodology in Bahrain through classroom interaction analysis. This is because the cognitive strategies employed by students are greatly influenced by the manner in which the teacher deals with the teaching material and the way he directs classroom interaction. His methodology, therefore, represents a crucial behavioural input to the learning situation.

ii. An investigation into the most effective method for learning

in a problem solving learning situation, a method which would yield a high rate of transfer and retention. Language learning in this context is viewed as a problem solving exercise.

The task of collecting empirical data in support of the formulated hypothesis and in relation to the research design suggested at the end of Chapter Two was carried out through two approaches. Firstly, a number of second year science classes were filmed at random in four secondary schools covering town and rural areas, boys and girls. Then a classroom interaction analysis was conducted using a specially devised system, based on Flanders' model [1970], to identify the general pattern of teaching/learning behaviour which prevails in these classrooms. This system and the analyses are discussed in the following chapter. Secondly, having accepted the notion that learning in general and language learning in particular is a problem solving process, two types of experiments were conducted involving three groups of students, one control group and two experimental groups, to compare the learning style proposed in the developed hypothesis (i.e. learning through principle application) with the one usually employed by current EST materials (i.e. learning through discovery). One type of experiments was based on solving tasks in the form of geometrical figures which were first presented in Katona's work [1940]. The other is based on language tasks dealing with certain grammatical and discoursal aspects of EST. A detail description of these tasks and a discussion of the experiments procedures and results will be given in Chapter Five.

Perhaps it is important at this stage to clarify the relationship between the two types of the empirical data mentioned above. The interaction analysis investigates teaching behaviour to identify the pattern of acts employed by the teacher in the given context to make learning possible. This is defined as "teaching strategies". The problem solving experiments, on the other hand, investigate learning behaviour to identify the pattern of acts employed by the learner to acquire a certain concept, rule, or principle. This is identified as "learning strategies". There is no doubt that the two types of strategies are greatly influenced by certain cultural and educational variables, and that they are inseparable in any learning situation. Taba et al (1964) drew attention to this point in relation to classroom interaction and remarked that teaching strategies and those of learning manifested by the students "form a reciprocal transaction in which one generates and influences the other, and both together are responsible for the end product, the quality of learning." [p.30]. The acknowledgement of this reciprocal relationship is manifested by the departure in recent studies from the contention that teacher's behaviour is solely responsible for shaping up classroom behaviour. In these studies [Jenkins, 1969; Fielder, 1975; Noble and Nolan, 1976; Doyle, 1979] striking evidence was found to suggest that students have a significant effect on teachers' behaviour. Doyle [1979] reports that studies of classroom behaviour have revealed that "The influence of students ranges from the general teaching methods and patterns of language teachers use in classrooms to the type and frequency of teacher questions and feedback given to individual students." [p.139]. This state of affairs underlines the importance of studying the

two types of strategies to determine the type of methodology most suitable to a given context. In fact, given the importance of this reciprocal relationship, one can perhaps rightly argue that, in certain cases, our failure to facilitate learning is largely due to the fact that there is usually a mismatch between the two sets of strategies employed in the two processes; i.e. teaching and learning. The present study should show that in the Bahraini context there is a shared pattern between the type of strategies prevalent in classroom interaction and those activated by students in the process of learning certain concepts, rules, or principles, and therefore that pattern should be high-lighted in our EST teaching materials and methodology.

There is no doubt that one of the most effective tools for identifying the teaching/learning pattern objectively and systematically is through analysing classroom interaction. This is because interaction analysis provides a fundamental measuring tool for identifying the dynamics of cognitive processes of teaching and learning behaviour which other tools, such as achievement test, fail to record. As Taba et al [1966] point out "Paper and pencil tests, no matter how well developed, inevitably provide data only on the end products of thinking, and neglect the dynamics in the evaluation of thought." [p.36].

3.4 Interaction Analysis: A Review.

The purpose of this section is to review the field that is being investigated and to define a position in relation to those developments.

Educational research has been for a long time preoccupied with curriculum development, syllabus design, teaching methods, textbooks, and testing. The manner in which these issues have been dealt with, however, manifests a tendency towards focusing on the provision of what goes into the classroom, i.e. teaching methods and textbooks, and the evaluation of what comes out of it, i.e. students' achievement, but ignoring what actually goes on in the classroom, i.e. teaching and learning behaviour. However, developments in educational research over the past two decades have witnessed a rapid and increasing interest in the investigation of classroom interaction as a focal area in research into learning and teaching behaviour. The result is that more and more techniques and systems with different theoretical and purposive emphases are being devised to analyse teacher-student interaction in classroom settings. The assumption is that teacher-student interaction immensely influences the learning process, and that it is only by fully understanding the pattern of this interaction and its implications that we can suggest ways of improving the learning conditions. Consequently, classrooms are no longer viewed as laboratories for testing certain educational theories, but rather "as busy, complex, multi-dimensional ecological systems and, as such, worthy of being the object of study rather than only the setting for it." [Hinely and Ponder, 1979, p.136].

Developments in the analysis of classroom interaction have also marked a significant shift in the relationship between theory and practice which used to take the form of a one-way direction. That is to say, theories about learning and teaching developed by theorists, psychologists, and educators used to be based on

controlled laboratory settings and were then put into practice in the classroom with the aim of improving learning and teaching methods. Currently, studies in classroom interaction have created a two-way traffic in which findings of those studies represent an essential ingredient to learning and teaching theories and play a significant role in modifying those theories. As Fanselow [1977] points out, "we can learn a great deal about how to teach by analysing descriptions that show how practicing teachers and their students communicate both in the classroom and outside the classroom." [p.17].

With regard to language teaching and learning, the interest in the analysis of classroom interaction reflects a shift in both theoretical and applied linguistics towards investigating language use, rather than language usage, to provide a deeper insight into language as a social as well as behavioural phenomenon, and subsequently focus on areas such as discourse analysis, language functions, and social interaction.

But even within this movement towards interaction analysis as an influential area in educational research we have recently witnessed some significant departures from earlier approaches. Most interaction analysis systems developed earlier were mainly simplistic models offering quantifying devices and dealing with duration and frequency of speech and silence. The focus was mainly on teacher training with emphasis on improving teacher efficiency and effectiveness. However, recent developments in the study of classroom interaction have been stimulated by the shift in research from contrasting certain teaching methods or

modifying teaching behaviour to investigating what the learners have, do,or can do in the learning process. These developments have also brought into contact issues from major sciences such as linguistics, sociology, anthropology , ethnomethodology and psychology. The result is that many attempts have been made to devise more objective and systematic systems to accommodate more subtle distinctions in interaction. This, however, has not been without a price. Interaction analysis systems have become so complex that they are difficult to apply or use by the non-specialists. A good example is the category system developed by Bellack et al [1966] which requires the analyst to assign eight parallel coding symbols to the transcription of each move spoken by the teacher or the student in the interaction process, as in the following excerpt:

T: I think you put the most important thing last,
but that's true. [The branch office in a foreign T/REA/FOD/-/-/STA/QAL/
country, which involves the exportation of American
capital, is so often done to avoid paying

what? [[22/14/4
T/SOL/FOD/XPL/3/-/-/-

P: Taxes. [P/RES/FOD/XPL/1/-/-/-

T: What kind of taxes? [[23/14/2
T/SOL/FOD/FAC/1/-/-/-

P: Import. [P/RES/FOD/FAC/1/-/-/-

T: Hm? [[24/14/2
T/SOL/FOD/-/-/ACV/RPT/1

P: Import. [P/RES/FOD/-/-/ACV/RPT/1

T: Why would a company open up a branch in England,

or Germany or France or Italy? T/SOL/FOD/XPL/2/-/-/- 25/21/70

P: Corporation won't have to pay tax? P/RES/FOD/XPL/1/-/-/-

T: No, if it's an American corporation it's still going to have a, have to pay corporation tax over here. It might save a little bit on the income earned by its branch office until it brings that income back to this country it is not taxed, but ultimately it would be. But it's a different kind of tax. T/REA/FOD/XPL/6/STA/NEG/1

P: The tariff. P/RESOM3/FOD/XPL/1/-/-/-

[From Bellack et al, 1966, p.268]

The increasing interest in interaction analysis as a method of studying social or cognitive behaviour of certain groups is manifested by the large number of systems developed in this area. Simon and Boyer [1970] list ninety-two different systems for analysing interaction in a wide variety of settings, eighty of which are exclusively related to the classroom situation.

Generally speaking, systems for analysing classroom interaction can be divided into two categories with regard to their general aims:

i. those which focus on the cognitive aspects of classroom behaviour, such as the study of teacher's questions and the type of cognitive processes and levels of thinking they promote, as in the work of Gallagher and Aschner [1963],

Smith and Meux et al [1967], and Taba et al [1964].

ii. those which focus on the affective and functional aspects of classroom behaviour and concentrate on the study of the type of language functions and meanings which that behaviour reveals, as in the work of Stubbs [1972], Sinclair and Coulthard [1975], and Fanselow [1977].

Simon and Boyer [1970], however, are sceptical about the possibility of differentiating between the two types and suggest that this is because "Every statement carries both a data message (cognitive) and an emotional message (affective) and in reality they probably are not separable" [p.2], and thus there is usually an overlap between the categories. Hence, a large number of systems contain categories which reflect the two aspects of classroom behaviour, cognitive and affective, especially in studies where the focal interest lies with investigating teacher behaviour in relation to certain pedagogical and cognitive domains of classroom interaction, as in the systems developed by Bellack et al [1966], and Anderson and Bingman [1969].

It is perhaps worth noting here that in the development of classroom interaction analysis a substantial investigation has been devoted to the application of this approach to foreign language learning and teaching situations. The result is that some systems are exclusively geared to foreign language classroom situations and accommodate such distinctions as the use of the mother tongue versus the use of the target language [Wragg, 1970], the use of the different language skills [Freudenstein, 1977], and the use of the different language systems, e.g.

grammar, phonology, register, etc. [Fanselow, 1977]. However, I think more research is still needed in the area of applying interaction analysis, and in relation to learning foreign languages, to the study of the cognitive behaviour of the learners and the influence of classroom interaction on shaping their learning strategies.

An historical review of the literature reveals that interest in studying teacher/student interaction and the influence of its pattern on the learning process can be traced back to as early as 1912 in the work of R. Stevens who investigated the number of questions asked in the classroom as a measure of efficiency of instruction. This, however, was a purely quantitative approach to analysing classroom behaviour. Investigations into the qualitative aspects of classroom behaviour was mainly established in the studies conducted by H. H. Anderson, between 1937 and 1939 and later in collaboration with J. E. Brower and M. F. Reed. Anderson was interested in studing the distinction between "dominative" and "integrative" behaviour of teachers. This distinction was to become a central theme in most studies conducted ever since. However, perhaps the most pioneering and influential work in the field of interaction analysis is that of Ned Flanders which was initiated at the University of Minnesota between 1945 and 1960 when a ten-category system was published. Since the system suggested in this study for the analysis of the accumulated interaction data is based on Flanders' model, the discussion of this system, its merits, and its criticism has been deferred to the end of this chapter.

It is beyond the scope of this study to offer a detailed and critical account of the numerous interaction analysis systems developed by different researchers and for different purposes. However, it is imperative to consider, if only briefly, some of the well-known systems in order to offer some examples of how different researchers view the phenomenon of classroom interaction and how they tackle the problem of analysing that interaction. Given the distinctive purpose stated in the present study for analysing classroom interaction, the discussion should also reveal why these systems had to be discarded in favour of Flanders'. My discussion here will be confined to the systems developed by Bellack et al [1966], Fanselow [1977], and Sinclair and Coulthard [1975], and will focus on those aspects relevant to the purpose of this study.

Bellack et al [1966] were interested in finding out, and in relation to classroom discourse, "which participant — teacher or student — speaks about what; how much, when , under what conditions, and with what effect." [p.2]. They suggested that classroom discourse could be analysed in relation to two dimensions:

i. Pedagogical meaning related to the pedagogical significance of teacher-student interaction, and which can be classified according to four pedagogical moves:structuring,soliciting, responding, and reacting.

ii. Content meaning related to what is being communicated in teacher- student interaction, and which can be classified according to four categories of meaning; substantive, substantive-logical, instructional, and instructional-logical.

The result, unfortunately, is that the category system they present is over-complicated and thus requires a mammoth coding task. (See Appendix 1). Bellack et al in fact acknowledge this and confess that it would be "unreasonable to expect that any one person, no matter how well-trained, would be able to code large sections of the data reliably without the checks offered by consultation with another coder." [p.14]. Besides, I believe Bellack's system is inconsistent in dealing with the focal area of the present study, i.e. the cognitive processes highlighted in the teacher-student interaction in the domain of classroom discourse. Bellack's system deals with this aspect under "Substantive-logical meaning" (See Category 4 in Appendix 1) and which refers to "the cognitive processes involved in dealing with the subject matter, such as defining, interpreting, explaining, fact-stating, opinion, and justifying." [p.5]. Within this main category the system presents the following under the sub-category "Empirical Process":

> "Explaining (XPL): relation between objects, events, principles; conditional inference; cause-effect; explicit comparison-contrast; statement of principles, theories, or laws."

It is obvious here that the system does not differentiate between statements or questions dealing with implicit as opposed to explicit information, between statements or questions which activate inferential as opposed to referential cognitive processes, as an aspect of interaction which is crucial in

directing classroom discourse.

To illustrate the relationship between the utterance and the cognitive process it activates, consider the following two statements about the formation of the focus in concave and convex mirrors:

A. Unlike the illusive focus, the real focus is formed by the meeting of the reflected rays not their extensions.

B. The real focus is formed by the meeting of the reflected rays but the illusive focus is formed by the extension of those rays.

It is quite clear that the principle that the illusive focus is formed by the meeting of the extension of the reflected rays is arrived at by two different types of cognitive processes with regard to the two statements. While this principle is explicitly stated in (B), and therefore it is arrived at through direct reference to the structure of the statement or the text, the reader has to make inferences with regard to statement (A) based on the substantive-logical meaning of the word "unlike" and the negative formation at the end of the statement in order to arrive at the same principle. Bellack's system, however, would code both statements under the same category: "Explaining (XPL)", and thus would not differentiate between the two cognitive processes. There is no doubt that the interpretations of classroom interaction analysis based on the occurrence of one type or the other would certainly yield different teaching and learning behaviour.

Fanselow's system "Foci for Observing Communications Used in Settings" (FOCUS), on the other hand, is primarily functionally oriented rather than cognitively. [See Appendix 2]. Fanselow attempts to set up an objectively defined set of terms "for classifying, creating and evaluating communications in a range of settings." [1977, p.19]. He, therefore, focuses on the functional and meaning domains of utterances in different communication settings, an aspect of language behaviour which was discussed earlier by Skinner [1957] and Aschner [1961]. Fanselow is basically interested in investigating the significance of the setting in determining the function, and subsequently the meaning, of an utterance in communication. He exemplifies this by suggesting that the communicative "content" of questions such as:

- How long have you been in Montreal?
- Why were you here?

would be coded "procedure" when asked by a customs officer, but "life" when asked over dinner by a friend. [Fanselow, 1977, p.39]. The system therefore distinguishes five characteristics of communications, three of which deals with "Medium", "Use", and "Content" of the utterance. The system also deals primarily, although not exclusively, with language teaching situations, and thus it allocates one of the four areas presented under "Content" for "language systems", with eight sub-areas such as "contextual", "grammatical", "literary", "meaning", and "sound". The 'FOCUS' system is also too detailed, which makes it difficult to modify, and offers no statistical means for the interpretations of the tabulated data.

The failure to distinguish between different types of cognitive processes in analysing classroom interaction is also shared by the system developed by Sinclair and Coulthard [1975]. Sinclair and Coulthard's system is closely related to Bellack's pedagogical moves but differs from them in the degree of delicacy. They view classroom discourse as being basically composed of three pedagogical moves, "initiation by the teacher, followed by the response from the pupil, followed by feedback to the pupil's response from the teacher." [p.21]. They suggest a rank scale consisting of four levels, with an "Act" as the lowest rank, then a "Move", then an "Exchange" and finally a "Transaction" as the highest rank. Each rank consists of a number of classes. A lesson is made up of a series of exchanges. (See Appendix 3). Thus, what Sinclair and Coulthard are interested in is the identification of the functional and pedagogical structure of classroom discourse, rather than the cognitive processes which underlie that discourse. Hence, all questions,for example, are coded under "Elicitation" which is defined as "an act the function of which is to request a linguistic response." [p.28]. Thus, they ignore the type of cognitive behaviour different questions postulate in the interaction process. The point is that in classroom situation the teacher does not embark on a particular type of question haphazardly, but rather the type of question he uses usually reflects the type of cognitive behaviour he chooses to postulate. There is no doubt that the type of questions a teacher asks is very crucial in determining the cognitive behaviour and learning strategies in the classroom and even achievement rate. This relationship was documented by many researchers like Gallagher and Aschner [1963], Smith and Meux et

al [1967], Barner [1971], Wright and Nuthall [1972] and Mehan [1979]. Finally, Sinclair and Coulthard confined themselves primarily to the study of classroom discourse with its overt stereotype structure and where control over discourse is exclusively with the teacher. Thus, they acknowledgedly overlook the "complications" and "problems" of analysing the discourse of normal conversation in favour of "a more simple type of spoken discourse, one which has much more overt structure, where one participant has acknowledged responsibility for the direction of the discourse, for deciding who shall speak when, and for introducing and ending topics." [p.6]. The result, however, is that certain communicative functions are dealt with in a restricted manner even in relation to clasroom discourse. In their consideration of the communicative functions of the interrogative form, for example, Sinclair and Coulthard discuss and supply rules for the identification of only two functions; as commands and as genuine questions. Thus they ignore other functions, such as the ones realised in the following utterances:

a. will you please help me with the projector, John? (request)

b. why don't you use your calculator to find the answer?(suggestion)

c. why don't you use your common sense, Peter? (criticism)

I think all these are genuine and typical classroom communicative functions which are realised by the use of the interrogative form. In short, the impression one gets is that the neatness and simplicity of Sinclair and Coulthard's approach is achieved at the expense of eliminating certain significant aspects of classroom discourse.

We now turn to the discussion of Flanders' system, to consider its main features, its drawbacks,and its relevance to the purpose of the present study. Flanders' Interaction Analysis Categories (FIAC) (See Appendix 4) focus on the social aspects of classroom interaction. The aim is to provide teachers and educators in both initial and in-service teacher education programmes with a feedback system which, through the study of verbal teacher-pupil interaction, will help improve teaching effectiveness. It suggests that this can be achieved by giving the teacher the opportunity to analyse his own teaching behaviour objectively and systematically and consequently adopt alternatives based on his new insights about the influence of his method on the learning process. The underlying assumption is that "a teacher can be helped to define more accurately his own concept of desirable or ideal teacher behaviour and subsequently to modify his behaviour in the direction of that ideal." [Amidon and Flanders, 1963, p.1]

Flanders' system is exclusively concerned with the analysis of overt verbal behaviour. This is justified on two grounds. Firstly, that verbal behaviour "can be observed with higher reliability than can non-verbal behaviour", and secondly, that "the verbal behaviour of an individual is an adequate sample of his total behaviour." [Amidon and Flanders, 1963, p.5].

Although Flanders' system has been applied and modified in a large number of studies by educators and researchers, it has, nevertheless, been subjected to scrutinising criticism. Some of that criticism is related to the fact that since Flanders' system, as well as its numerous offshoots, is primarily concerned

with overt observable verbal behaviour, such a system is incapable of handling other characteristics of speech behaviour, such as intention, and is also bound to ignore the temporal and spatial context. [Delamont and Hamilton, 1976].

From a social and socio-cultural viewpoint, some see Flanders' system as being closely oriented towards interaction in a classroom setting, and moreover, towards a particular type of classrooms, and are thus sceptical about its relevance to patterns of communication in other settings. Stubbs [1972] notes that Flanders' categories "are not applicable to speech situations other than traditional classroom teaching, or at least situations in which clear authority patterns hold between speakers." [p.28]. Delamont and Hamilton [1976] argue that Flanders', just like most other American interaction analysis systems, is ethnocentric, "based on a model of the classroom and a conception of education that is not always relevant in Britain", and that as it devotes seven out of its ten categories to "teacher-talk", it assumes "the 'chalk and talk' paradigm and focus predominantly upon the teacher." [p.10]. Other criticism of Flanders' system comes from lack of delicacy within its categories, and thus it attempts to include many verbal activities under one category. [Freudenstein, 1977].

Considered in the foreign language teaching perspective, Flanders is criticized for presenting analysis categories which offer quantitative interpretations, and therefore "do not tell us anything about the content of a lesson, the arrangement of instructional phases, or the problems which are specific to foreign language instruction." [Freudenstein, 1977, p.77].

Sinclair and Coulthard [1975] found the categories offered by Flanders particularly inconsistent and dealt with different levels of abstraction. They noted that "while some categories have a direct grammatical realization and discourse function (e.g. Asking Questions; Giving Directions), for others it is much harder to provide an explicit realization (e.g. Accepting Feeling, Criticizing or Justifying Authority)." [p.15]. Bailey [1975] also expresses a similar dissatisfaction and queries the ability of the observer to make a decision in a split second when dealing with the difference between, for example, Category I (Accepting Feeling) and Category 3 (Accepting or Using Ideas of Pupils). He also notes the ambiguities of the category definition, and casts doubts about the ability of the system to improve teacher effectiveness since it does not tell the teacher how to improve his teaching but simply shows him how he behaved. Flanders' system could also be criticized for the unequal distribution of categories between Teacher Talk (7 categories) and Pupil Talk (2 categories). This, however, is hardly surprising, given the fact that earlier works in interaction analysis, and Flanders is one of the pioneers in this field, aimed at investigating teaching behaviour (directness versus indirectness) and teacher effectiveness, and concentrated, therefore, on the teacher.

Another criticism of Flanders comes from the fact that he does not differentiate between work-oriented silence periods and those non work-oriented, a change which was incorporated in Moskowitz's system "Foreign Language Interaction System" (Flint) [1971 and 1976] and which is an adaptation of Flanders' system.

On the whole, I think some of the criticism which Flanders' categories have been subjected to is unjustified. What Flanders has offered us in his system is a guideline and an example of how intereaction can be analysed systematically and for a specific purpose. Many of those who are critical of Flanders' approach have overestimated its capacity or overlooked its aims and thus were dissatisfied with its outcomes. The fact is, human interaction behaviour, being so diverse and drawing upon different linguistic, social, psychological and even physical strands, is difficult to contain or cater for in a confined analysis system without running the risk of being so elaborate that it is difficult to handle or apply. The other alternative is to establish an interaction paradigm which is flexible and managable and can be modified to suit different purposes. I think Flanders' system has these characteristics. The point is that the nature and delicacy of the categories in an interaction analysis system would normally reflect the purpose of that analysis. Flanders in fact acknowledges this. After stating that his system is concerned with the study of the balance between initiation and response as an indicator of pupils' learning behaviour and their attitude towards learning, he notes that "A different category system would be needed in order to investigate other problems of teaching and learning, for example, how different pupil reactions affect class learning." [1970, p.36]. He goes on to suggest ways in which his categories can be, and have been, subscripted (modified) according to the main features of the problem which the system is investigating. I believe that it is particularly by being flexible and in the form of a guideline rather than a rigid system that Flanders' system has been found attractive enough to be the base of numerous studies in

interaction analysis. While the basic behavioural potential of each category remains the same, the task of the researcher becomes that of creating different levels of delicacy within each category as relevant to the purpose of the study.

Flanders [1970] cites a system developed by Measel in which Category 4 (Asking Questions), for example, was subscripted to cater for three different levels of thinking which Measel was investigating in classroom interaction: (i) memory; (ii) grouping things together; and (iii) higher reasoning processes. This resulted in the elaboration of Category 4 to include:

41. Teacher questions involving concrete objects or events.
42. Teacher questions calling for the mental operation of grouping.
43. Teacher questions calling for the mental operation of inferring.

[Cited in Flanders, 1970, p.146-147)

In another study, which aimed at focusing on the teacher's reaction to students' ideas and the influence of that reaction on students' thinking and participation, Category 3 (Accepting or Using Ideas of Pupils) was elaborated to include:

31. Merely repeats, very brief summaries, superficial acknowledgement.
32. Pupil's idea is developed in terms of teacher perceptions.
33. Pupil's idea is developed in terms of another pupil's ideas or in terms of ideas expressed earlier by the same pupil.

[Flanders, 1970, p.140-141]

While this type of exercise is possible with a system which offers a general guideline, as indeed Flanders' does, it is almost unattainable with other systems which are so detailed that they rule out any attempts for manoeuvring by the researcher. They in a way present a take-it or leave-it offer. The categories and subcategories in those systems are so closely knitted and so rigidly dependent that any modification would impair their structure and ultimately their applicability. This flexibility in modifying the system is one reason why it was decided to use Flanders' categories as a base for the suggested model in this study. Another reason is that it offers a simple coding system with attainable quantitative measures, and thus it is statistically more appropriate. The tabulation system also offers statistical means for making interpretations and inferences about the teacher-student interaction pattern and, consequently, the teaching and learning behaviour applied in the situation under study.

CHAPTER FOUR

INVESTIGATING LEARNING STRATEGIES 1: THE CLASSROOM INTERACTION ANALYSIS.

4.1 Introduction:

Systems for analysing interaction in general and that of the classroom in particular have so far been initiated in response to either a theoretical or an empirical investigation. That is to say, some systems stem from theory and speculation about what interaction is and how it is organised, which is then used as a base for developing a model to contain that organisation, as in the work of Fanselow [1977]. Other systems stem from the study of some empirical data which then leads to developing a model to describe that data, as in the work of Sinclair and Coulthard [1975]. Whatever the approach, there is usually a similarity between both types with regard to the main features of interaction. The difference lies within the particular aspect of interaction a given system chooses to focus upon. As has been mentioned in the previous chapter that focus has so far been either psychological or sociological,with an overlap in certain aspects of interaction. The purpose of the investigation usually determines where the focus lies as the categories contained in the system usually highlight the nature of what is being investigated.

It is imperative, however, to mention here that classroom interaction is not so neatly clearcut as to be easily classified, coded, and tabulated using this system or another, and therefore

most researchers in this area would admit that their models are far from being fully inclusive. This is particularly the case when one is not simply constructing data to exemplify a theoretical model but is working on empirical data accumulated from natural classroom interaction where the teacher is not cued. The fact is that many behavioural factors usually interweave in any classroom situation and influence the manner in which interaction is organised. Among these factors are:

i. Teachers' habits in dealing with students' responses, such as the use of praise expressions, or repetition of students' responses. This usually happens so frequently that it is difficult to decide whether words like "Good" and "OK" are meant to be genuine praise,or what Flanders [1970] calls "superficial verbal habits". [p.41]. However, these are important aspects of classroom interaction because the way they are interpreted by students would affect their responses. Genuine praise may generate motivation whereas superficial verbal habits are usually ignored by students.

ii. The overlap between some of the categories. When the teacher, for example, repeats students' responses, should this be coded as acceptance of students ideas, or as a repetition for consolidation, or is it merely a teaching habit?

iii. The different question techniques employed by teachers. Some teachers prefer short straight-forward questions, others use prolonged questions whereby each question is preceded or followed by explanatory statements. The question which the analyst has to answer is: Should such explanatory statements

be considered as explanation, setting up the situation for a consequent move, or as part of the question itself (by applying the paraphrasing technique)?

A further key point which has to be considered in coding interaction in general is the fact that single utterances are frequently multifunctional, and that in many cases the analyst has to speculate about the most important function in the given context. His decisions, however, should be justifiable and consistent. It also means that the system one develops for analysing the data has to go through a number of modifying phases in order to be as inclusive as possible. This is usually accomplished by working back and forth between the data and the suggested system. Consequently, as more data is considered, the system becomes more and more elaborate. To avoid having a system with a large number of categories, the analyst may have to organise his system in such a way that certain categories comprise a cluster of related interaction moves, but concentrating on those which serve his purpose.

As mentioned in the previous chapter, the system developed by Flanders has been accepted as an appropriate framework for establishing a relevant and coherent model for use in the present study. However, since the analysis in our case focuses primarily on an aspect of classroom interaction different from that studied by Flanders, the system had to be modified. Flanders [1970] uses the term "subscription" to refer to the process of dividing a category into additional subcategories in order to increase the discrimination between utterances which would otherwise be coded

under the same category. Thus, Flanders' system had to be subscripted in order to cater for such distinctions in classrom behaviour corresponding to those focused upon in this study, namely the cognitive behaviours related to two types of learning strategies, i.e. learning through reference to and application of overt rules and principles as opposed to learning through inference and discovery of covert rules and principles. Consequently a 20-category system, based on Flanders' original 10 categories, has been developed. A detailed description and examples of the categories is given below, but first it is necessary to make a few points about the suggested system and the modification procedures;

i. The analysis of classroom interaction in the present study is not an evaluative or critical process, but rather an analytic and descriptive one. In other words, it does not attempt to measure teaching effectiveness or suggest any procedures for improving that effectiveness but to identify the teaching pattern as an input to EST methodology. This is because the basic tenet of the developed hypothesis rests on the importance of appreciating and building on the existing teaching and learning strategies rather than modifying them and creating different learning conditions. In this respect I accept the fact that the teaching and learning behaviours manifested by the norms which govern teacher-pupil interaction in the data provided represent a frame of reference which is quite effective in the teaching situation given in the sense that they generate positive learning attitudes and respond effectively to the general aims of the learning process in the given context.

ii. The categories presented in Flanders' system focus exclusively on the social aspects of classroom interaction. Although the social domain cannot be eliminated or ignored in any study of classroom interaction, the aim of the present study is to focus on the psychological level of that interaction. Given this, it is no help to us to say, as Sinclair and Coulthard [1975] did, that classroom interaction is organised mainly in a pattern which consists of three moves; elicitation, response, and feedback. What we want to know is: what sort of cognitive processes does the teacher's elicitation move promote? What type of cognitive style does the student's response reflect? Consequently, most of the categories in the suggested system highlight the psychological domain of classroom interaction. However, as mentioned above, the main aspects of the social domain had to be accounted for also.

iii. In the suggested system, Flanders' Category 1 "Accepting feeling" has been omitted altogether. This is because the difference between such a move and the one presented under Category 3 "Accepting or using ideas of pupils" is usually so slim that it is very difficult to detect. Moreover, accepting or predicting pupils feelings is far removed from the type of cognitive behaviour focused upon in the present study and is therefore irrelevant to the analysis.

iv. Category 7 "Criticising or justifying authority" has been shifted in the suggested system form the "Initiation" to the "Response" moves. This is because a teacher's criticism is

usually made in response to students' behaviour, and therefore could be seen as parallel to Category 2 "Praises or encourages" which is also classified as a response move. This in fact is in line with Flanders' definition of a response which states that "To respond means to take action after an initiation, to counter, to amplify or react to ideas which have already been expressed, to conform, or even to comply to the will expressed by others." [Flanders, 1970, p.35].

v. Although the present study acknowledges the criticism frequently made about Flanders' Category 10 "Silence or confusion" for not discriminating between work-oriented and non-work-oriented periods of silence, this distinction is not of immediate importance as far as the purpose of the present analysis is concerned since our main interest lies in analysing verbal aspects of classroom interaction. Flanders' category 10 has, therefore, been retained as it stands.

vi. The subscription of some of Flanders' original categories aims at providing a higher level of delicacy in dealing with those moves corresponding to the main thesis of this study. These are Category 4 "Asks questions",Category 5 "Lecturing", Category 8 "Pupil talk-response", and Category 9 "Pupil talk-initiation". A new coding system has been adopted to cater for the new categories.

vii. Finally, since the model suggested here is based on Flanders' system, it is natural that some of Flanders' definitions are reiterated here, but only with regard to some aspects of the categories adopted from his system.

A SUGGESTED INTERACTION ANALYSIS SYSTEM

(Based on Flanders' System)

TEACHER TALK	RESPONSE	10. Praise or encourages student's action or behaviour. 20. Criticises student's behaviour or justifies authority. 30. Accepts or rejects student's responses, and corrects, modifies or extends student's ideas.
	ELICITATION	41. Asks student to repeat or recall a rule, formula, principle,or process. 42. Asks student to infer a rule, formula, principle,or process. 43. Asks Student to state, apply or explain a rule, formula, principle,or process. 44. Asks student to identify an object, substance, process,or give an example.
	INITIATION	51. Repeats or recalls a rule, formula, principle, or process. 52. Makes an inference of a rule, formula, principle,or process. 53. States, applies or explains a rule, formula, principle,or process. 54. Identifies an object, substance, process, or gives an example. 60. Gives directions, commands or orders. 70. Sets up or explains teaching procedures or subsequent actions.
STUDENT TALK	RESPONSE	81. Repeats or recalls a rule, formula, principle, or process. 82. Makes an inference of a rule, formula, principle,or process. 83. States, applies or explains a rule, formula, principle,or process. 84. Identifies an object, substance, process, or gives an example. 85. Reacts positively or negatively to questions or statements.
	INITIATION	90. Asks for clarification, explanation, exemplification or repetition.
OTHER		01. Silence or confusion.

4.2 A Suggested System for Analysing Classroom Interaction:

Category 10

This category deals with teachers' utterances which carry the value judgment of approval. Encouragement may take different forms and may be verbal or non-verbal. It includes such behaviours as nodding of the head or using phrases such as "Umhm" or "Go on". Another phrase which seems to occur quite frequently in the present data is "Heh" with a marked encouraging tone especially when the student hesitates or the teacher does not get an immediate response from the class. The teacher, however, may choose to use a different form of encouragement as in the following example:

> T: So when I say to you why was it called illusive, what's suppose to be your answer? ... I've told you the answer.

Expressions like "O.K", "Good", and "Right" are not considered as genuine praise expressions since they are usually used habitually by teachers as a punctuation device, or what Sinclair and Culthard [1975] call "markers".

Category 20

This category covers the teacher's utterances intended to reprimand or criticise a student for his or her misconduct or for failing to answer a question or perform a task which the teacher believes is within the student's grasp. This, however, may be expressed in the form of a statement or a question as in the following examples:

i. T: These are simple things and we said before we're

supposed not to have forgotten.

ii. T: Heh, and the remaining three who are sitting at the back? .. Your weren't with us?

iii.T: What? Only three girls? Four? (putting their hands up to answer).

Category 30

Accepting a student's idea is mainly expressed by repeating or summarising his or her utterance just expressed. This acceptance, however, serves as a consolidating device, as is the case in the data dealt with in this study, especially when it deals with rules and principles. Correcting, modifying, and developing students' ideas are aslo forms of accepting those ideas as in the following examples:

i. P: It's the radius of the ball which the mirror was cut from.

T: It's the centre of the ball of which the mirror is a part.

ii. P: They gather in one point called the focus.

T: Yes, they are reflected, gathering in one point and this point is called the principal focus.

However, as the teacher develops students' ideas and introduces some of his own, the coding shifts to one of the categories in the 50s. Finally this category also includes rejection of students' ideas, which may take different forms as in the following examples:

i. T: Heh, what's the meaning of the spherical centre? The

spherical centre of the mirror whether it's concave or convex?

P: It's the one which faces the shining surface.

T: This is not a definition.

ii. T: OK, in what form are carbohydrate substances absorbed?

P: Starch carbohydrate.

T: But carbohydrate is a substance ... Starch is a carbohydrate substance.

Categories 41, 42, 43, and 44.

In his system, Flanders deals with the teacher's elicitation move under Category 4 which simply states:

> "Asks questions: Asking questions about content or procedure, based on teacher ideas, with the intent that a pupil will answer."

Clearly this is a rather crude way of dealing with teachers' questions since the category does not discriminate between the different cognitive processes which different types of questions may call for and which represent a focal point in the present study. This can be illustrated by the following examples which correspond to the four categories suggested in the present system to deal with teachers' questions:

i. Who discovered gravity? (Data recall: Cat. 41).

ii. Why is the focus of the convex mirror called an illusive focus? (Inference: Cat. 42).

iii. What would happen if we raised or reduced the temperature of the enzyme? (Application: Cat. 43).

iv. What do we call this brown gas? (Identification: Cat.44).

The discrimination between these types of questions and the cognitive behaviours they usually promote is crucial in the analysis of the present data, and therefore they have to be discussed in some detail.

Category 41.

This category includes two types of questions. The first type, and incidentally the one most frequent in the present data, is in the form of questions requiring immediate repetition of what has been discussed or explained as a consolidation technique, and which is usually confined to the repetition of a noun or a phrase, as in the following examples:

i. T: If the quantity of the ultra nitrogen oxide is little, add copper filings, add what?
   P: Copper filings.

ii. T: Any line which passes through the spherical centre and any point on the surface of the mirror, heh, what do I call this line?
   P: The secondary axis.
   T: Heh, what do I call it?
   P: The secondary axis.

The other type of questions usually requires the use of memory to recall information taught previously and may concern names or a whole sequence of actions or ideas, as in the following example:

T: We said if rays of a parallel beam fell parallel to the

principal axis of a concave mirror, how are they reflected?

Recall questions may also be used at a later stage in the lesson, particularly at the end of the lesson, to summarise the main points.

It is commonplace, however, for teachers to insert questions in the course of explaining a point with no intention of receiving an answer from the students but rather to consolidate a point through the repetition of that point, as in the following example:

T: An exchange takes place, a double exchange takes place, because here are solutions. What takes place? A double exchange.

This types of question is not coded as a genuine question but as a part of a repetition move (Cat. 51).

Category 42 and 43:

Since the identification of the dominant cognitive pattern in the present interaction analysis hinges mainly on the distinction between the learning strategies pertaining to making inferences and those to applying principles, and the frequency rate of each of them in the classroom interaction, it is perhaps important to provide definitions for these two cognitive levels. Inferential learning behaviour corresponds to what is known as "Divergent Thinking" and which according to Gallagher and Aschner [1963] "represents intellectual operations wherein the individual is free to generate independently his own data within a data-poor

situation, or to take a new direction or perspective on a given topic." [p.187]. Utterances representing such a behaviour reflect cognitive processes such as making relationships between data, showing cause and effect, classifying, analysing and contrasting data. The categories which fall within this domain, in addition to Category 42, are Categories 52 and 82 as related to teachers' or students' utterances (See the suggested system on page 131). The cognitive level associated with principle application, on the other hand, corresponds to what is known as "Convergent Thinking" and which Gallagher and Aschner[1963] define as "the analysis and integration of given or remembered data. It leads to one expected end-result or answer because of the tightly structured framework through which the individual must respond." [p.187]. Utterances representing such a behaviour reflect cognitive processes such as making predictions based on known conditions, applying known principles in new situations and using known generalisations and facts to develop hypotheses. The categories corresponding to such a behaviour,in addition to Category 43, are Categories 53 and 83. It remains to be said here, however, that Gallagher and Aschner's distinction is not exclusive, and that some inferential thinking is convergent, depending on the amount of data available in the situation.

The question of recognising these two cognitive processes in classroom interaction is another crucial matter. Although certain amount of speculation is unavoidable in this respect, the recognition of these processes is usually dependent on either consideration of the preceding, and sometimes subsequent, utterances in the context, or the existence of certain linguistic

devices. In the present data, asking students to make inferences (Category 42) can be recognised by the existence of phrases such as " I wonder...?", and "Why do you think...?", or simply "What do we infer...? On the other hand, questions like "What is fat decomposed into?", or "How are parallel light beams on a concave mirror reflected?" are definite indications for the need to apply or state a certain principle or formula (Category 43).

Category 44:

This category deals with teachers' questions which require identifying certain objects or substances. It also includes questions which require exemplifications either explicitly or by using such utterances as:

T: These digestive enzymes are such as what?

Questions requiring detailed exemplification or description of processes, on the other hand, are not included in this category since answers to such questions normally require the use of one of the cognitive processes pertaining to Categories 41, 42, or 43, and should, therefore, be coded accordingly.

Category 51:

This category deals with the teacher's immediate or subsequent repetition of information for consolidation. It also includes repetition of information at the end of the lesson as the teacher summarises the main points on the blackboard or dictates those points to the students which is a common procedure in science classes in Bahrain.

Categories 52 and 53:

The same argument for establishing Categories 42 and 43 applies here. It is unnecessary to provide examples here of those categories since they can be found in the data provided in the next section.

Category 54:

In addition to giving examples, this category includes the teacher's utterances which identify objects as in:

T: Here's the focus of the concave mirror situated.

or T: This focal distance, we refer to it by the symbol (D).

However, a distinction should be made between identifying an object (Category 54) and a statement of a principle related to the identification or definition of that object (Category 53). Consider the following two utterances:

i. This point is the secondary focus.
ii. The focus is called principal if it is situated on the principal axis.

In example (i) the teacher is merely identifying an object and his action is usually associated with a gesture, i.e. pointing to a drawing. In example (ii), however, the teacher is making a statement about a certain scientific phenomenon, i.e. the relationship between the focus of a mirror and its axis. Thus, example (i) is a Category 54 type but (ii) is a Category 53 type.

Category 60:

This category deals with three types of directions or commands:

i. Disciplinary: as in "Pay attention to me", or "Please sit down".

ii. Directive: when asking students directly to perform a certain act related to the learning process, as in:

T: Come here and point to the focal distance on the drawing.

iii. Discriminative: in the case of identifying certain students to respond to questions by nominating a student or using utterances such as "The boy at the back".

It is imperative to distinguish here between Category 44 "Asks students to identify an object, substance, process, or give an example", and Category 60 "Gives directions, commands or orders". The two may overlap since both may require compliance to the teacher's utterances as in:

i. Give me an example.

ii. Come and draw the focal axis.

If, however, we accept Sinclair and Coulthard's definition [1975] that the function of elicitation is "to request a linguistic response",and that of a directive is "to request a non-linguistic response" [p.28], then the distinction between the two categories becomes clear. Thus, example (i) above is an elicitation and should be coded Category 44, whereas example (ii) is obviously a directive and should therefore come under Category 60.

Category 70:

This category covers those teacher's utterances which concern setting up teaching situations and explaining teaching steps and procedures, as in:

T: You hold the test tube and you put the solid salt in it.

or T: We are going to detect the acid element in the nitrite salt.

or T: I draw a point in the centre of the mirror.

Categories 81, 82, 83, and 84:

These categories represent students' responses to the teacher's questions. Therefore, they are normally reciprocal moves to Teacher's Categories 41, 42, 43, and 44, and usually reflect the cognitive processes which are identified in the teacher's questions. In natural classroom interaction, however, these two sets of categories do not always occur in pairs, i.e.(41→ 81), (42→ 82), (43→ 83), (44→ 84), and some deviation may occur. Examples for these categories can be found in the data.

Category 85:

This category deals with students' "Yes" and "No" answers. It also includes responses to the teacher's utterances expressing uncertainty, such as "I don't know".

Category 90:

This category is concerned with the student's utterances which indicate his desire to seek clarification or exemplification in response to the teacher's initiations and includes such utterances as:

i. Why must we use a dry test tube?

ii. Could you repeat that, sir?

iii. Give us an example.

Category 01:

All short periods of silence and confusion in which communication cannot be understood are coded under this category. These also include pauses when the teacher is writing on the blackboard or when students are consulting their textbooks for information.

4.3 The Coding and Decoding of Data:

Having identified and described the categories in the suggested system the next stage is to apply them to our data. The data presented in the current study was collected in Bahrain over a period of two months (November and December 1981) and from random science classes. To make as accurate decisions as possible in the coding process, it was decided to video record the data. The recording was carried out in a number of second year science classes in four secondary schools (boys and girls) to collect a wide variety of classroom interaction data. The classical problem faced in such a situation is the natural tendency of both teachers and students to change their usual behaviour and attitude once they are conscious that they are being systematically observed. This is what Labov [1972] refers to as the "observer's paradox". However, in order to minimise the effect of such a situation to record as normal class interaction as possible, the purpose of the recording was discussed with the teachers involved. It was also made clear to them that they were not being evaluated, studied, or used as a model, and therefore they should not make special preparations or adopt certain teaching techniques because of the filming. They, as well as the

students, were also told that in order to counteract the unnatural situation created by the presence of a camera in the class they were going to be recorded more than once and that they should try and ignore the camera. This in fact was remarkably achieved by both teachers and students half way through the first recording. The teachers were also asked to tell the observer whenever they felt that they did not want to be recorded because of stress or special arrangements. None of the teachers were informed in advance when their classes were going to be recorded.

Ten teachers (six males and four females) were involved in the recordings of a total of 19 sessions, covering three science subjects: Biology, Chemistry and Physics. The coding and tabulation procedures are similar to those discussed by Flanders [1970]. However, the following notes should serve as guidelines to be considered in relation to the coding of the data using the suggested system:

i. Although it is relatively easy to identify linguistic realisation of categories in an interaction analysis on the social level this is not the case when one is operating at the psychological level. The fact is that there are usually conventional linguistic signals which identify an elicitation, a response, a structuring move, or a feedback. Identifying moves pertaining to cognitive processes, such as making inferences or applying principles, however, is far from being steadfast and clearcut. In such cases the analyst has to fall back on subjective decisions. For any system to have any value, such decisions should not only be consistent

but should also correspond to the definitions of the categories incorporated in the system. I have tried to achieve this in the coding process.

ii. The coding of the data was carried out at the rate of one tally for every 3 seconds of actual classroom interaction and not the transcription of that interaction. This was essential given the fact that the data was initially recorded in Arabic. Obviously translation techniques do not always permit the production of sentences of the same time segments as in the first language. Also teachers usually vary the tempo of their speech according to the interaction moves and the variables of the learning situation. This should explain the difference in length between the segments.

iii. All complete moves of less than 3 second duration were coded as one tally. Such exchanges are quite frequent in the case of a student giving a short answer consisting of one or two words. This is important since these moves mark a shift in the interaction pattern. In longer moves, the final time segment was coded as one tally if it exceeded 1 1/2 seconds.

iv. The mark (#) was used to indicate periods of silence. Each mark equals one second. The broken line (- - -) was used to indicate that utterances cannot be understood.

v. "O.K." was not coded as Category 10 (Praise) because such a word is used quite frequently by teachers not as genuine praise but rather as what Flanders [1970] calls "superficial verbal habits". Since "OK" is almost always preceded by

Category 30 (Accepting student's responses) it was felt more practical and realistic to code it as a part of Category 30.

vi. The Expression "Heh" was coded Category 10 (Encouraging student) only when the teacher used a tone which suggested that he or she was encouraging students to think or come up with an answer. It could, therefore, be paraphrased to mean "Come on, give me an answer. Try". In other cases, where it had no distinct interactive value, it was included in the adjacent move.

vii. Incomplete statements, definitions, rules, etc., where the teacher starts the sentence and then pauses to give the students the chance to chip in with a word or two, were coded as Category 53 (Stating or explaining a rule, principle, etc.) This is because the teacher usually initiates such statements and directs the flow of interaction to reach the final form of the statement, modifying students' contributions to fit the form he or she has in mind.

viii. In applying the category system, a problem was faced in coding the type of question which is usually preceded by a conditional statement, extending sometimes over two 3-second segments. The following sequence is an example:

T: We said if rays of a parallel beam fell
parallel to the principal axis of a concave mirror
how are they reflected?

However, the paraphrasing of the three items would result in

something like "How are rays of a parallel beam which fell parallel to the principal axis of a concave mirror reflected?" This shows that the first two segments are in fact complementary to the question contained in the third segment. Thus such sequences were coded as Category 43 (Asking student to state or apply a rule, principle, etc).

ix. Another problem was faced when coding a statement where the teacher starts what sounds like a definition or principle, etc, but before the end he or she poses a question to encourage participation as in the following items:

T: Any line which passes through the spherical centre
and any point on the surface of the mirror
heh, what do I call this line?

Here again the problem was solved by applying the paraphrasing technique, which resulted in coding the sequence as Category 43 (Asking student to state or apply a rule, principle, etc). The following paraphrasing of the three segments confirms this:

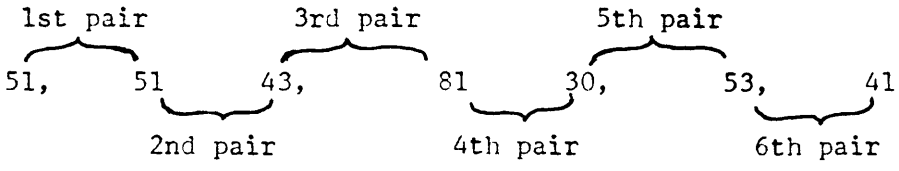
"What do I call any line which passes through the spherical centre and any point on the surface of the mirror?"

x. Finally, another problem stemmed from the difference between Arabic and English in the construction of adjectival phrases. In English the adjective precedes the noun, whereas in Arabic the opposite is the case, as in the following example:

English	Arabic	Arabic transcription
a concave mirror	merʔa moḥadabeh * mirror concave	مرآة محدبه
a principal focus	boʔra aṣliəh * focus principal	بؤرة اصليه

The problem is faced when the teacher makes an incomplete statement, pausing for students to take part in stating a rule, principle, definition,etc. He or she usually says the noun and the students supply the adjective. This is not possible in the translation. To give an accurate account of the interaction taking place, it was found necessary to stick to a literal translation and thus end up with structurally incorrect phrases. These phrases have been marked with an asterisk.

Finally, it was necessary to present a display of the data which would provide some quantitative measurements. This was achieved by tabulating the data in a matrix form. The calculation of frequencies and percentages on the matrix also serves in making interpretations and inferences, in behavioural terms, about the coded data. The tabulation process was based on Flanders' model, which uses a sequential pair of segments as the unit to be tabulated rather than a single event. Thus the sequence:



is tabulated as 51-51, 51-43, 43-81, 81-30, 30-53, and 53-41. This, as Flanders points out, squares the amount of information which can be obtained from the observation tallies. It also makes it possible to display the path ways followed in the interaction and the frequencies of transition from one category to another. Such information is undoubtedly essential in making any inferences about the pattern of interaction in the given data. The paired code symbols are then tabulated into a matrix. Each column and each row represents one of the categories, as in Table 2 below. The first number of each pair designates the row and the second number designates the column. The pair 51-43, for example, is tabulated into the cell at the intersection of row 51 and column 43 in this order.

Informal examinations of the collected data reveal that a common interaction pattern seems to prevail in the classes recorded. It was therefore decided to provide three ten-minute episodes from different classes and with different teachers as specimens to illustrate that pattern. More examples are provided in Appendices 5, 6, and 7.

Table 2: Cell Address in a 20 X 20 Interaction Analysis Matrix

Category	10	20	30	41	42	43	44	51	52	53	54	60	70	81	82	83	84	85	90	01	Total
10	10-10	10-20	10-30	10-41	10-42	10-43	10-44	10-51	10-52	10-53	10-54	10-60	10-70	10-81	10-82	10-83	10-84	10-85	10-90	10-01	
20	20-10	20-20	20-30	20-41	20-42	20-43	20-44	20-51	20-52	20-53	20-54	20-60	20-70	20-81	20-82	20-83	20-84	20-85	20-90	20-01	
30	30-10	30-20	30-30	30-41	30-42	30-43	30-44	30-51	30-52	30-53	30-54	30-60	30-70	30-81	30-82	30-83	30-84	30-85	30-90	30-01	
41	41-10	41-20	41-30	41-41	41-42	41-43	41-44	41-51	41-52	41-53	41-54	41-60	41-70	41-81	41-82	41-83	41-84	41-85	41-90	41-01	
42	42-10	42-20	42-30	42-41	42-42	42-43	42-44	42-51	42-52	42-53	42-54	42-60	42-70	42-81	42-82	42-83	42-84	42-85	42-90	42-01	
43	43-10	43-20	43-30	43-41	43-42	43-43	43-44	43-51	43-52	43-53	43-54	43-60	43-70	43-81	43-82	43-83	43-84	43-85	43-90	43-01	
44	44-10	44-20	44-30	44-41	44-42	44-43	44-44	44-51	44-52	44-53	44-54	44-60	44-70	44-81	44-82	44-83	44-84	44-85	44-90	44-01	
51	51-10	51-20	51-30	51-41	51-42	51-43	51-44	51-51	51-52	51-53	51-54	51-60	51-70	51-81	51-82	51-83	51-84	51-85	51-90	51-01	
52	52-10	52-20	52-30	52-41	52-42	52-43	52-44	52-51	52-52	52-53	52-54	52-60	52-70	52-81	52-82	52-83	52-84	52-85	52-90	52-01	
53	53-10	53-20	53-30	53-41	53-42	53-43	53-44	53-51	53-52	53-53	53-54	53-60	53-70	53-81	53-82	53-83	53-84	53-85	53-90	53-01	
54	54-10	54-20	54-30	54-41	54-42	54-43	54-44	54-51	54-52	54-53	54-54	54-60	54-70	54-81	54-82	54-83	54-84	54-85	54-90	54-01	
60	60-10	60-20	60-30	60-41	60-42	60-43	60-44	60-51	60-52	60-53	60-54	60-60	60-70	60-81	60-82	60-83	60-84	60-85	60-90	60-01	
70	70-10	70-20	70-30	70-41	70-42	70-43	70-44	70-51	70-52	70-53	70-54	70-60	70-70	70-81	70-82	70-83	70-84	70-85	70-90	70-01	
81	81-10	81-20	81-30	81-41	81-42	81-43	81-44	81-51	81-52	81-53	81-54	81-60	81-70	81-81	81-82	81-83	81-84	81-85	81-90	81-01	
82	82-10	82-20	82-30	82-41	82-42	82-43	82-44	82-51	82-52	82-53	82-54	82-60	82-70	82-81	82-82	82-83	82-84	82-85	82-90	82-01	
83	83-10	83-20	83-30	83-41	83-42	83-43	83-44	83-51	83-52	83-53	83-54	83-60	83-70	83-81	83-82	83-83	83-84	83-85	83-90	83-01	
84	84-10	84-20	84-30	84-41	84-42	84-43	84-44	84-51	84-52	84-53	84-54	84-60	84-70	84-81	84-82	84-83	84-84	84-85	84-90	84-01	
85	85-10	85-20	85-30	85-41	85-42	85-43	85-44	85-51	85-52	85-53	85-54	85-60	85-70	85-81	85-82	85-83	85-84	85-85	85-90	85-01	
90	90-10	90-20	90-30	90-41	90-42	90-43	90-44	90-51	90-52	90-53	90-54	90-60	90-70	90-81	90-82	90-83	90-84	90-85	90-90	90-01	
01	01-10	01-20	01-30	01-41	01-42	01-43	01-44	01-51	01-52	01-53	01-54	01-60	01-70	01-81	01-82	01-83	01-84	01-85	01-90	01-01	
Total																					

EPISODE (A): Chemistry.

(T = Teacher. S = Student. Ss = Students).	code No.
T: The nitric acid salt. We are going to detect its salt.(1) We are going to detect the acid element(2) in the nitrite salt, which is the(3) nitric acid salt, er..(4) so I'll give you a solid salt to work with,(5) and you detect the acidic element in this salt,(6) detect NO_2. So (7) you take the salt, and in front of you is the dry salt,(8) you take it # and let it be(9)# # # (10) sodium nitrite # (11) $NaNO_2$ and (12) you add to it # # (13) the acid. This is a dry salt (14) or solid salt and you add to it (15) the dilute hydrochloric acid (16) the dilute HCl acid.(17) # # # (18) I wonder the exchange would happen (19) between which, and what's the result? (20) Yes, Ghada?(21)	70,70 70, 54.70 70 54 54 54,01,54 54,70 54,70 70,54 01,42 42 60
(The student's response is missing here due to changing of the camera position.)	
T: Ah, chloride sodium is produced, Na (22)	30
S: Cl (23)	83
T: Cl, plus? (24)	30
S: Er..plus..er, nitric acid. (25)	83
T: Plus acid* what? (26)	43
Ss: Nitrite.* (27)	83
T: Nitrite.* (28)	30
Ss: NO # (29)	83
T: NO_2 # Finished?(30) When I heat, please sit down.(31)	30,60

HNO_2 which is the nitrite acid (32), it decomposes by 54
heat into?(33) Do you remember the preparation of 43
nitric acid? (34) In one of the steps you used to get 41
nitrite acid.(35) You used to take it and heat it (36) 51,51
so it used to decompose into? # Heh? (37) Remember? 41
Heh? (38) 10

S: Water and nitric oxide.(39) 81

T: No, it used to decompose into acid* (40) 30

S: Acid*..er (41) 81

T: Nitric acid # and (42) 51

Ss: Nitrite acid. (43) 81

T: Nitrite acid decomposes into nitric acid (44) and 30
water and oxide* (45) 51

Ss: Nitric* (46) 81

T: Nitric*. H_2O # (47) plus NO # (48) Finished? This 30,53
nitric oxide (49) as soon as it's formed, or as soon 53
as it mixes (50) with the atmospheric oxygen, it 53
reacts,(51) Amal, and gives me? (52) 53,43

S: Ultra nitrogen oxide.(53) 83

T: Ultra nitrogen oxide.(54) That is NO plus (55) O_2. As 30,53
soon as it mixes (56) with the atmospheric air it 51
gives me (57) NO_2 which is the gas* (58) 51,53

Ss: Ultra nitrogen oxide. (59) 81

T: Reddish brown, which is a gas (60) the colour of which 53
is brown* (61) 51

Ss: Reddish*. (62) 81

T: Reddish* # So (63) the first experiment you carry 30
out,(64) you hold the test tube and this test tube is 70

dry(65) and you put the solid salt in it (66) and you 70,70
add to it the dilute hydrochloric acid, (67) you add 70
to it what acid? (68) 41

Ss: The dilute hydrochloric.(69) 81

T: The dilute hydrochloric. And you (70) heat it. Brown 30
colour gases ascend.(71) What are these gases (72) or 51,44
what's the interpretation of the reaction? (73) 43

Ss: Ultra nitrogen oxide. (74) 83

T: The formulation of oxide* what? (75) 51

Ss: Nitrogen* (76) 81

T: Nitrogen*. What's it formed from? (77) Because a 30
reaction takes place and the nitrite acid is formed,(78) 51
it decomposes by heat and gives me nitric oxide.(79) 51
It reacts with the oxygen as soon as it mixes with
it,(80) and gives me ultra nitrogen oxide,(81) which 51,51
are brown colour gases.(82) This is the first 51
experiment you carry out.(83) The second experiment 70
your carry out(84) is with salt solution.(85) The 70,70

second experiment you carry out with what? (86) 44

Ss: Salt solution. (87) 84

T: Salt solution. This means (88) in this the salt was 30
solid and (89) the test tube must be what? (90) 53,41

Ss: Dry. (91) 81

T: After this you carry out the second (92) experiment 70
with salt solution.(93) You dissolve the salt in 70
distilled water.(94) Don't use the tap water.(95) You 70,60
dissolve the salt in the distilled water (96) and you 70
take the salt solution, $NaNO_2$ (97) in the form of a 70
solution, (98) and you add to it silver nitrite 70

solution, (99) which is Ag # NO_3 (100) An exchange 70,53
takes place, a double (101) exchange takes place, 53
because here are all (102) solutions. # What takes 53
place? A double exchange (103) and it gives me, 51
Ameena? (104) 43

S: Sodium nitrate (105) 83

T: And it gives me sodium nitrate, Na (106) # NO_3 #(107) 30,53
plus # # (108) nitrite* what? (109) 53.43

S: Silver * (110) 83

T: Silver*, Ag # (111) 30

Ss: NO_2 (112) 83

T: NO_2 and this (113) appears to you in the form of a 30
white residue (114) # which dissolves # (115)# # 53,53
by heating.(116) It appears to you in the form 53
of a white (117) residue which dissolves by 51
what?(118) 41

Ss: By heating. (119) 81

T: By heating. So the experiments which you (120) carry 30
out in order to detect the nitrite salt (121) two 70
experiments, one on the solid salt (122) and one on 70
the solution* what (123) 44

Ss: Salt* (124) 84

T: Salt* The experiment of the solid salt,(125) you add 30
the dilute hydrochloric (126) acid to the solid salt 70
(127) and you heat, so, er..(128) brown colour gases 70,70
ascend.(129) The reason for this, the solid salt(130) 51,51
reacts with the acid and forms nitric acid.(131) The 51
nitric acid, by heating, decomposes(132) and gives 51
nitrite oxide gas.(133) As soon as it mixes with the 51

air(134) it forms NO gas. This means (135) when the 51,51
gas first comes out you don't see its colour (136) 53
because it's oxide* what? (137) 44

Ss: Nitric* (138) 84

T: Nitric*. As soon as it reaches the tube neck (139) or 53
near the neck it meets the atmospheric (140) oxygen, 53
it combines with it and you see (141) the red colour 53
at the neck of the tube.(142) Finished? This is the 53
detection of the nitrite (143) salt, and of course 70
you draw the usual table (144) which we draw in the 70
practicals and write the experiment (145) and the 70
observation and the conclusion after you've (146) 70
finished with the experiments. # (147) The second 70
detection, I'll take the detection (148) of # 70
salt (149) # # of the acidic element(150) 70,70
(151) # # # (152) of the nitrate 01,01
salt # (153) which are the nitric acid salt, 70
HNO_3. (154) the detection of nitrate salt. (155) 54,51
You're given nitrate salt. (156) Your're given salt* 70
what? (157) 44

Ss: Nitrate*. (158) 84

T: Its acidic element is NO_3 (159) and you're asked to 53
detect this element.(160) So how do you carry out the 70
search? (161) # We conduct the first experiment 43
(162) and this experiment is also with dry salt,(163) 70,53
and let the salt be potassium (164) nitrate, KNO_3. 54
(165) The nitric acid salt #(166) does not 54,53
react with the dilute acids.(167) I mean, take the 53
solid salt (168) # # #(169) and react it with a 70,01
dilute acid, (170) no reaction takes place. (171) It 70,53

means, up there what used to happen? Reaction (172) 51
with the dilute acids. Here (173) no reaction takes 51
place with the dilute acids. (174) I must use 51
concentrated acids (175) like the sulphuric 53
acid.(176) H_2SO_4. (177) It must be what? (178) 54,54,41

Ss: Concentrated. (179) 81

T: Concentrated. And I heat.(180) when you heat, it 30
gives you (181) potassium sulphate and acid* (182) 53,53

Ss: Nitric* (183) 83

T: Nitric*. So it gives you (184) K_2SO_4 (184) plus 30,53
HNO_3 (186) 53

Ss: Three. (187) 83

T: While I heat, which one decomposes? (188) # which 43
one decomposes in this situation? (189) 43
Heh, Ghada? (190) 60

S: Nitric acid. (191) 83

T: Nitric. Nitric acid which is (192) HNO_3. This 30
decomposes (193) by heat, it decomposes by heat 53
into? (194) 43

S: Water. (195) 83

T: Water. (196) 30

S: And nitrogen oxide. (197) 83

T: And ultra nitrogen oxide and (198) 30

S: Acid*..er..(199) 83

T: Oxygen, and oxygen. The decomposition (200) of the 30
acid by heat gives you what? Water and (201) ultra 51
nitrogen oxide and oxygen. (202) i.e. it will give 51
you H_2O # (203) plus O_2 plus what? NO_2 (204) and 53,53

this is the gas whose colour (205) is reddish brown. 54

(206) Finished? So by adding (207) the fluid 54,51

concentrated sulphuric acid (208) to the # solid 51

salt, (209) the solid nitrate salt, brown colour(210) 71,51

gases ascend from ultra nitrogen oxide. (211) Why? 51

Because the forming nitric acid (212) decomposes by 51

heat and gives ultra nitrogen oxide. (213) If the 51

quantity of the ultra nitrogen (214) oxide is little, 53

and copper filings, (215) add what? (216) 53,41

Ss: Copper filings. (217) 81

T: Copper filings. Copper filings when (218) you add 30

them they react with what? (219) 43

S: Nitric acid. (220) 83

T: Nitric acid which results from the reaction. (221) 30

i.e. look, copper filings, (222) Cu with nitric (223) 53,53

acid # (224) resulting from the reaction (225) 53,53

gives me, # gives you what? (226) 43

Ss: Copper nitrate. (227) 83

T: Copper nitrate and ultra nitrogen (228) oxide and 30

Water. It gives you Cu (229) NO_3 # (230) plus 53,53

H_2O (231) plus NO_2 # (232) and these also brown 53,53

colour gases. (233) This is the experiment you carry 53

out with the solid salt. (234) 70

EPISODE (B): Biology.

		Code No
T:	The food substances which we eat like protein(1) are they absorbed in the form of complex protein(2) substances or what form are they absorbed in?(3) Who can answer this question?(4) Protein substances? Heh?(5)	43 43 43 43 43
S:	Amino acids.(6)	83
T:	Amino acids. The fatty substances? Abdel Mone'm?(7)	30
S;	Acids # (8)	83
T:	Fatty acids and glycine. # (9) Fatty acids and glycine. O.K. And carbohydrate(10) substances, are they absorbed in the form, er..(11) the carbohydrate substances are numerous,(12) like saccaHaride, er..(13)	30 51 43 53 54
S:	Monosaccharide. (14)	84
T:	Monosaccharide, disaccharide, polysaccharide.(15) O.K. In what form are carbohydrate (16) substances absorbed? Heh? Zeyad!(17) Pay attention to me. # Zeyad!(18) Abdel Mone'm.(19)	30 43 43 60,60
S;	Starch carbohydrate. (20)	83
T:	But carbohydrate is a substance, starch(21) is a carbohydrate substance. When I was given the division of..(22)	30 53
S1:	Glucose, teacher, glucose. (23)	83
S2:	It's absorbed in the form of glucose. (24)	81
T:	O.K. Which type of saccharide is this glucose?(25)	44
S:	Mono. (26)	84
T:	Mono. So we've seen that the last thing(27) carbohydrate substances reach is(28) that they change	30 53

into what? Monosaccharide,(29) which is like glucose. 53
O.K.(30) Er..we've seen, what performs the 53
digestion(31) process inside the digestive 43
system?(32) We've seen something, we've said are 43
called(33) digestive juices and enzymes. # (34) Is 53,53
the digestive process accomplished without(35) these 43
substances? Heh?(36) 43

S: No, it isn't. (37) 85

T: No. O.K. We've seen names of (38) er.. the substances 30
which we, er..(39) called the enzymes. # We've 53
seen(40) for example like the pepsin enzyme, (41) 53,54
This digests protein substances into peptide and
protease.(42) We've seen for example the lipase 53
enzyme.(43) This lipase enzyme decomposes fatty 54
substances.(44) This means that we infer from this 53
that,(45) do all, do the enzymes # (46) act on all 70,42
substrates? Heh?(47) 42

S; No. (48) 85

T: No, so for each enzyme there is(49) a particular 30
substrate it doesn't act except on it,(50) this means, 52
for example, if we get the lipase enzyme(51) which 43
decomposes fatty substances into(52) glycerol and 53
fatty acids,(53) we get it to act on protein 53
substances,(54) can it act on protein substances?(55) 43,43

Ss: No. (56) 85

T: No, therefore we infer from this that(57) the acids 30
or these enzymes are specialist(58) substances in 52
their action.(59) Specialist # in their action. This 52
means each enzyme has(60) its substrate which it 51

	doesn't act(61) except on it. O.K.(62) There's	51,51
	another thing we can infer. O.K.(63)# The enzymes	70
	in fact, what's the enzyme?(64) what's the enzyme?	43
	#(65) The enzyme, what's the enzyme? Zeyad.(66)	43,43
S:	Substances which help in the digestive process (67)	83
	but don't break up in the reaction.(68).	83
T:	Substances which help in the completion(69) of the	30
	digestive process but don't(70) take part in the	53
	reaction. O.K.(71) We've taken here # er(72) in	53,70
	chemistry, er, we've taken, or we've(73) heard about	70
	something called an agent.(74) We've taken something	54
	in chemistry called chemical(75) agents. The chemical	54
	agent is the one(76) which stimulates the reaction	53
	and(77) doesn't mix with the reaction substances,(78)	53,53
	or emerges unchanged. The enzymes exactly(79) are	53
	agents similar to(80) the chemical agents,they act(81)	53,53
	or speed up the reaction but don't (82) mix with the	53
	reaction substances. O.K.(83)can we prepare these	53
	enzymes in the laboratory?(84) What secretes	43
	them?(85) What prepares them?(86)	43,43
S:	The intestine, teacher.(87)	83
T:	The living cells in the body, they prepare(88) these	53
	substances. So we can come up with a definition.(89)	70
	Heh, a definition of an enzyme?(90) The definition?	43
	They are, heh,?(91) someone dictates to me, they are	43
	agents..(92)	60
Ss:	Agents which help in the digestion.(93)	81
T:	Which help..(94)	30
Ss:	In # the digestive process.(95)	81
T:	Similar to # the agents in what?(96)	41

S: In chemistry.(97) 81

T: The chemical agents.(98)# # # (99) # # # (100) 30,01,01
O.K. What do they do? # What do they do?(101) I say 41
here that they are similar to the chemical
agents,(102) what's their job?(103) 51,41

S: To speed up # # (104) 81

T: To speed up..(105) 30

Ss: In the process.(106) 81

T: Or stimulate the reaction..(107) 51

S: Without taking part in it.(108) 81

T: Stimulate the reaction..(109) 51

S: Without taking part # in the reaction.(110) 81

T: And emerge, or, as they are.(111)# # # (112) 30,01
#(113) O.K. # This is a definition.(114) 01,70
We come to what? Their characteristics.(115)##The 70
general(116) # characteristics # (117) of the 70,70
enzymes.# # (118) # # #(119) # # I've 70,01
mentioned(120) one characteristic. # What have(121) 70,41
we said? The first thing..(122) 41

S1: They're similar to..(123) 81

S2: They act on their special substrates.(124) 81

T: So, they're specialist in their action.(125) One, 30
Specialist...(126) 51

S: In their action.# #(127) 81

T: In what? In their action. # (128) That means # each 30
(129) 51

S: Enzyme..(130) 81

T: Has its own substrate # #(131) which # it doesn't 51
act..(132) 51

S: Except on it.(133) 81

T: Except # on it.(134) # # O.K.(135) # # We 30,30
come(136) # to what? To er..(137) another 70,70
characteristic.(138) 70

S: The specific temperature in which they act.(139) 83

T: The temperature. They act in the bodies of living
beings.(140) # So their action must be(141) at its 30,53
highest level when the temperature(142) is 53
appropriate to the temperature of the(143) living 53
being. So # # (144) They act # at(145) a specific 53,53
temperature(146) # similar to(147) # the 53,53
temperature # of what?(148) The temperature # of 53
the living(149) # # beings.(150) # # Something 53,53
else. (151) # # If we raised(152) or reduced their 70,43
temperature,(153) what would happen? # Heh? (154) 43,43

Ss: The action is reduced.(155) 83

T: And their action is reduced by raising (156) their 30
temperature above the temperature (157) of the living 53
being, or by (158) reducing their temperature below 53
the temperature (159) of the living being. Therefore 53
we add here,(160) Their action is reduced # (161) 53,51
by the increase # (162) or decrease # # (163) 51,51
in the temperature of (164) # # the body of the 51
being.(165) # # # (166) # # # (167) # # 51,01,01
(168) What secretes them? # (169) What secretes 01,41
them? Heh? (170) 41

S1: The intestine. (171) 81

S2: The living cells. (172) 81

T: They're secreted...No, the intestine are formed from
the cells.(173) They're then secreted by the living 30

	or dead cells? (174)	41
S:	The living cells. (175)	81
T:	The living cells. So, Three: They're secreted(176)	30
	# # by the living (177) # cells # (178) #	51,51
	# # (179) In fact the enzymes are difficult(180)	01,53
	to prepare chemically, because of course(181) we know	53
	they have a specific temperature,(182) they have an	53
	action temperature.(183). We come then to, I used to	53
	write(184) in the formula of the enzyme reaction,(185)	70,41
	what do I write on the arrow?(186)	41
Ss:	Alkaline. (187)	81
T:	Alkaline, or? (188)	30
S:	Acidic. (189)	81
T:	The alkalinity or acidity is called in chemistry,(190)	53
	you'll take it later, the hydrogen ion,(191) or pH.	53
	# It's called(192) the hydrogen ion or pH. So (193)	53,51
	# each enzyme (194) has a specific degree of	53
	acidity or alkalinity (195) # a specific degree of	53
	acidity..(196)	51
Ss:	Or alkalinity. (197)	81
T:	Or alkalinity in order to (198) be able to act on	30
	water. (199) So, er, what's Four? (200) # Each #	53,70
	enzyme (201) # has a sphere of what?(202) Of acidity	51,51
	# # (203) or alkalinity # # (204) # in order	51,51
	to act # (205) # on what? On water. (206)	51,51

EPISODE (C): Physics.

	Code No.
T: The spherical centre of a concave mirror(1) is situated in front of the shining face,(2) so what's the spherical centre?(3) Heh, what's the meaning of the spherical centre?(4) The spherical centre of the mirror whether it's concave or convex?(5)	53 53 43 43 43
S: It's the one which faces the shining surface.(6)	83
T: This is not a definition.(7) I want to determine the position of a point,(8) and this point means to us the spherical centre,(9) because it's important in relation to the mirror(10) whether it is concave or convex.(11) What do I say?(12)	30 70 53 53 53,43
S: It's the radius of the ball which the mirror was cut from.(13)	83
T: It's the centre of the ball of which(14) the mirror is a part. O.K.(15) Sit down #(16) When I draw the convex or concave mirror on the blackboard,(17) we say in the concave mirror the shining surface is inwards,(18) so # I draw a point in its centre,(19) and this point is the pole. # (20) A point in front of it at a reasonable distance (21) represents the centre of the ball(22) of which the mirror is a part.(23) So this point in relation to the mirror is its spherical centre. (24) Any line which passes through the spherical centre(25) and any point on the surface of the mirror,(26) heh, what do I call this line?(27)	30 30,60 70 53,70 54 53 53 53 53 43 43 43
Ss: The secondary axis. (28)	83
T: Heh, what do I call it? (29)	41

Ss: The secondary axis. (30) 81

T: The secondary axis. But the line which passes(31) 30
through the spherical centre and the pole of the
mirror(32) 53

Ss: The principal axis. (33) 83

T: This is the principal axis. O.K.(34) With regard to 30
the convex mirror, # (35) and it's a part of an 53
empty spherical surface(36) the shining surface of 53
which is outwards.(37) Therefore, in this case the 53
pole of the mirror(38) # this median point on the 53
surface(39) the spherical centre will be situated 54
behind it, like this.(40) We said if rays of a 53
parallel beam fell(41) parallel to the principal axis 43
of a concave mirror,(42) how are they reflected?(43) 43,43
Falling on the surface of a concave mirror, (44) and 43
parallel to the principal axis,(45) how is this beam 43
reflected?(46) What? Only three (girls) ? Four? 43
Heh?(47) 20

S: They gather in one point called the focus.(48) 83

T: Yes, they are reflected, gathering in one point,(49) 30
and this point..(50) 51

Ss: The focus.(51) 81

T: is called the principal focus. O.K.(52) But with 30
regard to the diverging mirror, the convex
mirror,(53) we said if rays of a parallel beam(54) 43,43
fell parallel to its principal axis,(55) how are they 43
reflected?(56) # How are they reflected?(57) Heh? 43,43
Say.(58) 60

S; We notice that they're reflected in a focus but it's

an imaginary focus.(59) 83

T: How are they reflected?(60) Rays of a beam..(61) 43,43

S: They're reflected divergingly.(62) 83

T: falling on the shining surface(63) of a convex # 43
mirror,(64) and these rays were parallel to the 43
principal axis,(65) how are they reflected?(66) 43,43

S: They're reflected divergingly, and if we try(67), 81
er, to extend the rays, (68) they meet in a focus 83
which is called an illusive focus or..(69) 83

Ss: Secondary. (70) 83

S: Yes. (71) 85

T: And why is the focus of the convex mirror called(72) 42
an illusive focus?(73) 42

S: Because it's from the extension of the rays, I
mean..(74) 82

T: Heh? (75) 10

S: Not from their reflection, from the extension(76) of 81
the reflection of the rays.(77) 81

T: I receive the reflected rays.(78) With regard to the 30
concave mirror, the reflected rays,(79) after falling 51
parallel, they gather in a point (80) were the 51
reflected rays come together(81) and we call this 51
point the principal focus.(82) O.K. With regard to 51
the # (83) the convex # mirror(84) the reflected 51,51
rays, you say, are reflected divergingly,(85) and 51
therefore we call this mirror..?(86) 43

S; Diverging. (87) 83

T: Diverging. # O.K.(88) These rays which are reflected 30
divergingly(89) # # # (90) their extensions meet, 43,01
where? In front of the mirror or behind it?(91) 43

Ss: Behind the mirror.(92) 83

T: Behind the mirror. Behind the shining surface.(93) 30
The extensions of the rays meet(94) behind the 51
shining surface in a point,(95) this point is the 51
focus*..(96) 54

Ss: Secondary*. (97) 84

T: What secondary? If the rays are parallel(98) to the 30
principal axis, the focus which is situated(99) on 51
the principal axis is a principal focus.(100) When it 51
is on the secondary axis I call it a focus*..(101) 43

Ss: Secondary*.(102) 83

T: Secondary*. The focus which results,(103) or the 51
point were the extensions of (104) the reflected rays 51
meet, we call this (105) an illusive focus, or an 51
estimated focus.(106) So when I say to you why it is 51
called illusive, (107) what's supposed to be your 41
answer?(108) # I've told you the answer.(109) 41,10

S: Teacher..because, er.. because it's formed by(110) 81
the meeting of the extensions of the rays..(111) 81

T: Ah..because it's the extension of the reflected
rays.(112) But if the point # (113) is formed from 30,53
the meeting of(114) the reflected rays themselves and 53
not(115) their extensions, the focus is a real 53
one.(116) The focus is called principal if it is(117) 53,53
situated on the principal axis. (118) There's a real 53
focus and an illusive focus.(119) The real one is the 53
one formed by the meeting of the reflected rays(120) 53
and this is the case of # the mirror*..?(121) 43

Ss: Concave*.(122) 83

T: Concave*. But the estimated focus(123) is formed by 30
the meeting of the extensions(124) of the reflected 51
rays, and this(125) happens with regard to the 51
mirror*..?(126) 43

Ss: Convex*.(127) 83

T: Convex*. The..er.. convex mirror(128) when rays of a 30
parallel beam fall on it,(129) we knew that they are 51
reflected divergingly, (130) and for this reason we 51
called it a mirror*.. heh ? (131) 41

Ss: Diverging*. (132) 81

T: Diverging*. The concave mirror, # (133) the rays of 30
a beam falling on it are parallel, (134) when they're 51
reflected, they're reflected meeting in one
point,(135) and therefore we call it a mirror*.?(136) 51,43

Ss: Converging*. (137) 83

T: Converging*, or..? (138) 30

Ss: Gathering*. (139) 83

T: Gathering*. O.K. er.. # (140) We said before that 30
the focus,(141) either with regard to the concave 43
mirror(142) or with regard to the convex mirror 43
(143) where's the position of the focus(144) with 43,43
regard to..er, the line(145) extending between the 43
spherical centre(146) of the mirror and its 43
pole?(147) The spherical centre and the pole of the 43
mirror,(148) where's the position of the focus in 43
relation to(149) the line extending between the 43
spherical centre (150) and the pole of the mirror, 43
where's the focus situated?(151) 43

S: The focus is situated in the middle of the line
extending between..(152) 83

T:	Heh..?(153)	10
S:	_ _ _ _ _ _ (154)	01
T:	The spherical centre and the pole of the mirror.(155) The position of the focus is in the middle of the distance.(156) Here's the focus of the concave mirror situated,(157) and here's the focus of the convex mirror.(158) Now can I define the focal distance?(159) When I define,.. Here's the focus(160) and here's the mirror pole.(161) Heh, # what's the focal distance either (162) with regard to the concave mirror or the convex mirror?(163) # These are simple things and(164) we said before we're supposed not to have forgotten.(165) # Heh, and the remaining three who are sitting at the back?(166) # You weren't with us?(167) # The focal distance?(168)	30 53 54 54 42,54 54 42 42 20 20 20 20 42
S:	It's half the half of the distance between the pole and..(169)	82
T:	Half the half of the distance? # (170) The distance, ..Come here and point to the focal distance on the drawing.(171) # # # (172) # It's the distance. O.K.(173) Here's the position of what?(174)	30 60,01 30,44
S:	The focus. (175)	84
T:	And here? (176)	44
S:	_ _ _ _ _ _ (177)	01
T:	The focus of the mirror. O.K.(178) Can't I define this distance?(179)	30 42
S:	It's the distance between the..er.. (180)	82
T:	Between what? Identify the two points and..(181)	44

S: Between the focus and # (182) 82

T: Between the focus and the pole of the mirror.(183) 30
Come. And with regard to the convex mirror?(184) 42
Where is the focal distance?(185) # # # (186) 44,01
Heh? What does it mean?(187) 42

S: The distance between the pole and the..er(188) 82

T: The distance between the focus of the mirror and it's pole.(189) This is the focal distance. This focal 30
distance(190) we refer to it by the symbol (D)#(191) 54,54
and it has a relation with the spheric radious.
(192) Heh, what's the relation between the focal 53
distance(193) and the spheric radious?(194) Heh, the 42,42
one down there?(195) 60

S: The radious equals two # (196) 82

T: Ah, the spheric radious, this distance (197) and I 53
refer to it by the symbol (R), and (198) it equals 54
twice the focal distance.(199) 53

Table 3: Interaction Analysis Matrix for Episode A (Chemistry).

Category	10	20	30	41	42	43	44	51	52	53	54	60	70	81	82	83	84	85	90	01	Total
10														1							1
20																					
30						2		4		10		1	3	1		6					27
41	1							1													7
42					1							1									2
43				1		1						1				8					12
44						1											4				5
51				2		1	1	21		5											36
52																					
53				2		4	1	5		23	3		4	1		2					45
54				1		1		2		1	5		3							2	15
60			1								1		1			1					4
70				1		1	3	1		3	5	1	21							3	42
81			9					1		1			1								12
82																					
83			15			1		1													17
84			2							2											4
85																					
90																					
01					1						1		3							1	6
Total	1		27	7	2	12	5	36		45	15	4	42	12		17	4			6	235

Table 4: Interaction Analysis Matrix for Episode B (Biology).

Category	10	20	30	41	42	43	44	51	52	53	54	60	70	81	82	83	84	85	90	01	Total
10																					
20																					
30			1	1		1		4	2	7			1	3		1				2	23
41				3				1						6							10
42					1													1			2
43						14				3		2				4		2			25
44							1										1				2
51				1		1		13		1			1	6						3	26
52						1		1	1												3
53						4		3		31	3		6			1					48
54										3	1						1				5
60												1		1		1					3
70				2	1	3		1			1		7			1				1	17
81			11	1			1	3		1				2							19
82																					
83			6							1				1		1					9
84			2																		2
85			3																		3
90																					
01				2		1				1			2							1	10
Total			23	10	2	25	2	26	3	48	5	3	17	19		9	2	3		10	207

Table 5: Interaction Analysis Matrix for Episode C (Physics).

Category	10	20	30	41	42	43	44	51	52	53	54	60	70	81	82	83	84	85	90	01	Total
10														2						1	3
20		3			1											1					5
30			1		2	3	1	7		4	1	2	1			1					23
41	1			1										2							4
42		1			3		1				1	1			4						11
43		1				27						1		1		11				1	42
44															1		1			2	4
51				2		4		14			1			1							22
52																					
53					1	5				16	3		1			1				1	28
54					2					4	3						1				10
60													1		1	1				1	4
70										2	1										3
81			5											2		1					8
82	1		3				1			1											6
83	1		10	1		2		1								2		1			18
84			1				1														2
85					1																1
90																					
01			3		1	1				1											6
Total	3	5	23	4	11	42	4	22		28	10	4	3	8	6	18	2	1		6	200

4.4 Some Comments and Interpretations:

Before attempting to make any inferences form the matrices of the three episodes, a few remarks about the coding procedures followed should be made. Firstly, due to the large number of formulae which were dealt with in Episode A (Chemistry), the teacher was constantly putting information on the blackboard as she spoke. Hence the exceptionally short segments of tallies in this episode. However, since such information involved teaching new principles and formulae, those tallies were coded as Category 53 (States, applies, or explains a rule, formula, principle, or process).

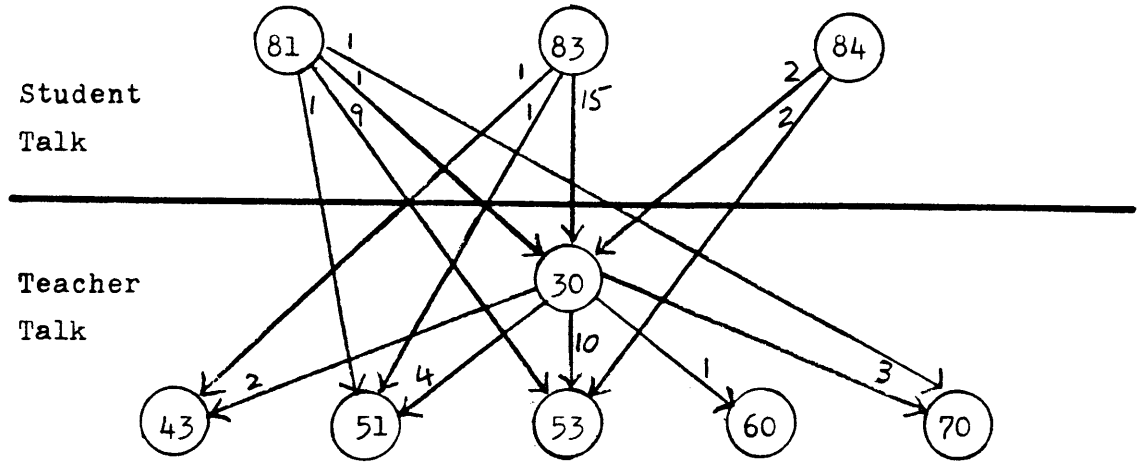
Secondly, in Episode A also the teacher frequently used the present simple form "You + verb (to do)" when dealing with experiments. This was not coded as Category 60 (Gives directions) but rather as Category 70 (Sets up teaching procedures). This is because the teacher used this form not as genuine directions but rather as a presentation technique as she explained each experiment. This was made obvious by the fact that the students were not asked to carry out the experimental work immediately but were in fact "taught" the experiments. In fact Episode A is a good example which illustrates the point made earlier in Chapter Three about the manner in which science knowledge is treated in the Bahraini context, i.e. as a body of knowledge which has to be acquired and memorised through principles and formulae. It also illustrates the manner in which experiments are dealt with, i.e. as an illustrative and confirmatory, rather than investigatory, process.

Thirdly, there were a lot of overlap between teachers' and students' utterances in the three episodes. However, most of the overlaps were transcribed as independent moves. This is because such moves are important indicators of the type of teaching/learning strategies prevailing in these classes, one of which is based on the approximation and consolidation of principles, formulae and definitions which are being taught. The teacher's agreement, in the form of repetition of students' utterances, is also an indication of that consolidation strategy.

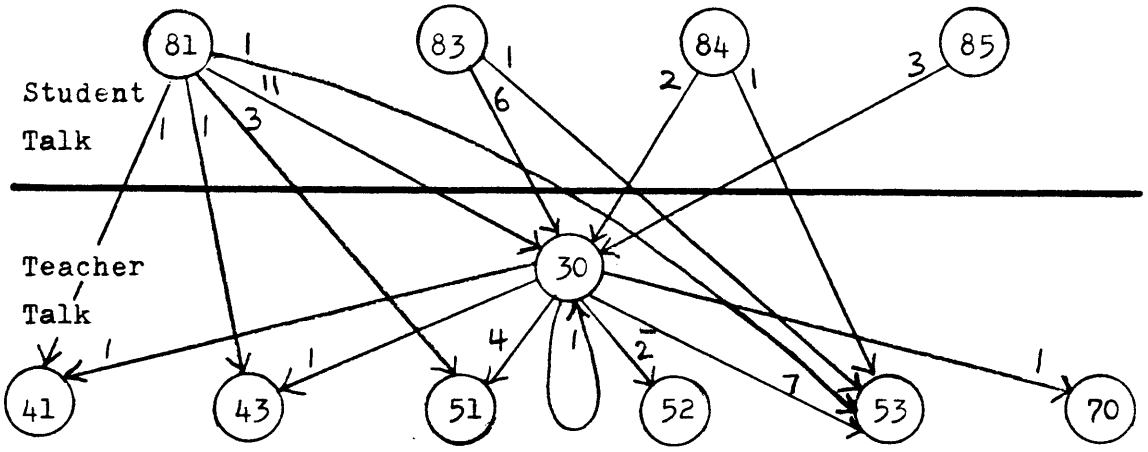
Another interesting feature which is apparent in the first two episodes is the insertion of questions in the middle of statements, as in tallies 77, 103, 161, 172, 201, and 212 (Episode A) and tallies 29, 115, 128, 148, 202, and 206 (Episode B). However, these are not genuine information seeking questions but either confirmatory, as they are usually followed by a repetition of the preceding statements, or a time gaining device, or a 'breather', when the teacher is writing on the blackboard. Such questions were considered as parts of the behavioural move they happen to be in and were coded accordingly.

To conduct any behavioural interpretation of the tabulated matrices, perhaps it would be helpful to display teachers' moves diagramatically. Figure 6 below shows the transition pathways followed by the teachers in the three episodes following the termination of students' responses. The analysis of the pathways displayed on the figure indicates that students' responses (Categories 81, 82, 83, 84, 85, and 90) are in most cases followed by Category 30 (78.8% of the teacher's moves following

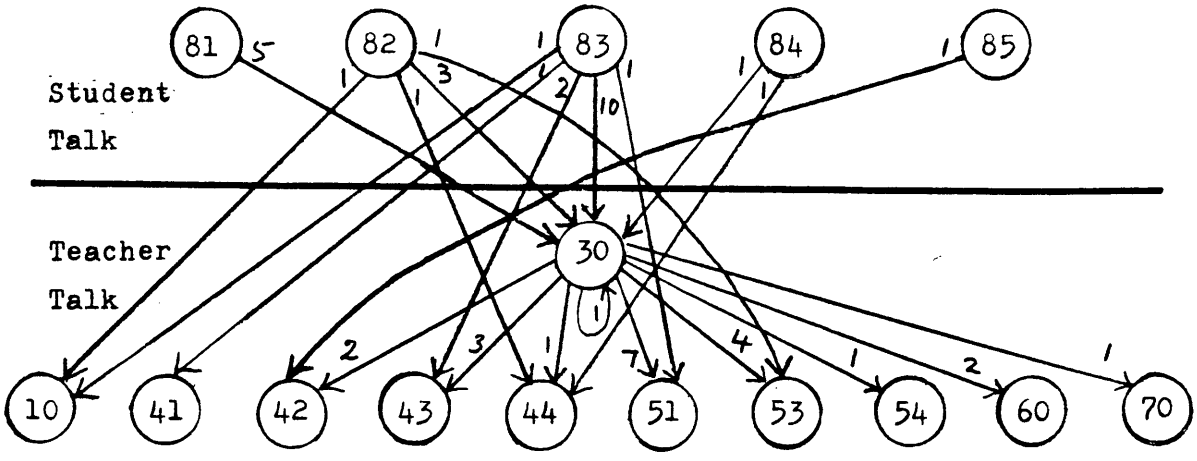
Fig. 6: Transition Pathways of Interaction in Episodes A, B, and C.



Episode A



Episode B



Episode C

students' moves in Episode A, 73.3% in Episode B, and 65,5% in Episode C), when the teacher accepts those responses mainly through repetition. Consolidation of previously taught principles and formulae (Category 51) also has a significant occurence as the 30-51 transitions account to 20% in Episode A, 23.5% in Episode B, and 31.8% in Episode C. of all the tallies starting from Category 30.

The analyses of the tallies, as presented in Tables 3,4, and 5 indicate that the teaching/learning process is dominated by the teacher in the three episodes as manifested by percentages of 'Teacher Talk' categories (83.4% in Episode A, 79.2% in Episode B and 79.5% in Episode C.)

The matrices for the three episodes also indicate a tendency towards developing reference and application, rather than inference and discovery, strategies. This conclusion is based on the following interpretations of the tallies in the given episodes as displayed on the matrices:

i. The frequency of stating or explaining principles, formulae or processes by the teacher, calculated by the formula

$$\frac{53 \times 100}{51 + 52 + 53 + 54}$$

is 46.8% in Episode A, 58.5% in Episode B, and 46.7% in Episode C.

ii. The frequency of the teacher's questions asking for a statement or application of a principle or a formula, calculated by the formula

$$\frac{43 \times 100}{41 + 42 + 43 + 44}$$

is 46.2% in Episode A, 64.1% in Episode B, and 68.8% in Episode C.

iii. The frequency of students' statements of a principle or a formula, calculated by the formula

$$\frac{83 \times 100}{81 + 82 + 83 + 84 + 85}$$

is 51.5% in Episode A, 27.3% in Episode B and 51.4% in Episode C.

iv. The ratio of questions requiring inference strategies (Category 42) to those requiring application strategies (Category 43) is 2:12 in Episode A, 2:25 in Episode B and 11:42 in Episode C.

The matrices also show a significant proportion of consolidation of rules, principles, or formulae through repetition. In the case of teachers this repetition, calculated by the formula

$$\frac{51 \times 100}{51 + 52 + 53 + 54}$$

is 37.5%, 31.7% and 36.7% in the three episodes respectively. In the case of students this is calculated by the formula

$$\frac{81 \times 100}{81 + 82 + 83 + 84 + 85}$$

giving frequencies of 36.4%, 57.6%, and 22.9% respectively. The recapitulation of factual information is also an indication that

the teaching strategy applied here is to take one step at a time, i.e. gradual exposure. Meanwhile the 'false' questions used by some of the teachers in the middle of their statements are indications of the teacher's insistence on exact verbal reference. Finally, the fact that students frequently managed to conform to the teacher's expectation in answering questions strongly suggests that the teaching pattern employed is an effective one in creating appropriate learning conditions as far as the given context is concerned.

A final point with regard to the behavioural interpretation of the present data is related to the phenomenon of turn taking in interaction. Turn taking is manifested in what is known as "adjacency pairs", which Coulthard [1977] defines as "the basic structural units in conversation" [p.70]. He cites Sacks as suggesting that in conversation settings, turn taking is usually controlled by the current speaker who has the choice of:

i. selecting the next speaker and the next utterance,

ii. constraining the next utterance but not selecting the next speaker,

iii. selecting neither.

The question we have to consider here, however, is what factors govern the choice of any of these options? I think the speaker's choice is governed by his strategy in the given stretch of interaction. That is to say, his decision to choose the next speaker, constrain the next utterance, do both or do neither depends on whether he seeks support, confirmation, consolidation,

or even confrontation from the listener or listeners. In the episodes given above the teachers seem to constantly choose the second option. They closely monitor the next utterance but are not concerned about who the next speaker is. This is mainly achieved by:

i. Asking questions which require the repetition of previously stated information, as in:

T: ... and you add to it the dilute hydrochloric acid (67) you add to it what acid?(68)

P: The dilute hydrochloric (69) (Episode A)

ii. Posing suggestive questions the answers of which are quite predictable either from the preceding statements as in:

T: Er .. we've seen .. what performs the digestion (31) process inside the digestive system? (32) We've seen something, we've said are called (33) digestive juices and enzymes. (34) Is the digestive process accomplished without (35) these substances? Heh? (36)

P: No, it isn't. (37) (Episode B)

or from the format of the question, as in:

T: .. they're then secreted by the living cells, or dead cell? (174)

P: The living cells. (175) (Episode B)

The choice of option in this case, it seems to me, is closely related to the teaching strategies which dominate the learning

context. That is to say, in the given teaching situation, the teacher in each case is more concerned with confirming that knowledge is being transmitted and assimilated in the way he or she considers best. In this case it is of less or no importance who fulfils the teacher's expectation. In other words, the first part of the adjacency pair in this type of classroom interaction is mainly concerned with controlling the next utterance rather than the next speaker. This is clearly demonstrated by the fact that in most cases the questions are not addressed to a particular student, and that answers in the form of class chorus are considered as an acceptable norm of behaviour.

Finally, one can argue that the behavioural description of the teaching method employed in the present data manifests an overall pattern which is in the form of teaching an explicit fact, principle, or formula which is then followed by a question requiring either the provision of more facts, principles or formulae, or repetition of previously taught ones. Students' short answers are then consolidated through repetition on the part of the teacher and then developed to generate more facts, principles or formulae. Using the coding symbols adopted in the suggested system, this pattern produces the following sequence:

$$53(51) \rightarrow 43(41) \rightarrow 83(31) \rightarrow 30 \rightarrow 53(51)$$

This pattern is illustrated in the tallies 101-116 and 222-232 in Episode A, and 60-71 and 181-195 in Episode B, and 9-18 and 113-125 in Episode C.

To conclude then, the general pattern of interaction exemplified

in the three episodes given reflects the type of teaching/ learning behaviour typical of most science classes in Bahrain and which, as argued earlier, plays down inference and discovery strategies in favour of principle learning. There is no doubt that the intellectual ability of students play an important role in directing classroom interaction. Intelligent students, for example, by initiating and enquiring could provoke higher levels of thinking in the classroom and thus influence the teaching strategies. However, this sometimes works against classroom norms which are mainly established by the expectations of the majority of the students in the classroom. In the Bahraini context those expectations are usually in the form of receiving rules and principles which are consolidated and then practised. Another important factor which affects the shaping up of those strategies is the time factor, i.e. the amount of time a teacher can afford to spend on discussing a given teaching item. Due to the state of centralisation of the educational system and the domination by the syllabus of what goes on in the classroom, teachers are usually anxious to keep up with the teaching schedule specified by the syllabus. This means they usually seek the shortest possible route to convey whatever they are supposed to teach. In such teaching conditions learning through discovery becomes the first victim and the teaching of principles becomes the norm. In the three episodes given, one aspect of that norm is manifested by the types of questions enployed and which usually require short, repetitive, and predictable answers. Obviously the use of inference and discovery strategies in learning requires the use of a divergent type of thinking which includes the skills of relating ideas, grouping things together, and reasoning

processes. It is evident that most questions used in the present data do not provoke this type of thinking, but rather promote convergent thinking and encourage a type of learning based on the identification and consolidation of facts and principles and the application of those facts and principles in new situations.

CHAPTER FIVE

INVESTIGATING LEARNING STRATEGIES 2: THE PROBLEM SOLVING EXPERIMENTS.

5.1 Introduction:

The analyses of the sample data of classroom interaction from a cognitive stand-point in the previous chapter have revealed that the learning process in the classes studied is largely dominated by a set of learning strategies which is closely associated with presenting the learner with data in an explicit manner in order that learning takes place. Such findings, however, remain as an outcome of the process of interaction between the learner and the teacher who, in this context, seems to dominate the learning situation and who is therefore responsible for promoting the type of learning strategies he feels fit in the given context. If we are to take the type of learning strategies prominent in the classes studied as a code of reference for organising the learning process in other contexts, then such strategies have to be verified in an experimental set-up. Having accepted the notion that learning in general and that of a language in particular is basically a problem solving process, those strategies will have to be tested in a problem solving situation where learners are presented with certain tasks to solve. Furthermore, since we have rejected the type of learning strategies underlying current EST materials as being unrepresentative of the cognitive profile of the Bahraini learner, the experimental set-up should create a comparison with regard to learning effectiveness between the strategies identified by the interaction analysis and those pre-

assumed by current EST materials. To achieve this, the two types of strategies will have to be interpreted into two learning methods which are then applied according to certain experimental procedures. The following sections discuss in behavioural terms those experimental procedures, the learning methods compared, the materials used as well as the results of those experiments and some interpretations of those results in relation to the learning context given.

i. General Aims:

The purpose of the experiments is to determine, in a problem solving situation and in relation to learning effectiveness, the type of method which is most effective for learning in the Bahraini context, with a special reference to learning English for science and technology. The criteria for measuring the most effective method as far as this study is concerned are twofold. First, its effect on transfer of the capabilities learned to novel situations, and secondly, and more importantly, its effect on retention of those capabilities after a period of time. In problem solving terms, this means that the most effective method is that which would enable the largest number of subjects to apply the acquired knowledge to solve the largest number of tasks immediately after the learning session and, more importantly, after a period of time.

ii. Materials:

In order to test learning effectiveness, the experimental set-up should make it possible to measure the learner's ability to transfer what he has learned in the learning session to similar

and novel situations. An important prerequisite, therefore, is the use of a type of task which can be presented in different forms and yet requires the same principle to solve. The Match Tasks used by Katona [1940] in his studies of problem solving seem to fulfil this requirement (see Appendix 8). In summary, subjects are presented with a geometrical figure consisting of a number of squares or triangles, and are asked to reduce the number of squares or triangles (by one or two) by changing the position of a given number of sides but without changing the actual number of sides in the original figure. The solution of each task also represents a similar task but in a reverse form whereby subjects have to increase the number of squares or triangles by changing the position of a certain number of sides.

The match tasks tests discussed in the following section could be considered in many aspects as a re-run of Katona's tests with some modifications. However, the re-run was restricted to those tests in Katona's work which correspond to the purpose of the present study. Wherever possible the same experimental conditions and instructions used originally in Katona's tests were observed as accurately as possible. Figure 7 below shows the tasks used in the present study. Some of Katona's original tasks have been slightly modified in order to create a comparable level of difficulty between certain tasks. The numbering of the tasks have also been slightly changed.

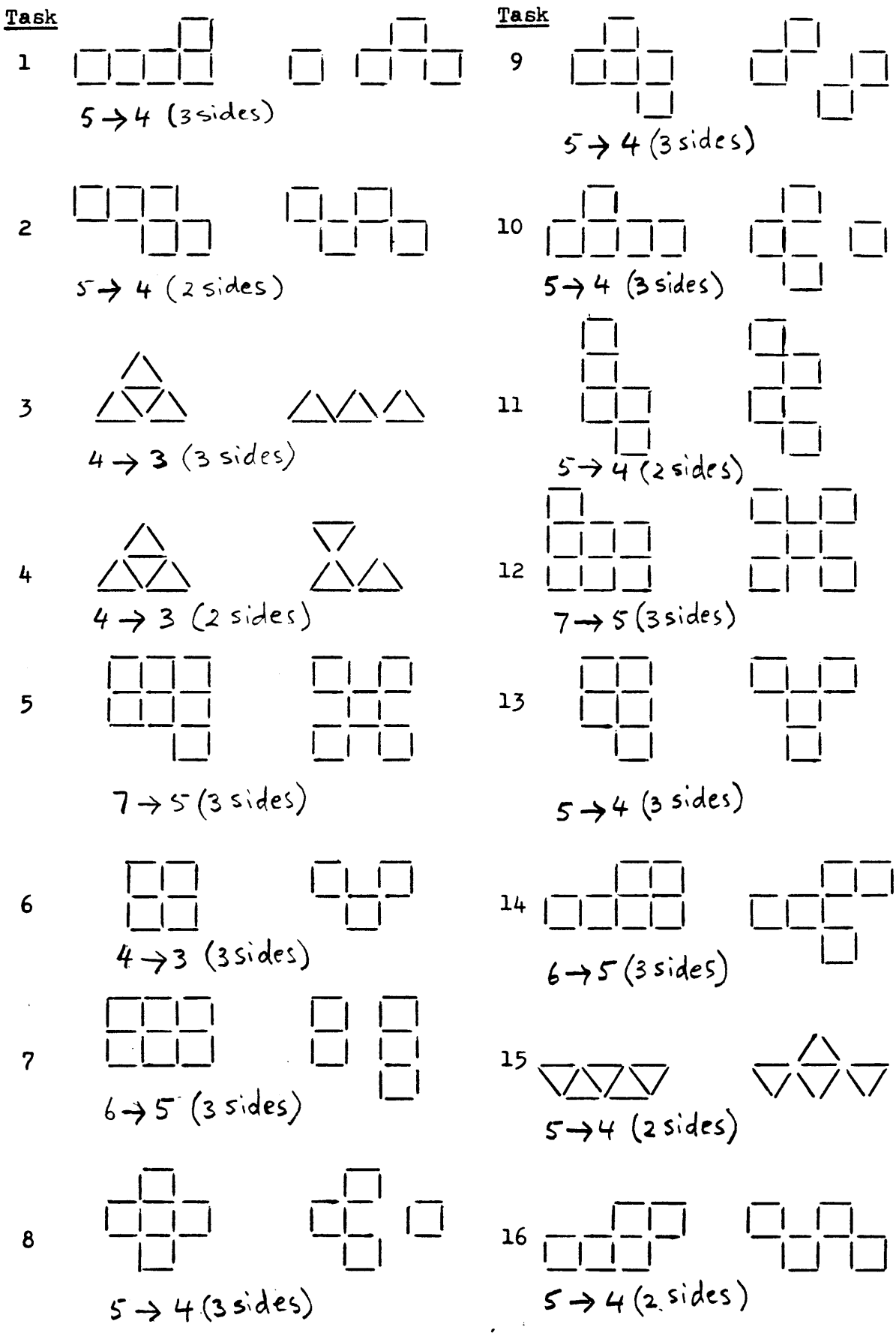

Task
1
5 → 4 (3 sides)
2
5 → 4 (2 sides)
3
4 → 3 (3 sides)
4
4 → 3 (2 sides)
5
7 → 5 (3 sides)
6
4 → 3 (3 sides)
7
6 → 5 (3 sides)
8
5 → 4 (3 sides)
Task
9
5 → 4 (3 sides)
10
5 → 4 (3 sides)
11
5 → 4 (2 sides)
12
7 → 5 (3 sides)
13
5 → 4 (3 sides)
14
6 → 5 (3 sides)
15
5 → 4 (2 sides)
16
5 → 4 (2 sides)

Fig. 7

Since the ultimate aim of the present study is to measure learning effectiveness with regard to language learning, a set of language tasks comparable to Katona's match tasks had to be constructed. This attempt was faced with a number of problems. These, as well as the solutions applied, will be discussed below in a separate section. Suffice it to say at this stage that the language tasks were based on the same conceptual framework applied in the match tasks. The testing procedures for the two types of tasks will be discussed in separate sections below.

iii. Methods of Learning:

In comparison with a control group, where no specific method of practice was offered, the experiments attempted to measure the effectiveness of the following two methods of learning:

A. Guided Discovery: This method aims at guiding the learner in his task to gain knowledge of the underlying principle for solving a given problem without it being overtly stated or explained verbally. It is argued that by offering the learner some hints and examples which are organised in a specific manner to direct his thinking to certain aspects of the task, he would develop an understanding of the structural qualities of the task and the intrinsic relationship between the task and its solution. This would consequently lead the leaner to develop knowledge of the underlying principle for solving such a task. That knowledge then becomes part of the learner's cognitive repertoire and is retained for a long period of time, enabling the learner to solve novel tasks of similar qualities with ease. It is argued that learning in this manner is more effective than any other form of

learning since the learner is in fact participating actively in acquiring knowledge. What he discovers will represent his personal contribution to the learning process and will therefore become a solid part of his learning experience.

In order to achieve learning in this manner, the learner is guided in discovering the principle during the learning period by some clues in the form of consecutive steps leading to the solution. The steps are not offered arbitrarily but are organised according to the structure of the task and the principle for solving it so that there would be an understanding of the role and function of each step. To explain the importance of organising meaningfully the consecutive steps leading to the solution of a given task in order that the learner discovers the underlying principle, Katona [1940, p.76] offers the following two methods of presenting those steps in dealing with the same task:

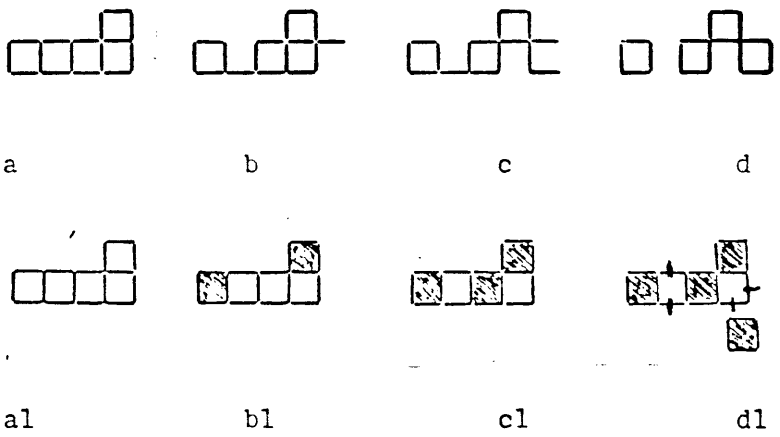


Fig. 8

(Reducing the number of squares from 5 to 4 by moving 3 sides)

It is obvious from the figure above that steps b, c and d present arbitrary moves for changing the position of three sides without any relation to the structure of the task, and therefore it would be difficult to convey any underlying principle through these steps. The shading of the squares to be retained presented in steps b1, c1, and d1, on the other hand, represents a solution which is closely related to the structure of the task as a "whole". (Katona argues that the need to leave one of the four sides in its place in order to solve the task by moving three sides as required will be understood by most subjects either in step c1 or d1). Thus, the three steps present a meaningful set of actions which would convey the underlying principle; that is "the closed unified figure must be broken up and expanded in order to solve the task." [Katona, 1940, p.77].

B. Principle Learning: This method rests on the argument that in order to facilitate learning, the learner must be told explicitly what he is supposed to be learning. In learning to solve problems, therefore, the principle must be verbally presented and taught. The explicit presentation and exemplification of the principle during the learning period is considered essential in leading the learner to develop an understanding of the structural qualities of the task and of the relationship between the task, the principle, and the solution. Thus, the knowledge of the principle and its operation would be acquired in a meaningful and rational way. Taking the task in Figure 8 as an example, the learner is told that in order to solve this task he will have to create holes in the figure. Then he is shown where those holes might be created, possibly using the shading technique as in Figure 8. Principle learning is particularly important in the

case of adult learners where learning is mainly a principle or rule-governed behaviour and is dependent on verbal statements and rational organisation of verbal information.

A further reflection on principle learning in relation to the process of problem solving is fitting here. Newell et al [1958] point out that the process of problem solving is mainly a search for a solution out of a number of possible solutions. This means that a successful strategy for solving a problem is one which either leads to reducing the number of those possible solutions to facilitate the search, or one which leads the learner to rearrange those solutions in a manner which would speed up the discovery of one of them. They suggest that one way of reducing the search, and thus arriving at one of the solutions, is through "the process of working backwards, which uses information about the goal to rule out large numbers of attempts without actually trying them." [p.161]. If that is so, then it logically follows that by providing the learner with a principle we are in a way defining the goal he should work towards. That is to say, by instructing him to create holes in the figure of the task given in Figure 8 above, we are directing his attention to what he should aim at in order to solve such a task. Thus, we have greatly reduced his search for a solution.

It is imperative to stress here that principle learning as conceived of in this study does not correspond merely to the learning and understanding of the verbal representation of a certain principle and the ability to reproduce it whenever required but, more importantly, it is related to the

understanding of the effect of that principle and to the ability to demonstrate its application. The learning of the verbal proposition of a given principle is, therefore, a means to an end and not an end in itself. Once the application capability has been acquired the verbal proposition is not sought, although if full understanding has taken place, this will result in the ability to produce some kind of verbal representation of that principle even when the original form has been forgotten. Thus, having acquired the knowledge of the principle in a meaningful way, the learner would develop the capability of applying that principle in solving novel tasks of similar structural qualities. It is also argued that by learning through this method, the learner acquires the right principle and in the shortest time possible, and that solutions are arrived at through conscious understanding of the task and the principle rather than through chance.

iv. Subjects:

Three male and three female second year science classes from two secondary schools in Bahrain were chosen at random, making a total sample of 180 students (83 males and 97 females) with an age range of 15-20. The schools chosen are unique in the sense that their populations represent a wide geographical cross-section. In fact the sample chosen in this study contains students representing more than 20 different towns and villages in Bahrain. The students were divided randomly into three groups corresponding to the two learning methods discussed above, in addition to a control group. The three groups were called Guided Discovery, Principle Learning, and Control. For convenience sake,

they will be sometimes refered to here as G.D., P.L., and C. respectively. There were 50 subjects (27 males and 23 females) in group G.D., 65 (28 males and 37 females) in group P.L., and 65 (28males and 37 females) in group C.

5.2 The Match Tasks Tests:

Procedures:

It is important to mention at the outset that all the instructions and testing procedures in all the tests were administered by the researcher in order to create a tight experimental set-up where all the groups received identical treatments, and to eliminate any misunderstanding or misrepresentation of the aims or organisation of the tests. Help was only sought in the timing of each test. The subjects were timed individually and the results were registered on a Success scale and a Time scale. All the instructions were given in the mother tongue of the subjects, which is Arabic in this case, to eliminate any failure due to incomprehension. For administrative reasons each sex was tested separately. As mentioned earlier, an attempt was made to observe, as far as possible, the same experimental conditions and procedures as in the original experiments in Katona's work. This meant using the same original instructions in some cases. The experiments consisted of five sessions in the following order: an introduction to the tasks, followed by a preliminary test where subjects were given a number of tasks to solve. Then each of the experimental groups went through a learning session. This was immediately followed by another test. Finally, a third test was administered 28 days later. These five sessions will be referred to in the following

discussion as "Introduction", "Pre-test", "Practice Period", "Post-test", and "Re-test" respectively.

i. Introduction:

The purpose of the experiment was explained to the subjects in the following manner:

> "I will show you a few tasks dealing with geometrical figures. Try to solve the tasks to the best of your ability. But you should know that the experiment is not a test of your ability or intelligence. What I want to test are various methods of presenting and explaining the tasks, because with the help of this experiment I hope to gain some knowledge of how you learn to solve certain problems."

After this introduction the design of Task 1 was drawn on the blackboard. (The task number refers to Figure 7 above). The following instruction was then given:

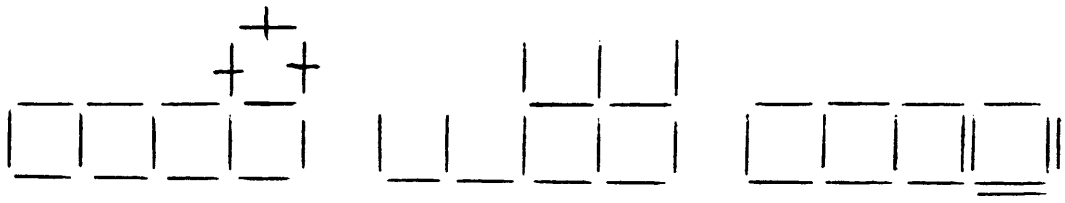
> "Here are five equal squares. The task is to make four similar squares out of the five by changing the position of three sides only."

The subjects were then given the following conditions:

i. The new figure should consist of equal squares of the same size as those in the original figure.
ii. All the sides must be used in composing the new figure.
iii. The new figure should consist, as does the original, of squares only, not of squares and unused sides which are not the sides of any square.

iv. Duplication of sides is not permitted. Each square must have only four sides.

The following three types of wrong solutions were explained on the blackboard:



Omission Incomplete Duplication

Fig. 9

ii. Pre-test:

The purpose of this test was to determine the initial ability of the subjects in dealing with these types of tasks, and thus establish a yardstick for measuring achievement as a result of receiving treatment by one or other of the learning methods. In this session parallel tests were administered in which the subjects in the three groups were each given six tasks to solve. Each task was presented on a separate sheet of paper (see Appendix 9) which contained the task design and the instruction, e.g. "Make four squares out of these five squares by changing the position of three sides only". The subjects were also given match sticks to work with, and were told in each case to use the sticks to construct the figure given on the sheet first and then proceed to find the solution by moving the sticks. They were also told that they were allowed three minutes only to find the solution of each task, and were asked to tell one of the instructors in the

room as soon as they thought they had found the solution. Each instructor had a stop watch and all the watches were started simultaneously after all the subjects in the group had constructed the original figure and the signal to start finding the solution had been given. When a subject had found the right solution, he or she was timed and then told to draw the solution on the sheet provided. The term "solution" is used here to denote only the final drawing consisting of the required number of squares, and implies no presentation of the intermediate steps by which this final form is achieved. The six tasks given in the pre-test were Tasks 9, 7, 6, 11, 4, and 5 in that order.

iii. Practice Period:

This immediately followed the pre-test. The subjects in the two experimental groups were given instructions on how to solve the tasks following a certain learning method according to the group they were in and using Task 1 and Task 8 as examples. The control group had no practice session. The duration of the practice period was ten minutes, and was used differently for each experimental group as follows:

A: Guided Discovery: Task 1 was drawn on the blackboard and the subjects were told to "Look at the blackboard and try to find the solution." Thirty seconds later, they were told "In order to teach you how to solve such tasks I will solve this task for you. Please watch carefully and try to understand what I am doing." Then the corner squares on a new drawing beside the first were shaddeed as illustrated in step b1 in Figure 8 above. After another thirty seconds the second step was given on a new drawing, and so on as in Figure 8. When the task had been solved,

the subjects were told "Now we have solved the task by changing the position of four sides." Thirty seconds later a solution was shown which involved the moving of three sides only as required by leaving one of the four sides in its place. (In fact in almost all cases the subjects understood this step before it was presented by the researcher). As mentioned earlier, the steps were presented and organised in this manner to convey the idea that in order to solve the task the closed unified figure must be broken up and expanded by creating holes, which is the underlying principle in this case. There was no repetition, each step being shown only once. The drawing representing all the steps were left on the blackboard so that at the end of the learning period they could be examined simultaneously. Task 8 was then dealt with in the same manner as in Figure 10 below.

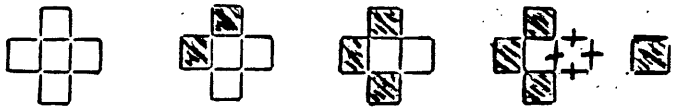


Fig. 10

B. Principle Learning: Task 1 was drawn on the blackboard and the subjects were told that in order to solve such tasks, they need to follow a certain principle. Then the following principle was slowly read to them: "To reduce the number of squares we must create holes and loosen the figure." Then they were told "Let us see how the principle works." The solution was then presented on

the blackboard using the shading technique again as in Figure 8 and Figure 10 above, and explaining how and where those holes should be created. Later Task 8 was dealt with similarly. The principle was taught in a way to focus on the whole qualities of the task. The subjects were encouraged to perceive of the figure as squares attached to each other, and that in order to reduce the number of those squares we have to create holes by destroying two squares and creating one only in this case. Thus the steps provided were seen as concrete and meaningful operations determined by the structure of the entire figure.

iv. Post-test:

The three groups were given six tasks to solve (Tasks 10, 3, 13, 2, 15, and 12) and were allowed three minutes to solve each task. The two experimental groups were told to try and apply the knowledge they had gained during the practice period. The tasks given in this test are comparable in difficulty to those given in the pre-test. The correlation between the two sets of tasks was based on Katona's findings as well as on a pilot experiment conducted separately on a smaller group of Bahraini students of a similar background. Results obtained by Katona's preliminary experiments indicate that Task 9 is comparable to Task 10 in difficulty (Katona, 1940, p. 96). In fact Task 10 has a solution of exactly the same form as one of the solutions of Task 9. Task 4 and Task 15 both consist of triangles and their solutions require the movement of the same number of sides (2 sides). They are also two of the easiest tasks. The results obtained from the pilot experiment indicate that Task 3 is similar in difficulty to Task 7 although they are structurally different. Task 6 and Task 13 have almost a similar form, and require the same kind of

operation to solve, i.e. the destruction of two diagonal squares and the creation of a new square attached to the side of the figure. Task 11 can be considered as a vertical version of Task 2 and therefore they are structurally identical. Also, in both tasks the solution requires the movement of 2 sides only. Finally, Task 5 is also identical in form to Task 12 and both require the creation of 5 squares out of 7 by moving 3 sides. Both require the same kind of operation to solve and have only one solution. Further discussion of the correlation of tasks in relation to the results obtained will be conducted later in this chapter.

In order to eliminate any further practice which would impair the results of the re-test, the subjects were told at the end of the post-test not to try to reconstruct the tasks or attempt to solve them at home. They were also given the impression that they were not going to be given any more tests. At the beginning of the re-test, however, they were asked whether they had tried to reconstruct or solve the tasks. The test papers of those who admitted that they had were eliminated from the scores.

v. Re-test:

Since the effectiveness of the different learning methods cannot be decided merely on the basis of the results of immediate recall, a re-test was administered 28 days after the post-test in order to measure retention. The choice of 28 days was simply a matter of observing the same experimental conditions as those applied originally in Katona's work. The subjects in each group were given six tasks to solve; two practised tasks (Tasks 1 and

8), two tested tasks (Tasks 7 and 10), and two new tasks (Tasks 14 and 16), and were allowed three minutes to solve each task. The six tasks were given in the order 7, 14, 1, 8, 10, and 16. The following table summarizes the experimental design discussed above.

Table 6: A summary of the Experimental Design for the Match Tasks Tests.

Group	Pre-test	Practice Period	Post-test	Re-test (After 28days)
Guided Discovery Principle Learning	Tasks 9, 7, 6, 11, 4, 5. (3mins.each)	Tasks 1 and 8 (10mins.)	Tasks 10, 3, 13, 2 15, 12. (3mins.each)	Tasks 7, 14, 1, 8, 10, 16. (3mins.each)
Control		None		

Finally, in order to determine whether there is any correlation between performance and verbal formulation of the principle learned, the subjects were asked at the end of the re-test to write down briefly the principle they had used to solve the tasks.

5.3.0 The Language Tasks Tests:

It is evident that the purpose of the match tasks tests was to compare learning effectiveness between the two learning methods investigated in dealing with abstract tasks. However, if such a comparison is to have any relevance to the process of teaching/

learning of English for science and technology, it will have to be related to a set of language tasks comparable in behavioural terms to the match tasks. The key word in the previous proposition is "comparable", since at a first glance it may perhaps seem rather difficult, if not impossible, to construct language tasks containing structural qualities and characteristics similar to those of the match tasks. However, this may not be so if we shift our focus from the substance of the task to the cognitive qualities required to solve such a task, i.e. if we consider, from a behavioural viewpoint, the nature of the task in relation to the strategies required to solve it. Thus, the defence for the comparability of the language tasks to be discussed below with the match tasks can be based on the definition, from a behavioural point of view, of the notion "strategies". Gagné [1970] points out that the term refers to the manner in which the learner instructs himself and guides his thinking process. He stipulates that strategies "pertain more generally to the behaviour of the learner, regardless of what he is studying. In this sense, they are 'content free'." [p.230]. He also suggests that among the considerable variety of strategies governing the learning process "There must be strategies of attending, strategies of coding, strategies of storage and retrieval, strategies of hypothesis forming — and strategies that are particularly relevant to solving problems." [p.231]. Newell et al [1958] also argue that there is a common pattern of strategies employed in the problem solving process regardless of the subject. They write "The programme that a human subject uses to solve mathematical problems will be similar in many respects to the programme he uses to choose a move in chess; the programme

one subject uses for any such task will resemble the programmes used by other subjects possessing similar training and abilities." [p.152]. If that is so, and if we accept the notion suggested in Chapter Two that language learning is a problem solving exercise, then we can argue that from a conceptual point of view the language tasks, as presented below in a problem solving model, are similar to the match tasks in the sense that they would require the activation of the same cognitive capabilities regardless of the difference in substance. This argument is supported further by the fact that although, for example, "field-dependence-independence" tests [e.g. Witkin et al, 1971] are based on the perceptual function of identifying certain embedded figures and shapes, the results of such tests are, nevertheless, used to predict the individual's cognitive and linguistic performance in different contexts and, more broadly, to draw inferences about many aspects of his personality.

Naturally, the language tasks have to reflect the main linguistic features of current EST materials. An informal investigation in this area would reveal that those materials deal basically with two main linguistic features: discourse and grammar. Consequently, the experiments had to deal with these two features separately. The discourse tasks dealt with the organisation of classificatory texts in scientific English, in which the subjects were in each case asked to arrange in a logical order a set of mixed sentences dealing with a certain scientific phenomenon, process, or a set of objects (see Appendices 10, 11, and 12). The grammar tasks dealt with the passive transformation of the main four tenses (see Appendices 13, 14, and 15). The choice of these two types of tasks was based on an informal study of the most

predominant language data in one of the most widely used EST series, namely "English in Focus", published by Oxford University Press, and more specifically of "English in Physical Science" [1974] by Allen And Widdowson. However, the attempt to produce language tasks dealing with discourse and grammar comparable to the match tasks proved to be a rather tricky problem, and certain limitations have to be recognised in this respect:

i. In dealing with the match tasks, the learner knows when he has been successful in solving the task, i.e. creating a figure with the required number of squares or triangles. This is not the case when dealing with both types of language tasks, and therefore the feedback factor is severely restricted.

ii. Although there is one principle for solving all the match tasks, the form of the individual tasks is different. This is not possible with the language tasks, unless we consider the structural and thematic differences between the sentences in each language task as corresponding to the structural differences between the match tasks.

iii. It is extremely difficult to decide whether all the language tasks, and especially the grammar tasks, are new to the subjects since, in this case, they have had eight years of English in which they should have, at least theoretically, covered a fair amount of language data. However, this limitation was tempered by conducting a pre-test which was used, as in the match tasks tests, as a yardstick for

measuring the learning effect.

iv. Whereas each match task may have different solutions, the language tasks, and especially the grammar tasks, may have only one possible solution.

v. As far as the time and effort required for solving the tasks are concerned, although the discourse tasks could be considered comparable to the match tasks, it is obvious that the grammar tasks require far less time and effort to solve. It was, therefore decided to double the number of the grammar tasks.

vi. For practical reasons the language tasks in each test were not given and timed individually as in the match tasks tests, but were presented collectively on one sheet and were allotted the same total time as that for the match tasks. This meant that in each of the discourse tests the subjects had a sheet of paper with six tasks (sets of sentences) to solve in a total time of 18 minutes, whereas in each of the grammar tests they had a sheet of paper with twelve tasks (sentences) to solve in a total time of 18 minutes.

vii. Whereas the match tasks and discourse tasks dealt with one principle for finding the solution, this was not possible with the grammar tasks since dealing with the passive form of a single tense would have been repetitive and would, consequently, have not been a valid testing item for measuring learning effectiveness.

viii. Finally, to eliminate any errors due to miscomprehension and to test only the application of the principle dealt with, the Arabic equivalence of the key words, and the past participles of the verbs in the grammar tasks, were provided.

The language tests were conducted separately but in a manner and procedures identical to those mentioned earlier in discussing the match tasks tests. The following section presents a detailed account of those procedures.

5.3.1 The Language (Discourse) Tests:

i. Introduction:

As in the match tasks tests, the subjects were told that the purpose of the tests was to investigate the manner in which they learned to solve certain language tasks and not to test their intelligence.

ii. Pre-test:

Parallel tests were administered in which the subjects in the three groups were each given six sets of sentences to arrange in a logical order (see appendix 10). They were allowed 18 minutes for finding the solutions for all the tasks and were individually timed.

iii. Practice Period:

This immediately followed the pre-test and lasted for ten minutes. The practice period varied according to the two experimental groups. The control group received no practice. The following is a discription of the practice session for the two groups:

A. Guided Discovery:

Task A from the following practice tasks was presented to the subjects:

Practice Tasks:

Arrange the sentences in each task in a logical order:

Task A:

1. Natural water is the water we get from rivers, the ground or rain.
2. It is produced in industry.
3. Man-made water is called pure water and is made up of only hydrogen and oxygen.
4. There are two types of water in nature: man-made water and natural water.
5. Therefore it is not good for drinking.
6. It usually contains dissolved elements.

Task B:

1. Monobasic acids have only one replaceable hydrogen atom in each molecule.
2. Hydrochloric acid is a monobasic acid, but sulphuric acid is dibasic.
3. Dibasic and tribasic acids have two or three replaceable hydrogen atoms in each molecule.
4. The hydrogen in an acid is replaceable by a metal.
5. They are monobasic acids or dibasic and tribasic acids.
6. Acids can be devided into classes according to the number of atoms in each molecule which a metal can replace.

Then after making sure that the subjects understood the content of the sentences, they were given the following instructions: "In scientific English, sentences dealing with classification are ordered in a certain way. I will show you how they are usually ordered. Try to understand what type of sentences are put first and how the rest of the sentences are ordered." Then the solution was shown on the blackboard by presenting one step at a time until all the sentences were presented in the order 4, 3, 2, 1, 6, 5. There was no repetition but the solution was left on the blackboard so that the order of the sentences in the solution could be compared with their order in the original task. Task B above was then dealt with in the same manner and the sentences were presented in the order 4, 6, 5, 1, 3, 2.

B. Principle Learning:

Task A above was presented to the subjects, and after making sure that they understood the content of the sentences they were given the following instructions: "In scientific English, sentences dealing with classification are ordered in a certain way. The text usually moves from the general to the specific. In other words, the sentences dealing with the general aspects of the classification are written first, then the classifying sentences, then the sentences dealing with each of those divisions separately including any examples. Sometimes examples for all the divisions collectively are given in one sentence at the end of the text (Task B above)." This principle was then presented on the blackboard in the form of the following figure, with the

Arabic figures indicating the order of the sentences:

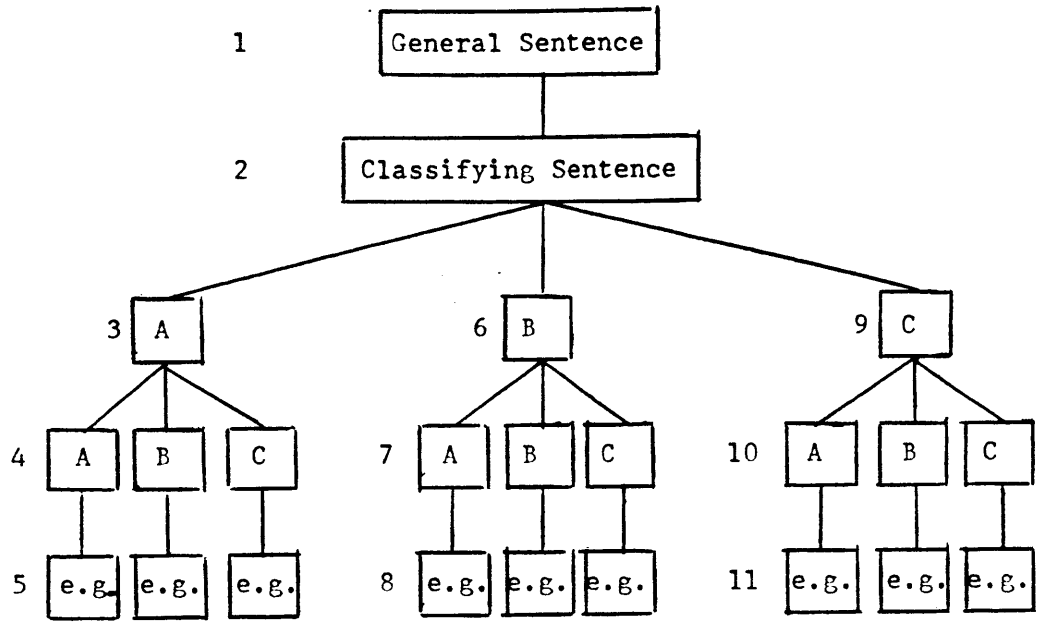


Fig. 11

The principle was then exemplified using Practice Task A above and the solution was shown step by step on the blackboard. There was no repetition but the figure and the solution were left on the blackboard so that they could be examined and compared with the original task at the end of the practice period. Task B above was dealt with in the same manner.

iv. Post-test:

The three groups were given six tasks to solve (see Appendix 11), and were allowed 18 minutes to find the solutions for all the tasks. The two experimental groups were told to try and apply the knowledge they had gained during the practice period. The tasks given in this test were comparable in difficulty to those given in the pre-test. The correlation between the two sets of tasks was based on the structure of the solutions of the tasks as illustrated in the following figure and which shows an almost identical structure, except for the last two pairs.

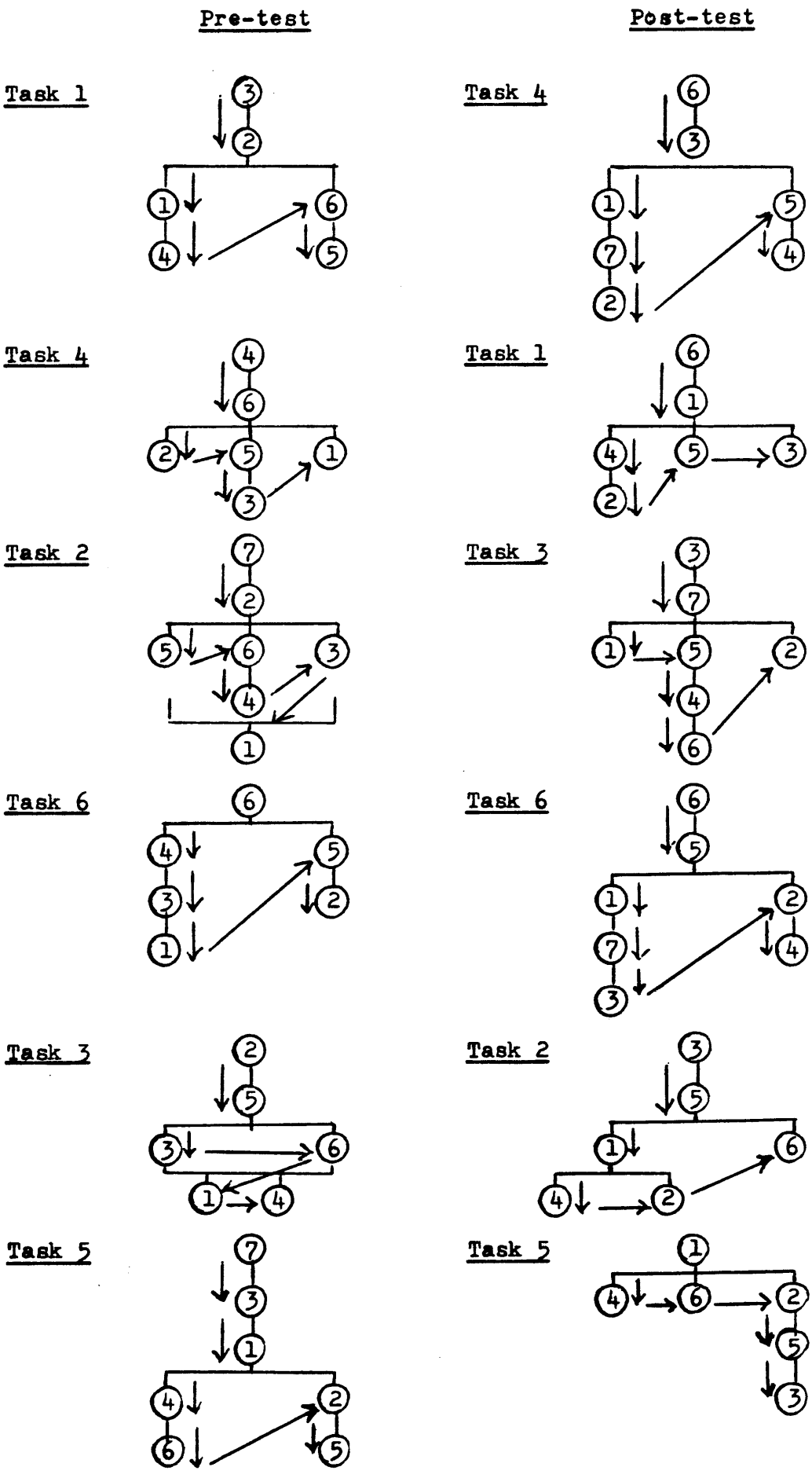

Pre-test
Post-test
Task 1
Task 4
Task 4
Task 1
Task 2
Task 3
Task 6
Task 6
Task 3
Task 2
Task 5
Task 5

Fig. 12

(For the task number in the figure given above reference should be made to Appendices 10 and 11. The Arabic numerals represent the sentence numbers as given in the original tasks, and the arrows indicate the sequence in which the sentences are to be ordered.)

v. Re-test:

This was administered 28 days after the post-test. Each group was given six tasks to solve (See Appendix 12); two practised tasks (Tasks 3 and 4), two tested tasks (Tasks 1 and 5), and two new tasks (Tasks 2 and 6). They were allowed 18 minutes to solve all the tasks, and at the end of the test the subjects were asked to write down briefly the principle they had used to solve the tasks.

5.3.2 The Language (Grammar) Tests:

i. Introduction:

As in the discourse tests above, the purpose of the tests were made clear to the subjects, and that is to investigate the manner in which they learned to solve certain language tasks and not to test their intelligence.

ii. Pre-test:

The three groups were given parallel tests in which the subjects were presented with twelve sentences to change to the passive form (see Appendix 13). They were allowed 18 minutes to solve all the tasks and were individually timed.

iii. Practice Period:

This lasted for 10 minutes and the following sentences were used as practice items with the two experimental groups:

	Active	Passive
a.	We heat the mixture	The mixture is heated
b.	We heated the mixture	The mixture was heated
c.	We may/can/should heat the mixture	The mixture may/can/should be heated
d.	We have heated the mixture	The mixture has been heated

The control group received no practice, but the experimental groups were given instructions in the following manners:

A. Guided Discovery:

The active sentences given above were written on the blackboard and then the following instructions were given: "The passive is very common in scientific English. Look at these active sentences and try to undestand how each type is changed into the passive. Note that a past participle is used in all the types." Then the passive version of each sentence in turn was written on the blackboard slowly and carefully. All the sentences and their solutions were left on the blackboard until the end of the practice period in order to give the subjects the opportunity to compare the two versions of each sentence and to observe the changes in the form of the verb in each type.

B. Principle Learning:

Using the active sentences as examples, the subjects were given the following instructions: "The passive is very common in scientific English. Look at these different types of active sentences. Each type has a different passive form. If the sentence is in the present simple (heat), we use a form of the verb 'to be' in the present, i.e. 'is' or 'are' depending on whether the preceding noun is in the singular or plural form. If the sentence is in the past (heated), we use a form of the verb 'to be' in the past, i.e. 'was' or 'were' depending on whether the preceding noun is in the singular or plural form. If the sentence contains a modal, i.e. 'may', 'can', 'should', 'must', etc., then the same modal is used followed by the infinitive of the verb 'to be' which is 'be'. If the sentence is in the present perfect (has/have heated), then 'has' or 'have' is used, depending on whether the preceding noun is in the singular or plural form, and is then followed by the past participle of the verb 'to be', i.e. 'been'. Note that a past participle is used in all the types." Both versions of the sentences were left on the blackboard until the end of the practice period in order to give the subjects the opportunity to observe how the principle for solving the tasks was applied.

iv. Post-test:

The three groups were given twelve sentences to change to the passive (see Appendix 14) and were allowed 18 minutes to find the solutions for all the sentences. The two experimental groups were told to try and apply the knowledge they had gained during the practice period. The sentences given in this test were comparable

in difficulty to those given in the pre-test in the sense that in both tests there were four sentences in the present simple tense, three in the past tense, two in the present perfect tense, and three contained modals. The two tests also contained a similar proportion of sentences dealing with singular and plural nouns.

v. Re-test:

This was conducted 28 days later. Each group was given twelve tasks to solve (See Appendix 15); four practised tasks (sentences 5, 6, 11, and 12), four tested tasks (sentences 1, 2, 7, and 8,), and four new tasks (sentences 3, 4, 9, and 10). They were allowed 18 minutes to solve all the tasks. At the end of the test all the subjects were asked to reconstruct the principle they had used to solve the tasks by completing the following formulae:

Active		Passive
heat	→	_ _ _ _ _ _ _ _ _
heated	→	_ _ _ _ _ _ _ _ _
may/can/should heat	→	_ _ _ _ _ _ _ _ _
has/have heated	→	_ _ _ _ _ _ _ _ _

5.4.0 Results and Comments:

In an experimental set up of the type described above, the statistical analysis should go beyond examining the performance of the three groups in each test separately. Since there were three testing sessions, the difference between the experimental groups ought to be examined in relation to their results in the three tests collectively. In other words, to test the effect of each learning method (treatment) we have to look at the

differences in performance of the three groups across the repeated measures. In statistical terms, this means conducting what is known as "Repeated Measures Analysis of Variance". Furthermore, our analysis should not only demonstrate whether there are differences between the groups over the repeated measures, but should also determine whether these differences are conditional on group or sex. And since time was one of the major variables which affected the groups' performances, in the sense that they had to solve the tasks in a given time, our analysis should also consider the correlation between performance and the time variable. That is to say, we have to see which treatment resulted in the least time being required to solve the same number of tasks. This is particularly important since school learning is often dominated by the time variable in the form of the length of each period, the number of periods allotted to each subject per week, and the length of each term in the academic year. The following section discusses the results of the two types of experiments (i.e. the match tasks and the language tasks) separately and in relation to the issues mentioned above. It should be indicated at this stage that in the analysis of variance, differences between the groups greater than the 0.05 level of significance were not considered significant.

5.4.1 The Match Tasks Tests:

Before studying the results of the repeated measures analysis, we have to look at the performance of each group in each test separately. This would allow us to compare their performance in dealing with each task, and accordingly, to adopt a scoring system which corresponds realistically to the difficulty of the

individual tasks. The following tables show the performance of the three groups in the three tests with regard to the percentages of correct solutions and means for the time taken (in seconds) to solve each task. For comparison purposes, the tasks have been matched in Table 7 and 8 according to the correlation of difficulty discussed earlier in this chapter. The tasks in Table 9 have been listed according to their status of being tested, practised, or new tasks in this order. For the tasks numbers, refer to Figure 7.

Table 7: Percentages and Means of Time (in seconds) for the Match Tasks Pre-test.

Task No	Guided Discovery (N=49)		Principle Learning (N=58)		Control (N=61)	
	%	M.Time	%	M.Time	%	M.Time
9	10.2	90.6	10.3	86.5	9.8	92.6
7	63.3	60.9	56.9	84.9	59.0	85.3
6	16.3	119.4	19.0	107.0	14.8	118.3
11	4.1	138.5	3.4	142.5	3.3	143.0
4	65.3	29.1	70.7	40.5	72.1	58.7
5	14.3	85.8	15.5	83.1	13.1	92.4

Table 8: Percentages and Means of Time (in seconds) for the Match Tasks Post-test.

Task No	Guided Discovery (N=49)		Principle Learning (N=58)		Control (N=61)	
	%	M.Time	%	M.Time	%	M.Time
10	46.9	65.0	62.1	62.3	21.3	111.6
3	73.5	27.8	93.1	23.7	52.5	49.0
13	63.3	62.0	77.6	50.4	39.3	94.1
2	14.3	89.4	50.0	88.4	9.8	99.1
15	83.7	27.6	93.1	20.1	73.8	34.2
12	28.6	72.3	31.0	69.3	6.6	131.7

Table 9: Percentages and Means of Time (in seconds) for the Match Tasks Re-test.

Task No	Guided Discovery (N=46)		Principle Learning (N=53)		Control (N=54)	
	%	M.Time	%	M.Time	%	M.Time
10	54.3	85.2	73.6	52.5	35.2	78.8
7	87.0	22.1	100.0	21.1	79.6	34.9
8	65.2	59.7	88.7	41.6	31.5	82.2
1	21.7	63.8	37.7	59.1	14.8	104.2
14	54.3.	78.3	81.1	67.4	38.9	77.1
16	32.6	92.6	37.7	82.9	9.3	124.2

Looking at the percentages of each group in the pre-test (Table

7), the first observation one can make is that the three groups may be assumed to be comparable both in ability to solve the tasks and the means for the time taken to solve each of them. This means that whatever gains the post-test results may reveal should be considered as indicative of the effect of the learning method applied in the practice period in the case of the two experimental groups since the experimental conditions, as discussed earlier, were identical.

The first comparison to be made here is between the results in Table 7 and those in Table 8. The figures in the two tables reveal an improvement in the performance of the three groups in the post-test from that in the pre-test. The improvement in the case of the Control group, however, is not as high as it is in the two experimental groups and could, therefore, be attributed to the increased familiarity with the nature of the test items. The comparison between the results of the two experimental groups in Table 8 also indicate that the performance of the Principle Learning group is better than that of the Guided Discovery Group, and that the means for the time are lower. This is also true with regard to the re-test as shown in Table 9. The figures in the three tables also indicate that there is a marked difference in difficulty between the tasks. Consequently, the results were computed using two scoring systems to reflect those differences. One system, ranging from 0 (i.e. no tasks solved) to 17 (i.e. all tasks solved correctly), was used for both the pre-test and the post-test and was related to the difficulty of the tasks. Given the structure of the tasks and their correlation as discussed earlier in this chapter, and in the light of the results shown in Tables 7 and 8, Tasks 3, 4, 7, and 15 were

considered to be the easiest and were therefore allocated 2 points each. Tasks 5, 6, 9, 10, 12, and 13 were considered more difficult tasks and were therefore allocated 3 points each. Tasks 2 and 11, being the most difficult ones since the solution requires the movement of two sides only, were allocated 4 points each.

The other system, ranging from 0 to 18, was used for the re-test only and corresponded to the subjects' degree of familiarity with the tasks, allocating the lowest points to the tested tasks, as the most familiar ones, followed by the practised tasks, and finally the new tasks. This meant that Tasks 7 and 10 were allocated 2 points each, Tasks 1 and 8 were allocated 3 points each, and Tasks 14 and 16 were allocated 4 points each.

Just as was indicated by the percentages in Table 7 above, the computed scores of the three groups using the new scoring systems, as illustrated below, also show no significant difference in the means between the three groups in the pre-test and they may, therefore, be assumed to be comparable.

Table 10: Means and S.D.s for the Match Tasks Scores.

Groups	Pre-test Max.score 17		Post-test Max.score 17		Re-test Max.score 18	
	M	S.D.	M	S.D.	M	S.D.
Guided Discovery (N=46)	3.91	3.12	7.85	3.87	8.91	3.70
Principle Learning (N=53)	4.13	2.89	10.70	3.46	12.02	4.04
Control (N=54)	3.98	3.01	4.94	3.69	5.61	3.95

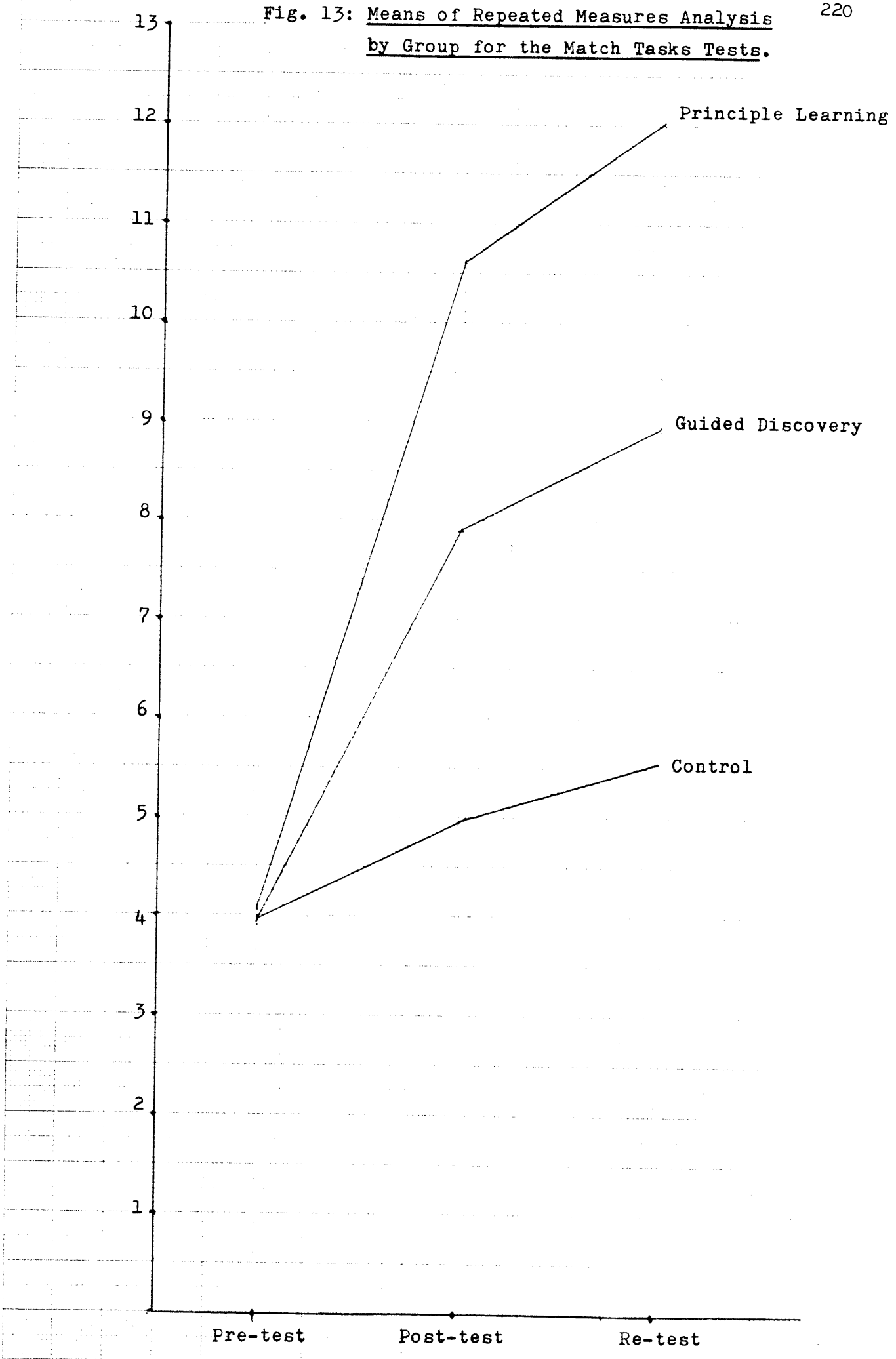
The table also reveals a difference between the three groups with regard to the post-test and the re-test. The results of the repeated measures analysis of variance based on the mean scores shown in Table 10 above indicate, as illustrated in the following table, that this difference is highly significant, with a value of $F= 26.52$, $p < 0.001$, and therefore the null hypothesis, which assumes that the results of the groups tested are equal, is rejected.

Table 11: Repeated Measures ANOVA for the Match Tasks Scores.

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob.
Tests Score	1965.80	2	982.90	171.19	0.0
Score X Sex Interact.	4.64	2	3.32	0.40	0.6678
Score X Group Interact.	608.98	4	152.25	26.52	0.0
Score X Sex X Group Interact.	26.55	4	6.64	1.16	0.3303

The plotting of the means of each group given in Table 10 above reveals that the two experimental groups show significant gains in the post-test which is retained in a varying degree in the re-test (see Figure 13 below). However, although the scores of both the Principle Learning group and the Guided Discovery group seem to rise systematically in the post-test, the scores of the Principle Learning group are significantly higher than that of the Guided Discovery group in both tests. The t tests comparing the means of these two groups reveal a value of $t=4.22, p < 0.001$ in the post-test, and $t=3.87, p < 0.001$ in the re-test. The scores of the Control group also rise slightly in both tests but this rise may be attributed to practice and increased familiarity with the testing items.

Fig. 13: Means of Repeated Measures Analysis by Group for the Match Tasks Tests.



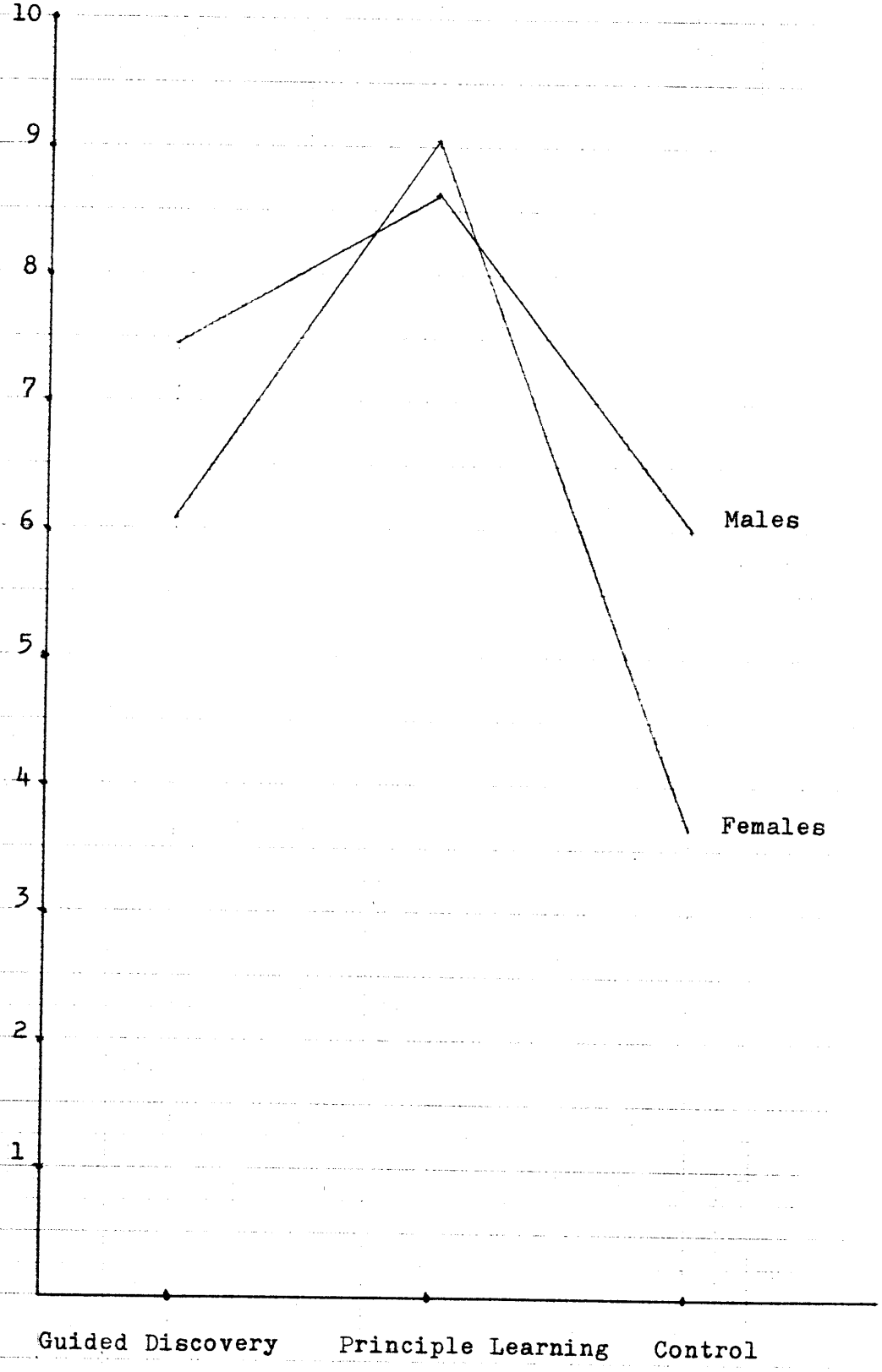
One important result which we should study with regard to these tests is the difference between the two sexes within each group and across the three groups. This can be illustrated by showing a breakdown of means for each sex in the three groups as given in the following table:

Table 12: Means by Sex by Group for the Match Tasks Scores.

Testing Session	Males			Females		
	G.D	P.L.	C	G.D.	P.L.	C
Pre-test	4.58	3.95	4.60	3.05	4.26	3.45
Post-test	8.38	10.82	6.24	7.15	10.61	3.83
Re-test	9.35	11.45	7.16	8.35	12.42	4.27
Marginal	7.44	8.74	6.00	6.18	9.10	3.85

The plotting of the overall mean for each sex in the three groups, represented by the marginal figures in the table above, shows that there are significant sex differences irrespective of group, with a value of $F=4.40$, $p<0.03$. The analysis indicates that the males in the Guided Discovery group and the Control group seem to do better than the females, whereas in the Principle Learning group there does not seem to be any significant difference. This relationship is illustrated in Figure 14 below.

Fig. 14: Sex by Group Interaction for the Match Tasks Tests.



Another comparison which should be made in these tests concerns the difference in time taken by each group to solve the tasks in each testing session. The analysis of the time scores indicates that the Principle Learning group required less time than the other two groups to solve the tasks. The following table shows the differences in means (in seconds) and standard deviations between the three groups.

Table 13: Means and S.D.s of Time Scores (in seconds) for the Match Tasks Tests.

Groups	Pre-test		Post-test		Re-test	
	M	S.D.	M	S.D.	M	S.D.
Guided Discovery	871.94	142.42	668.28	204.24	703.80	170.43
	(N= 49)				(N= 46)	
Principle Learning	887.46	122.58	531.93	139.02	580.94	186.68
	(N= 58)				(N= 53)	
Control	906.20	130.18	844.24	174.20	841.68	179.92
	(N= 61)				(N= 54)	

The last aspect we have to look at in this context is the subjects' recognition of the principle they were exposed to in different manners in the case of the experimental groups, and their ability to reproduce it verbally in one form or another. The results obtained from the data show that in the Guided Discovery group 3.8% of the males and 15% of the females could

reproduce the underlying principle, giving an average of 9.4% for the whole group. In the Principle Learning group 72.7% of the males and 60% of the females could reproduce the principle, giving an average of 66.3% for the whole group. In the case of the Control group 16% of the males and 3.4% of the females could reproduce the principle, giving an average of 9.7% for the whole group. These results show that there is no dominance by any single sex across the three groups. They also show that the Principle Learning group was more capable of reproducing the principle they used to solve the tasks, but this is quite expected since that principle was explicitly taught to this group. However, given our earlier findings that the performance of this group was in fact significantly better than the other two groups, one cannot help feeling that the verbal knowledge of the principle helped in achieving that result and in less time as has been suggested above. These results also show that the ability to recognise or discover the principle was similar between the Guided Discovery group and the Control group, although the latter was not exposed to that principle as was the former group. This may suggest that familiarity with the data may lead to a similar level of recognition of the principle similar to that of implicit exposure but not its application, since the analysis shows that the scores of the Guided Discovery group are in fact higher than those of the Control group in both the post-test and the re-test.

Finally, another interesting observation is that the examination of the answer sheets of the three groups revealed that subjects in the Principle Learning group produced more varying solutions for the same task than the other two groups whenever there were

more than one solution for that task. This suggests that these subjects have developed an understanding of the structural qualities of such tasks and the components of the principle, and have consequently achieved a degree of flexibility in applying the principle.

5.4.2 The Language (Discourse) Tests:

As was mentioned in the case of the match tasks, we need first to look at the performance of each group in the three tests in order to adopt a realistic scoring system which is based on the difficulty of each task. Tables 14, 15, and 16 below show that performance in percentages and the means for the time taken (in seconds) for solving all the tasks collectively. For comparison purposes, the tasks in Tables 14 and 15 have been matched according to the structural correlation discussed earlier and illustrated in Figure 12. The tasks in Table 16, on the other hand, have been ordered according to their status of being tested tasks (Tasks 1 and 5), practised (Tasks 3 and 4), or new (Tasks 2 and 6). For the tasks numbers, reference should be made to Appendices 10, 11, and 12.

Table 14: Percentages and Means of Time (in seconds) for the Language (Discourse) Pre-test.

Task No	Guided Discovery (N=50)		Principle Learning (N=62)		Control (N=65)	
	%	M.Time	%	M.Time	%	M.Time
1	34.0	1059.7	21.0	1080.0	18.5	1066.8
4	24.0		21.0		23.1	
2	30.0		12.9		12.3	
3	18.0		14.5		18.5	
5	6.0		4.8		7.7	
6	2.0		3.2		1.5	

Table 15: Percentages and Means of Time (in seconds) for the Language (Discourse) Post-test.

Task No	Guided Discovery (N=50)		Principle Learning (N=62)		Control (N=65)	
	%	M.Time	%	M.Time	%	M.Time
4	48.0	1034.6	54.8	972.8	21.5	1015.3
1	40.0		62.9		29.2	
3	26.0		38.7		9.2	
2	36.0		37.1		10.8	
5	24.0		41.9		18.5	
6	2.0		8.1		1.5	

Table 16: Percentages and Means of Time (in seconds) for the Language (Discourse) Re-test.

Task No	Guided Discovery (N=43)		Principle Learning (N=61)		Control (N=61)	
	%	M.Time	%	M.Time	%	M.Time
1	25.6		63.9		26.2	
5	23.2		52.5		16.4	
3	30.2	955.5	44.3	930.4	14.8	977.3
4	2.3		8.2		0.0	
2	20.9		50.8		14.8	
6	32.6		32.8		18.0	

A few observations can be made here. First, that except for the results of Tasks 1 and 2 in the case of the Guided Discovery group, the percentages of the pre-test (Table 14) are on the whole similar, which suggests that the groups may be assumed to be comparable. This also applies to the means for the time taken to solve the tasks collectively. The other observation is that the three groups did badly in Tasks 5 and 6 in the pre-test and Task 6 in the post-test. This should not, however, be interpreted as a reflection of the difficulty of these tasks, but rather as a result of lack of time which was verified by examining the answer sheets. This is because although all the six tasks were presented on one sheet, the subjects were told to try and solve them in turn. On the other hand, the sudden drop in the performance of the three groups in solving Task 4 in the re-test (Table 16) can only have one explanation and that it is due to content difficulty.

Overall, the Principle Learning group again seems to do better than the other two groups in both the post-test and the re-test, and require less time to solve the tasks. The figures show that although the performance of the Guided Discovery group improved in the transfer test (i.e. the post-test), its performance dropped in the retention test (i.e. the re-test). This was not the case with the Principle Learning group. The control group maintained a somewhat low result throughout the three tests.

Given these results and the structural differences between the tasks which was discussed earlier in this chapter, two new scoring systems were used in the computation of the scores of each group. One system, ranging from 0-18, was used for both the pre-test and the post-test and reflected the difference in structural difficulty as illustrated in Figure 13 above. Accordingly, Tasks 1 and 4 in both tests were considered as the easiest tasks and were therefore allocated 2 points each. Tasks 2 and 3 were considered more difficult and were allocated 3 points each. And since, as mentioned above, few subjects managed to solve Tasks 5 and 6 in the pre-test and even in the post-test, allowing for the effect of the practice period, these two tasks were allocated 4 points each in both tests.

The other system, ranging from 0-18, was used for the re-test and corresponded to the subjects' familiarity with the tasks. Consequently, Tasks 1 and 5 (tested tasks) were allocated 2 points each as being the most familiar ones, followed by Tasks 3 and 4 (practised tasks) which were allocated 3 points each, and finally Tasks 2 and 6 (new tasks) which were allocated 4 points

each. The scores of the three groups after applying the new scoring systems were as follows:

Table 17: Means and S.D.s for the Language (Discourse) Scores.

Groups	Pre-test Max.score 18		Post-test Max.score 18		Re-test Max.score 18	
	M	S.D.	M	S.D.	M	S.D.
Guided Discovery (N=43)	3.02	3.14	4.88	3.66	4.09	4.56
Principle Learning (N=61)	2.02	2.79	6.57	4.29	7.25	5.48
Control (N=61)	2.18	2.91	2.39	3.08	2.61	3.76

The table shows that the scores are comparable in the pre-test but significantly different in the post-test and the re-test. The results of the repeated measures analysis of variance given below indicate that the difference is highly significant, with a value of $F=26.23$, $p<0.001$, and therefore the null hypothesis is rejected.

Table 18: Repeated Measures ANOVA for the Language (Discourse) Scores.

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob.
Tests Score	508.36	2	254.18	56.50	0.0
Score X Sex Interact.	23.15	2	11.57	2.57	0.0779
Score X Group Interact.	472.00	4	118.00	26.23	0.0
Score X Sex X Group Interact.	24.13	4	6.03	1.34	0.2546

The plotting of the means of each group given in Table 17 above shows that the scores of the Principle Learning group are significantly higher than the other two groups in both the post-test and the re-test (see Figure 15). It also indicates that although the scores of the Principle Learning group and the Guided Discovery group show a significant improvement in the post-test, the latter group does not maintain that improvement in the re-test. Tests of t comparing the means for these two groups reveal a value of $t=2.81$, $p < 0.01$ for the post-test, and $t=3.40$, $p < 0.001$ for the re-test. Meanwhile, the scores of the Control group stay constant.

The breakdown of the means by sex for each group, represented by the marginal figures in Table 19 below, indicates that although there are significant differences in the performance of males and females between the three groups, the performance within each group is similar. Figure 16 illustrates this relationship.

Fig. 15: Means of Repeated Measures Analysis by Group for the Language (Discourse) Tests.

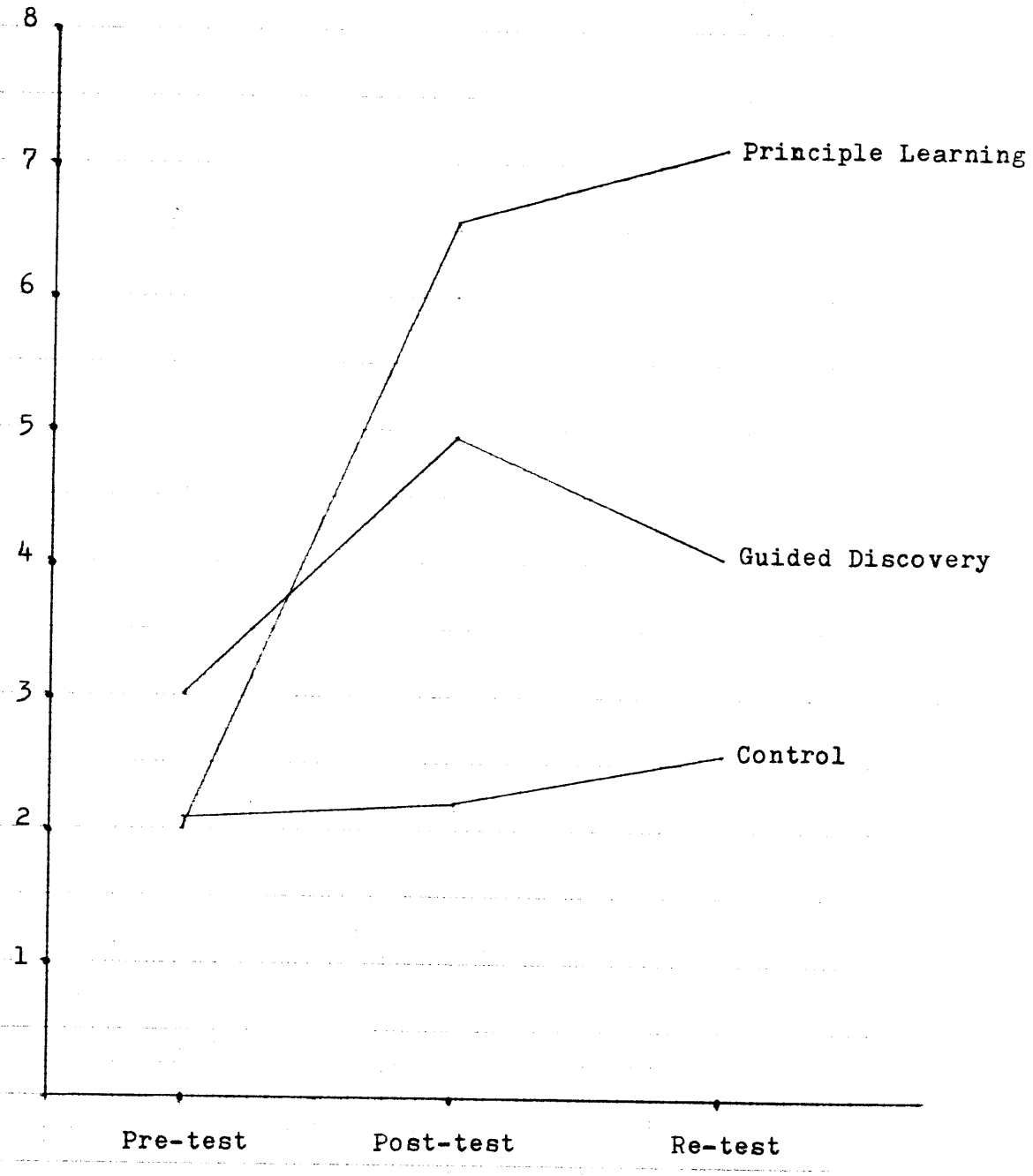


Fig. 16: Sex by Group Interaction for the Language (Discourse) Tests.

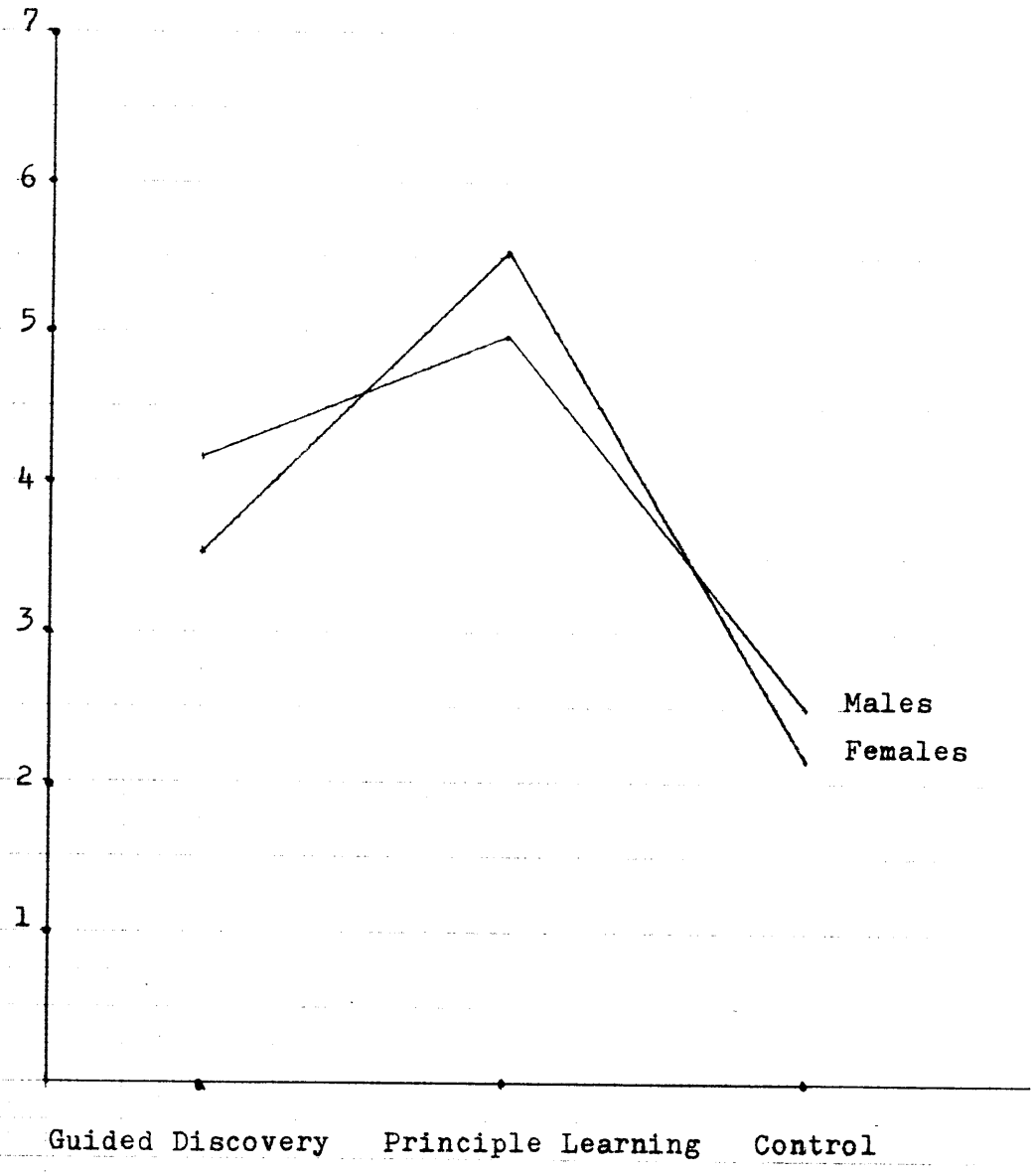


Table 19: Means by Sex by Group for the Language (Discourse) Scores.

Testing Session	Males			Females		
	G.D	P.L.	C	G.D.	P.L.	C
Pre-test	2.87	1.92	2.31	3.20	2.09	2.08
Post-test	5.26	5.81	2.19	4.45	7.18	2.54
Re-test	4.96	7.04	3.00	3.10	7.41	2.31
Marginal	4.36	4.92	2.50	3.58	5.56	2.31

The comparison between the three groups with regard to the time taken (in seconds) to solve the tasks in the three tests (Table 20 below) shows that the scores of the Principle Learning group are the lowest in the post-test and the re-test. However, the difference between the mean for this group and that for the Guided Discovery group in the re-test is not very high (just over 25 seconds).

Table 20: Means and S.D.s of Time Scores (in seconds) for the Language (Discourse) Tests.

Groups	Pre-test		Post-test		Re-test	
	M	S.D.	M	S.D.	M	S.D.
Guided Discovery	1059.74	78.59	1034.62	68.21	955.49	122.96
	(N= 50)				(N= 43)	
Principle Learning	1080.00	0.0	972.82	143.10	930.39	160.40
	(N= 62)				(N= 61)	
Control	1066.78	40.32	1015.35	76.49	977.28	108.64
	(N= 65)				(N= 61)	

Finally, the results for the subjects' ability to recognise and reproduce the principle they were exposed to were as follows: 43.5% for males and 60% for females (an overall average of 51.7%) in the Guided Discovery group, 66.6% for males and 82.3% for females (an overall average of 74.4%) in the Principle Learning group, and 40.7% for males and 31.4% for females (an overall average of 36%) in the Control group. These results show that in this case the females are more capable of reproducing a principle they have been taught in one or another manner. The result of the Control group cannot be taken into account since this group was not exposed to any principle in any manner.

5.4.3 The Language (Grammar) Tests:

Tables 21, 22, and 23 below show the performance of the three groups in the three tests in percentages and means for time (in seconds). The tasks in Tables 21 and 22 have been ordered and matched according to the type of tenses they deal with. That is to say, the first four tasks in both tables are in the present simple tense, followed by two tasks in the present perfect, followed by three tasks in the past simple, and finally three tasks containing modal verbs. In Table 23 the tasks have been ordered according to their status of being tested (Tasks 1,2,7, and 8), practised (Tasks 5, 6, 11, and 12), or new (Tasks 3, 4, 9, and 10). The tasks numbers in Tables 21, 22, and 23 refer to the sentences as they appear in Appendices 13, 14, and 15 respectively.

Table 21: Percentages and Means of Time (in seconds) for the Language (Grammar) Pre-test.

Task No	Guided Discovery (N=50)		Principle Learning (N=62)		Control (N=65)	
	%	M.Time	%	M.Time	%	M.Time
1	38.0		30.6		26.2	
2	46.0		25.8		26.2	
10	38.0		25.8		32.3	
7	38.0		30.6		30.8	
4	4.0		3.2		6.2	
9	16.0	487.6	11.3	479.4	13.8	491.3
6	46.0		41.9		44.6	
11	44.0		37.1		50.8	
12	40.0		35.5		41.5	
3	4.0		3.2		4.6	
5	8.0		1.6		13.8	
8	4.0		3.2		6.2	

Table 22: Percentages and Means of Time (in seconds) for the Language (Grammar) Post-test.

Task No	Guided Discovery (N=50)		Principle Learning (N=62)		Control (N=65)	
	%	M.Time	%	M.Time	%	M.Time
1	86.0		90.3		66.2	
12	78.0		67.7		52.3	
2	28.0		59.7		41.5	
8	68.0		82.3		53.8	
6	16.0		29.0		12.3	
10	14.0	363.5	38.7	344.1	21.5	376.8
5	16.0		41.9		24.6	
11	42.0		51.6		52.3	
9	46.0		45.2		49.2	
3	10.0		29.0		9.2	
4	40.0		54.8		13.8	
7	30.0		45.2		13.8	

Table 23: Percentages and Means of Time (in seconds) for the Language (Grammar) Re-test.

Task No	Guided Discovery (N=43)		Principle Learning (N=61)		Control (N=61)	
	%	M.Time	%	M.Time	%	M.Time
1	53.5		72.1		67.2	
2	41.9		67.2		45.9	
7	39.5		49.2		16.4	
8	7.0		23.0		16.4	
5	44.2		44.3		24.6	
6	39.5	343.3	68.9	305.0	47.5	353.1
11	48.8		86.9		47.5	
12	7.0		47.5		11.5	
3	2.3		27.9		9.8	
4	25.6		47.5		36.1	
9	9.3		23.0		8.2	
10	58.1		88.5		62.3	

The figures for the pre-test (Table 21) indicate that except in two or three cases, the results of three groups are on the whole similar, which suggests that they may be considered comparable. This is also true with regard to the time taken to solve the tasks. The other observation is that all the three groups did badly in dealing with the present perfect sentences and those containing modal verbs, and although the two experimental groups improved their results in dealing with the modal sentences after the practice period, their results in dealing with the present

perfect sentences remained remarkably low (see Table 22). This suggests that this type of sentences represents an area of difficulty for these learners. The other interesting observation is that although the past tense sentences proved to be the easiest in the pre-test, the practice period did not seem to have much effect on the results of the post-test in this case as it did in the case of the present simple sentences. In fact the results deteriorated in certain cases.

Based on these results, two scoring systems were used to compute the scores of each group in the three tests. One system, with a range of 0-17 was used for the pre-test and the post-test results and was related to the difficulty of the tasks as revealed by the percentages in the pre-test. According to this system, all the sentences in the present simple and the past simple in the pre-test (Tasks 1, 2, 7, 10, 6, 11, and 12) were allocated one point each. The sentences in the present perfect (Tasks 4 and 9) and those containing a modal (Tasks 3, 5, and 8) were allocated two points each. The same criterion was used in scoring the corresponding tasks in the post-test, and therefore Tasks 1, 2, 8, 12, 5, 9, and 11 were allocated one point each, and Tasks 6, 10, 3, 4, and 7 were allocated two points each.

The other system, with a range of 0-18, was applied on the results of the re-test and was related, as in the case of the previous two types of tasks, to the degree of familiarity with the tasks. Accordingly, Tasks 1, 2, 7, and 8 (tested tasks) were allocated one point each, Tasks 5, 6, 11, 12 (practised tasks) were allocated 1.5 points each, and Tasks 3, 4, 9, and 10 (new tasks) were allocated 2 points each. The following table shows

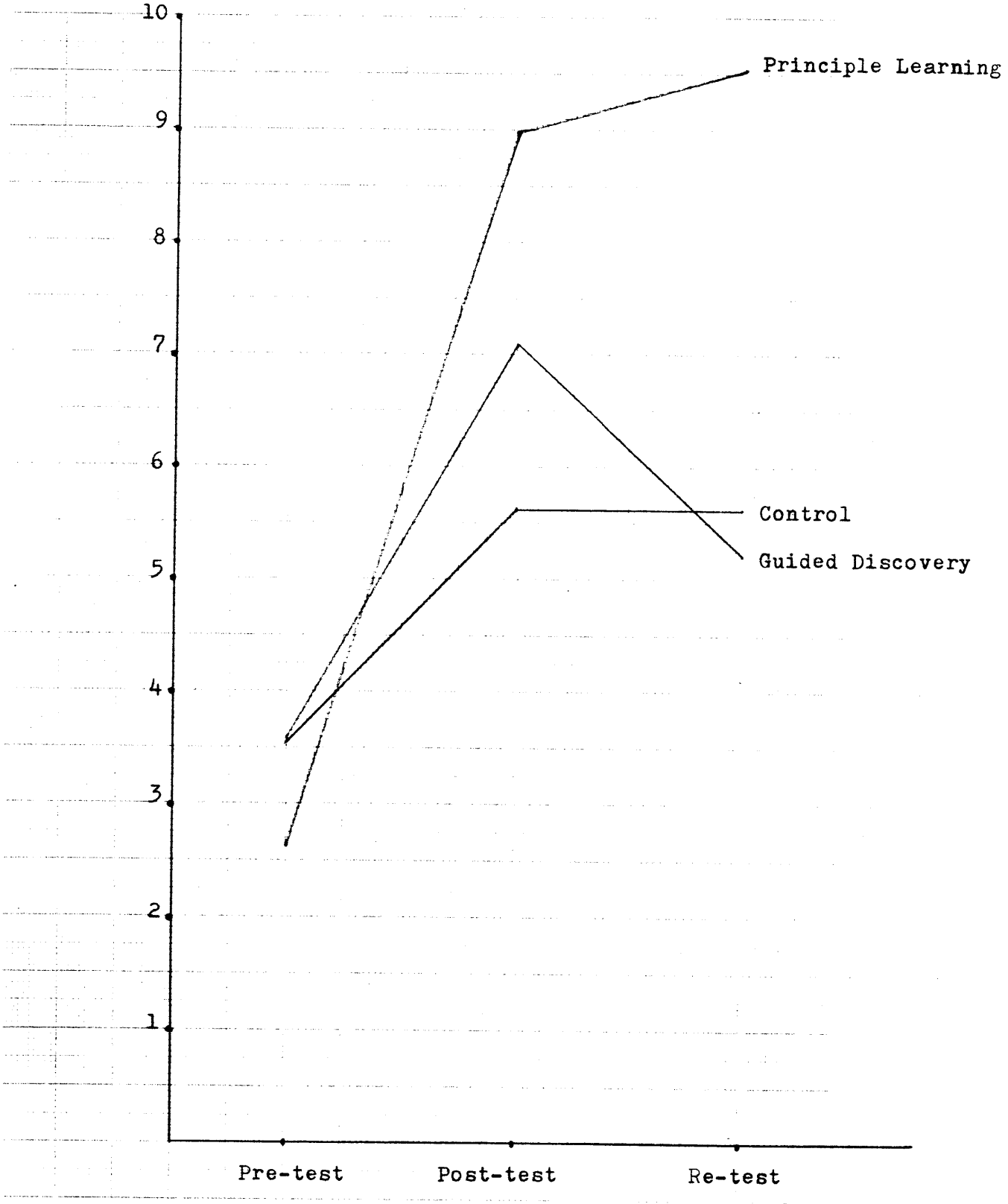
the results after the application of these scoring systems:

Table 24: Means and S.D.s for the Language (Grammar) Scores.

Group	Pre-test Max.score 17		Post-test Max.score 17		Re-test Max.score 18	
	M	S.D.	M	S.D.	M	S.D.
Guided Discovery (N=43)	3.67	3.40	7.16	3.92	5.42	3.88
Principle Learning (N=61)	2.77	3.13	8.97	4.51	9.56	4.24
Control (N=61)	3.57	3.67	5.74	4.43	5.75	4.17

These figures show a significant improvement in the performance of the two experimental groups in the post-test. This, surprisingly, also applies to the Control group which received no training in between. The results, however, show that only the Principle Learning group maintained that improvement in the re-test, as illustrated in Figure 17 below. This indicates that although the Guided Discovery learning condition resulted in a significant gain in transfer with a rise in mean from 3.67 in the pre-test to 7.16 in the post-test, it was not effective in the retention of what was learned as the mean dropped to 5.42 in the re-test.

Fig. 17: Means of Repeated Measures Analysis by Group for the Language (Grammar) Tests.



An interesting observation here is that although the scores of the Control group in the post-test were not as high as those of the two experimental groups, the gain of this group was, nevertheless, much higher in this type of task than in the other two, i.e. the Match tasks and the Language (Discourse) tasks. This may suggest that repeated exposure to test items of this type, i.e. grammatical language tasks, may lead to some degree of attainment and self-correction greater than that in the case of the other two types even when no training or guidance is offered. This, however, seems to happen only when exposure to the test items is conducted at short intervals, as the score of the Control group did not improve in the re-test conducted 28 days later despite the fact that one third of the tasks were included in the previous two tests.

The repeated measures analysis of variance for the three groups indicates a significant difference in performance, with an F value of 26.63, $p < 0.001$, as shown in the following table, and therefore the null hypothesis is rejected.

Table 25: Repeated Measures ANOVA for the Language (Grammar) Scores.

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob.
Test Score	1514.61	2	757.30	166.32	0.0
Score X Sex Interact.	22.18	2	11.09	2.44	0.0892
Score X Group Interact.	484.96	4	121.24	26.63	0.0
Score X Sex X Group Interact.	28.63	4	7.16	1.57	0.1815

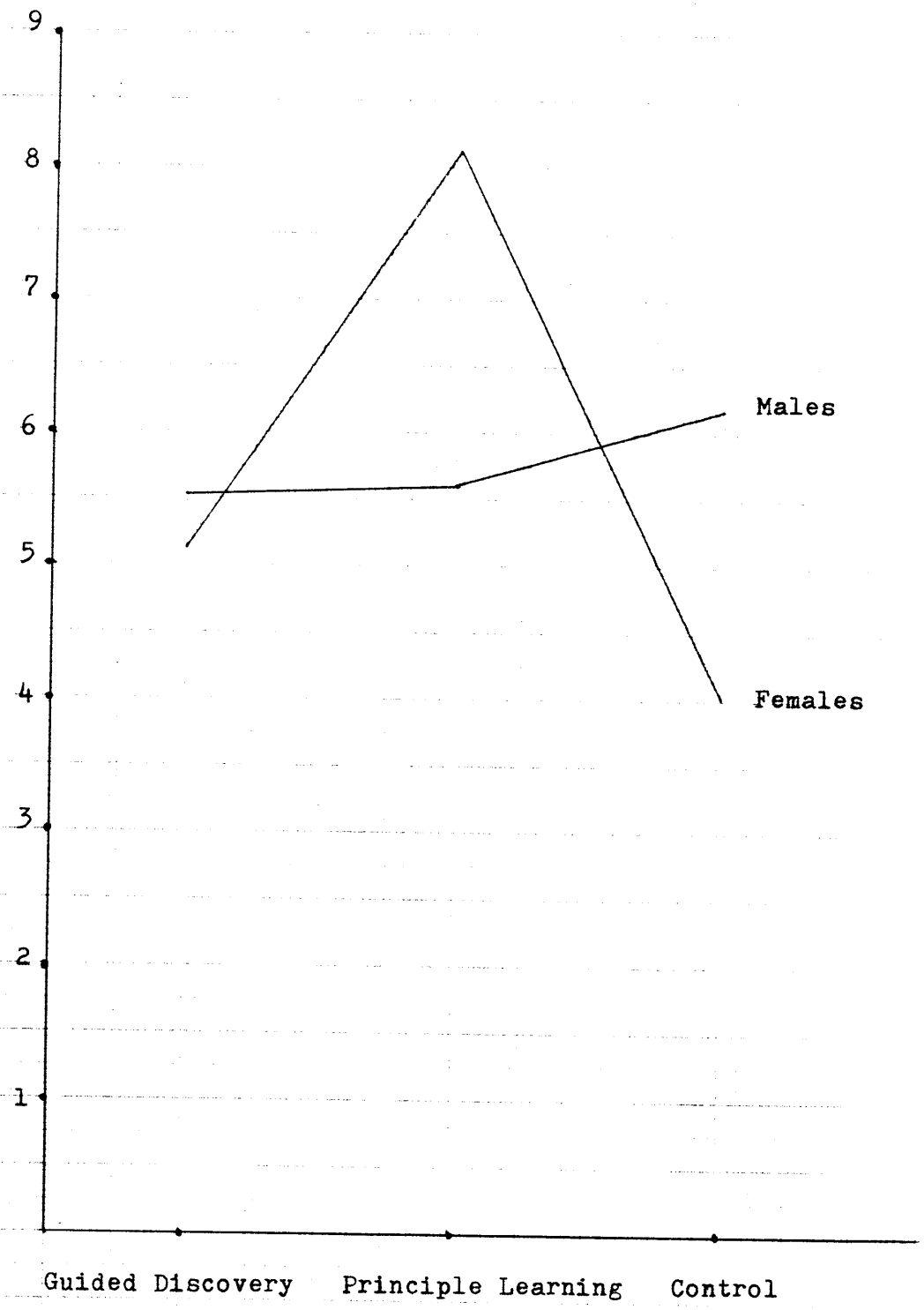
The analysis of variance for the three groups shows a significant sex group interaction, with a value of $F = 6.88$, $p < 0.001$, implying that sex differences are conditional on group, and group differences are conditional on sex. This interaction means that the comparison between the groups has to be made in relation to each sex. The following table shows the breakdown of means by sex for the three groups:

Table 26: Means by Sex by Group for the Language (Grammar) Scores.

Testing Session	Males			Females		
	G.D.	P.L.	C	G.D.	P.L.	C
Pre-test	4.17	1.67	4.77	3.10	3.65	2.68
Post-test	7.30	7.96	7.08	7.00	9.76	4.74
Re-test	5.17	7.48	7.21	5.70	11.22	4.67
Marginal	5.55	5.70	6.35	5.27	8.21	4.03

Figure 18 below, showing the plotting of the overall means of each sex as represented by the marginal figures in Table 26 above, indicates that the differences between the three groups is highly significant in the case of females, but insignificant in the case of males. There are no sex differences in the Guided Discovery group, whereas the females' scores are significantly higher than the males in the Principle Learning group. In the Control group the

Fig. 18: Sex by Group Interaction for the Language (Grammar) Tests.



males' score are significantly higher. As for the comparison between the two experimental groups, i.e. the Guided Discovery and the Principle Learning, the analysis yields a value of $t=0.716$, $p > 0.05$ in the case of males, and $t=2.91$, $p < 0.01$ in the case of females in the post-test. In the re-test, the values are $t=1.67$, $p < 0.1$ in the case of males, and $t=5.85$, $p < 0.001$ in the case of females. These results indicate that the difference between the two groups is significant only in the case of females. The analysis of the time taken by each group to solve the tasks resulted in the following means and standard deviations:

Table 27: Means and S.D.s of Time Scores (in seconds) for the Language (Grammar) Tests.

Groups	Pre-test		Post-test		Re-test	
	M	S.D.	M	S.D.	M	S.D.
Guided Discovery	487.62	145.30	363.52	93.06	343.30	99.34
	(N= 50)				(N= 43)	
Principle Learning	479.43	212.60	344.11	132.75	305.05	109.63
	(N= 62)				(N= 61)	
Control	491.31	148.13	376.80	132.16	353.11	95.72
	(N= 65)				(N= 61)	

These results show that although the three groups were comparable with regard to the time taken to solve the tasks in the pre-test, in the post-test and the re-test the Principle Learning group, once again, required less time to solve the tasks, suggesting that explicit knowledge of the principle speeded up the finding of the solutions to the tasks. Another relevant observation in this respect is the fact that the three groups required significantly less time to solve the grammatical tasks than the other two types of tasks. This can evidently be attributed to the type of solution required in the case of these tasks, and which was in the form of filling in a space with two or three words.

Finally, the grammar tasks differ from the other two types of tasks with regard to the question of recognition of the principle for solving the given tasks. This is because the principle in this case consists of a sub-set of four principles, since the sentences deal with four tenses. Consequently, the results of the recognition of the four principles have to be presented separately. The following table shows the results of the three groups by sex:

Table 28: Percentages for Principle Recognition for the Language (Grammar) Taks.

Type of Principle	Guided Discovery			Principle Learning			Control		
	M	F	O	M	F	O	M	F	O
The Present Simple	52.2	75.0	63.6	66.7	97.0	81.8	57.7	68.6	63.1
The Past Simple	52.2	75.0	63.6	63.0	97.0	80.0	57.7	60.0	58.8
The Present Perfect	39.1	40.0	39.5	37.0	58.8	47.9	57.7	14.3	36.0
Modal Sentences	47.8	65.0	56.4	14.8	85.3	50.0	50.0	25.7	37.8

NOTE: M = Males, F = Females, O = Overall

A number of interesting observations can be derived from this table. First, that these results are comparatively higher than those shown in the other two types of tasks. This may suggest some knowledge of the principles involved prior to the tests, and which was perhaps consolidated or confirmed by the tests. Secondly, that the females seem to have more knowledge of these principles in this type of tasks than the males, as the table shows that the females' results are higher in ten out of the twelve cases cited above. The other observation in relation to the recognition and recall of the sub-set of principles is that the results are highest in the case of the present simple sentences, followed by the past simple, then the modal sentences, and finally the present perfect sentences which have the lowest scores. These results are in fact consistent with the performance

of the groups in the three tests as recorded in Tables 21, 22, and 23. In this case there might be some ground to suggest that these results reflect the 'natural order' of difficulty of these types of sentences. The high scores in the case of the Principle Learning group, on the other hand, definitely suggest a strong link between knowledge of the principle and achievement.

5.5 Conclusions:

There appears to be learning effects in the case of the two experimental groups by repeating the tests. The difference between the two groups in the repeated tests demonstrates treatment effects beyond the level of improvement one would expect as a result of familiarity with the test items. The scores of the groups in the three types of tests indicate that, in the case of these learners, problem solving learning based on the explicit teaching of the underlying principle and exemplifying its application seems to lead to a higher level of transfer immediately after the learning session than that of the Guided Discovery, where the learners are helped to discover the principle by exemplifying its application through consecutive steps. Principle Learning also seems to result in a higher level of retention after a period of time (28 days in this case). The results of the three types of tests are consistently in favour of the Principle Learning method. They also indicate that explicit learning of the given principle results in less time being required to find the solution for the given problem than in any other learning condition. This is perhaps because learners in this type of condition know exactly what they are looking for and

therefore need only a short time to familiarize themselves with the structure of the task. There is also some evidence that knowledge of the verbal representation of the given principle may have a significant effect on attainment. In so far as the correlation between the three types of tasks in this study is concerned, the scores suggest that the language (discourse) tasks are more difficult than the other two types, i.e. the match tasks and the language (grammar) tasks. Since in order to solve the discourse tasks the subjects had to be able to read the set of sentences given before they could arrange them in a logical order, one explanation may be that these subjects suffer from some reading difficulty and/or that they are slow readers, and that this may have had some effect on the results. Comprehension problems may be ruled out because the subjects were provided with the Arabic equivalence of the key words, and the sets of sentences dealt with topics familiar to them.

The results on the whole indicate that the subjects' achievement in both types of the language tasks was lower than that in the match tasks. One reason for this difference is perhaps because there was no immediate knowledge of results in dealing with the language tasks, since the subjects could not tell, in this case, whether they had solved the task correctly. Whereas it was always apparent to the learner in the match tasks tests whether he or she had solved the problem correctly by checking the number of the squares created and that there were no extra sides left, this was not possible in arranging the sentences in the classifying texts, or in transforming sentences into the passive. Knowledge of results is considered as an essential behavioural input to successful learning. Garry and Kingsley [1970] point out that

"Studies of knowledge of results, or feedback as it is often called, show it to be the most important variable at the teacher's command for controlling performance and learning, certainly with perceptual motor and verbal learning, and probably conceptual learning." [p.222]. Bruner [1966] also argues that learning depends upon knowledge of results, provided it is given at the right time and place. [p.50-51].

As for the achievement of the two sexes, the results across the three types of tests show that neither sex is uniformly superior, except in the recognition and recall of the grammatical principles where the females seem to be better.

Another interesting outcome from these tests is that the result, which is in favour of the Principle Learning method, is consistent with the findings of the classroom interaction analysis discussed in the previous chapter. Those analysis have indicated a strong tendency towards a teaching/learning method which is based on presenting rules and principles which are then consolidated by repetition or exemplification, and then applied in explaining further data or developing further rules and principles, and providing practice.

Finally, it is imperative to indicate here that the conclusions drawn from the results of these tests are not meant to establish any broad generalisations, but are related specifically to the conditions and procedures applied in the experiments. What the results have proved, however, is that our most fashionable approaches in language teaching may not be as effective as we

would like to believe if they are not in harmony with the established learning strategies of the learner. We, therefore, have to work towards making our pedagogy fit the learner and not the other way round.

CHAPTER SIX

THEORETICAL AND PEDAGOGICAL IMPLICATIONS

6.1 Introduction:

The underlying objective of this study, as was discussed in the earlier chapters, is to suggest certain parameters for modifying current EST materials from a pedagogical point of view. This, however, could not have been achieved without examining the theoretical bases of those materials and assessing their validity and appropriateness to our local learner in an experimental set-up, and in relation to a developed hypothesis. Having achieved that, and with the results of the emperical investigation, our task now is to interpret those results in a set of guidelines on how EST materials have to be presented and taught in the Bahraini context. But first, it is perhaps fitting to provide some theoretical reflection on the implications of the results of the tests discussed in the previous chapter in relation to some recent theories in language teaching and language learning. This chapter, therefore, will contain two sections. The first will be devoted to consideration of some recent views and theories in language teaching in general as applicable to the scope of this study. The second section will deal with the implications of the findings obtained for the production and presentation of EST materials in Bahrain, and an attempt will be made to offer some suggestions and examples on how some current EST materials have to be modified to suit the local learner in the light of the learning strategies discussed in the previous chapters.

6.2 Theoretical Considerations of Some Related Theories in Foreign Language Learning:

It is perhaps clear by now that the wider scope of this study, as far as the teaching and learning of English as a foreign language is concerned, has been the ongoing debate whether foreign languages should be taught in an inductive (i.e. implicit) or a deductive (i.e. explicit) manner. In other words, whether the learners should be presented in the learning session with language data in a way which would enable them to discover the underlying rules or principles of the language, or whether they should be taught those rules and principles overtly which they then apply and practise. The difference between the two approaches is summed up by Seliger [1975] who points out that in the deductive approach "it is assumed that the introduction of the rule at the beginning of the lesson would allow the learner to apply the rule during the practice segment of the lesson rather than spend the time confirming hypotheses", whereas the inductive approach "assumes that the learner absorbs and internalises better when he has discovered the underlying abstraction for himself." [p.1].

The essential point which should be made in this respect is that the effect of and the difference between the two approaches should be considered in the light of the idiosyncratic profile of the learner. The present study has shown that the learning style of the learner is not an independent identity but rather a derivative construct which is greatly influenced by social, educational, and cultural variables. Any observations about language teaching should take into account the effect of those variables on the learning process, and should consequently be

based on the appreciation of the learning strategies prevailing in the learning context. The fact that those learning strategies are usually so deeply rooted has given rise to the belief in educational psychology that a realistic and practical pedagogy should concern itself not with teaching the learners but rather with helping them to learn by structuring the learning situation in a way which facilitates the application of their learning strategies. In this sense "A method of teaching anything should be no more and no less than a reflection of how the learner learns something. The purpose of teaching is really to provide a structured, non-coincidental situation where the strategies that are used by the learner are exploited and focussed on the particular matter to be learned." [Seliger, 1975, p.3].

One perhaps cannot discuss the debate between the explicit rule-learning adherents and those supporting the discovery of those rules by the learner without referring to Krashen's Monitor Model for adult language learning. Krashen [1978] sums up his theory in the following manner:

> "The model of second-language performance, termed the Monitor Model, posits that the adult second - language performer can 'internalize' rules of a target language via one or both of two separate systems: an implicit way, termed subconscious language acquisition, and an explicit way, conscious language learning. Language acquisition is very similar to the process children use in acquiring first and second languages." [p.1].

By definition then, Krashen believes that only an implicit and

subsconscious process (i.e. language acquisition) would result in fluency and communicative ability. This is because conscious learning, according to Krashen, is only effective in altering the performer's output, before or after the production of a certain utterance, to improve accuracy, but "does not initiate utterances or produce fluency." [1978, p.23]. Thus, language learning operates as a Monitor which is conditioned by two factors: time to monitor and a focus on form or correctness. Language acquisition in Krashen's theory, on the other hand, hinges on one major supposition which I would like to reflect on in relation to the learning context in Bahrain. The acquisition of language, as Krashen [1978] puts it,"requires meaningful interaction in the target language -natural communication- in which speakers are not concerned with the form of their utterances but with the messages they are conveying and understanding." [p.1]. In this context, the language structure is internalised subconsciously or, in terms related to this study, by discovery of that structure through exposure. The implication here is that massive exposure is required for that acquisition to take place, something which may only be feasible in a first language context, or that of a second language where the learner has great access to the target language as in the case of foreign students studying in Britain or America. Although learners in Bahrain have adequate exposure to the English language in society, since it is used frequently in many industrial and commercial spheres, that exposure is nowhere near a second language context. It is also questionable whether the type of English which exists outside the classroom, and sometimes even in the classroom, is characteristically appropriate or conducive for language acquisition since it is

produced mainly by non-native speakers.

On a more realistic note, however, the implication of Krashen's notion of language acquisition has to be considered cautiously. If it is true, as Krashen claims, that only language acquisition, which requires a high level of exposure to the target language, produces communicative ability, one wonders whether learners who do not have that type of exposure have any chance at all of achieving such an ability. The number of successful and fluent learners of foreign languages all over the world who have had no direct exposure to the speech community of the languages they have learned compels one to consider Krashen's claim with scepticism. I think it would be more realistic to suggest that first hand exposure to the target language would offer the learner the opportunity to test, modify, and consolidate his communicative ability, and to put to practice what he has previously learned, rather than to claim that ability is totally dependent on that exposure.

Perhaps it would be true to suggest, then, that the discovery (inductive) learning approach in general finds its roots in theories about first language acquisition and the efficacy which such an acquisition produces, since we all succeed in acquiring our first language with maximum efficiency. This position, however, can be attacked, in relation to foreign language learning, on two fronts. First, that theories, techniques, and observations based on first and even second language acquisition are not necessarily transferable to foreign language learning, since there is very little similarity between the two processes. First language acquisition is coupled with concept development as

one aspect of the total psychological development of the individual. Also, acquisition of first language is greatly influenced by strong positive motivational tendencies, since acquiring a first language is a matter of possessing a tool for survival. All this means that the strategies which the individual activates in acquiring his first language will no doubt differ from those he uses in learning a foreign language. In fairness to Krashen, one has to mention that he actually concedes that the results of different tests and research with regard to his model may not hold for foreign language situations. This, as he indicates, is because "Generally, foreign language students have less access to language acquisition and rely more on learning. It would not be at all surprising if foreign language students show a great learning effect, manifested by more 'unnatural orders' (i.e. not the child's acquisition or difficulty order)." [1978, p.6].

The second point is related to the age and experience of the learner. Adult foreign language learners, as is the case in the present study, are already in possession of a developed set of concepts, attitudes, learning strategies, and other cognitive capabilities which they usually apply to any learning situation, something which cannot be claimed for in acquiring a first language. In this case "it is notoriously difficult to deny adult learners explicit information about the target language (TL) since their intellectual maturity as well as their previous teaching/learning experience makes them cry out for explanations." [Sharwood Smith, 1981, p.159]. Teaching explicit rules and principles would also offer short cuts in language learning and consequently cut down the amount of time and effort

which is usually associated with the implicit approach. It is imperative to point out here that the term "rules and principles" does not, at least as far as the present study is concerned, refer only to grammatical rules, but also includes rules of discourse, i.e. how certain speech acts are realised and used, and how those acts are organised to form discourse.

It would seem then that for the adult foreign language learner, a more effective approach would be to take him through a process of conscious exposure to the rules and principles of the language in a deductive manner in order to facilitate his proficiency in using the language. It is interesting to note that this process seems to be effective even in second language learning. Krashen and Seliger [1975] point out that a number of studies have confirmed that "for adults, formal instruction is in general of more benefit for second language learning than is exposure to and use of the second language in 'natural' situations." [p.173].

Before we leave the debate whether a foreign language should be learned in an explicit and conscious (deductive) manner or in an implicit and subconscious (inductive) manner, a further point needs to be made. The classical criticism against the teaching of explicit rules, and which is associated with the old method of grammar-translation, is that this approach would focus totally on the teaching of the formal structure of the target language as an intellectual exercise. This should not necessarily be the case if the aims of the teaching/learning process are clearly defined and related to the learning context. The teaching and learning of language rules and principles should not be concieved of as a totality or an exercise for its own sake, but rather as a way of

providing a tool for internalising certain aspects of the language structure which would then serve as a base for building communicative ability. Furthermore, conscious learning of language rules can be presented in a varying degree and manner according to the nature of those rules and the nature of the prevalent learning strategies. Sharwood Smith [1981] has shown how rule learning can be presented on a two dimension model dealing with elaboration and explicitness to suit the learning context. [p.161].

Another objection to the teaching of rules and principles is usually made on the ground that it is difficult to produce conclusive rules and therefore there would always be the problem of dealing with the violations of those rules. I think this is a vacuous argument since creating discovery learning conditions does not solve that problem either. On the contrary, it is through conscious learning that those irregularities can be pin-pointed, explained, and dealt with.

Finally, perhaps it would be of some interest to quote some of the empirical investigations which have offered some insight into this debate. Pickett [in British Council ETIC, 1978a] conducted a questionnaire in which he invited a number of adult fluent speakers of at least three foreign languages to write about their introspective accounts of their own experience in learning and using languages. In the accounts he received, many of the contributors stated that they were disappointed with the inductive approach in learning their foreign languages [p.61 and 67], and that they often needed explicit grammatical rules of a

pedagogical type which are coupled with practice and which often facilitated their use of the language [p.61, 64 and 67]. Some of them also found that the learning of the grammar of the language in a deductive (explicit) manner was faster than the inductive discovery method [p.65]. Pickett then concludes that "From the accounts it would seem that the vast majority of the contributors like and benefit from clear pedagogic grammar -or benefit even if they do not like them- providing there is plenty of practice material to reinforce and internalise what has been learnt cognitively." [p.67]. Seliger [1975] compared the effectiveness of the deductive method with that of the inductive method in learning a foreign language and found that although there was no significant difference between the two methods on the recall test, "on the retention test which was given three weeks after the lessons, the experimental group which was taught by the deductive method performed significantly better than the group taught by the inductive method." [p.15] He concluded that "a deductive method can be more effective for teaching English as a foreign language to adult learners." [p.17]. The results of a study by Chastain and Woerdehoff [1968] also confirmed that "the deductive presentation of material was superior to inductive" and that "Deductive presentation of structure freed more class time for contextual practice." [p.279].

As far as the present study is concerned, the results have shown that deductive learning strategies (i.e. conscious learning of rules and principles), which are in some way the product of interactive variables of the learning context, are more effective than the inductive discovery learning strategies. One major reason, perhaps, is that our subjects are adult learners who

prefer to have conscious control and understanding of the underlying principle of the language they are learning. Chastain [1971] has provided us with the following quotation by Wilder Penfield who studied the developmental stages of language learning:

> "After the age of 12 or 13, however, nature withdraws that gift and replaces it by the power to reason. At that age, he prefers to reason rather than to memorize; he seeks general knowledge by a process of reason. In other words, he wants rules of grammar as a help to learning. This law of bilingualism explains why an intelligent adult is never successful in mastering a foreign language without learning in a functional way certain fundamental principles that govern the structure of the language and that enable him to generalize, to multiply his experience a thousand times." [117].

6.3 Implications for Teaching EST in Bahrain:

The results of the interaction analysis and the problem solving tasks seem to suggest that the learning process discussed in this study is characteristically dependent on three prominent learning strategies:

i. Explicit presentation and learning of knowledge, rules, and principles to ensure understanding and assimilation.

ii. Recurrence of data at reasonable intervals in the learning process to aid assimilation and consolidation of knowledge,

rules, and principles taught.

iii. Intensive practice dealing first with similar data to that dealt with in the practice period and then with novel data of a similar nature.

The implication of the first strategy is that information contained in an EST textbook, be it passages or exercises for practice, should be presented explicitly and in a straightforward manner. To illustrate this point and in relation to presenting EST discourse, let us reconsider the text quoted by Selinker et al [1976] and which was discussed earlier in Chapter Two (see page 67). Applying this strategy, the complex implicit information dealing with classification of water in paragraph B will have to be made explicit, and the paragraph should therefore be modified to read as follows:

> "A similar need for scientific research exists in the branch of hydrology that deals with the quality of water. In nature, there are two types of water: man-made water and natural water. Man-made water is called pure water and is made up of only hydrogen and oxygen. Natural water is the water we get from rivers, the ground, or rain. This water is not as good as pure water because it always contains other dissolved or suspended elements, and these, even when present in small quantities, play an important role."

It is obvious that the first level classification of water is made explicit by the phrase "there are two types of water" which will indicate to the reader that two classes of water are going

to be mentioned, something which is not provided in the original text. At the second level, the classification is also made explicit by placing the phrase "Natural water is" at the beginning of the sentence, and the use of the commas as a deviding device. This information is obscured in the original text since the sentence dealing with the second level classification begins with the members "river water, ground water, and rain water" rather than the class "natural water".

Other examples to illustrate the type of problems some EST materials present with regard to the notion of explicitness, and how such problems may be tackled can be drawn from certain EST textbooks. I will do that in a moment, but first I would like to mention at this stage that all examples and discussions henceforth will be restricted to materials taken from "English in Physical Science", [Allen and Widdowson, 1974], as representative of the approach employed by the "English in Focus" series which is currently used in some science and technical secondary classes in Bahrain.

In the first unit dealing with "The Properties of Air", the authors present the following text:

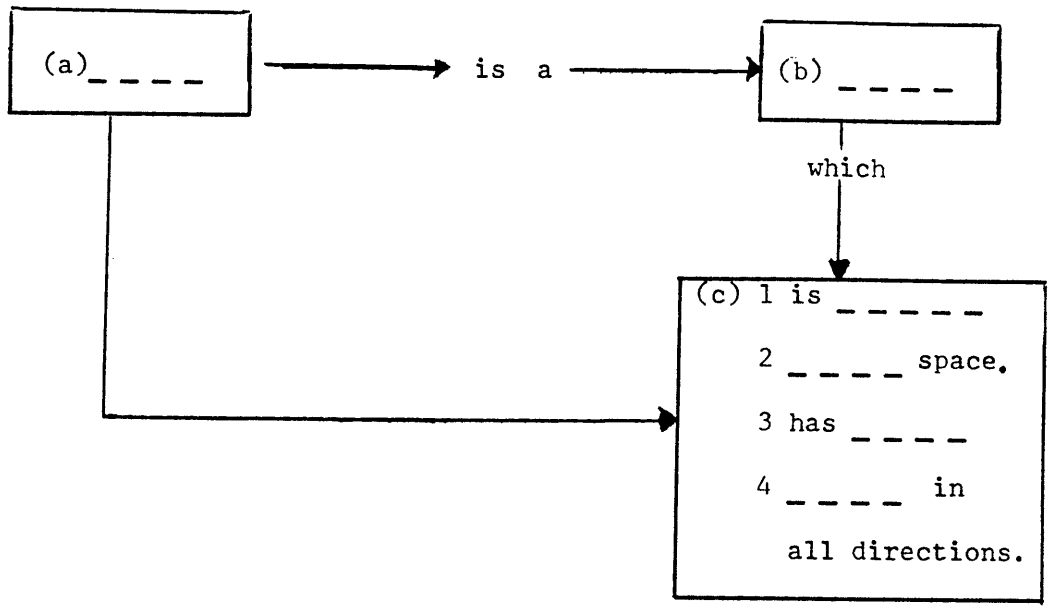
> "1 The earth is surrounded by a layer of air. 2 This is between 150 and 200 km. thick and is called the atmosphere. 3 Air is invisible and therefore it cannot be seen. 4 But it occupies space and has weight in the same way visible substances do," [p.1].

The reading passage goes on to provide more information about the

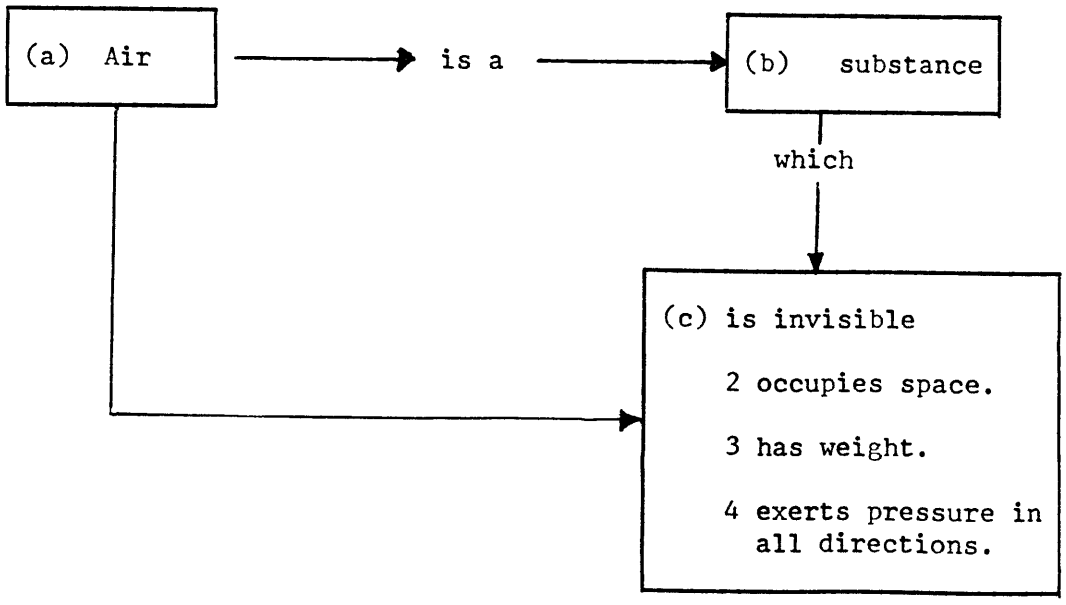
properties of air. Later on in the unit (on page 4), the authors present the following exercise:

EXERCISE D Statements based on diagrams

1. Draw the following diagram and complete it, by referring to the reading passage.



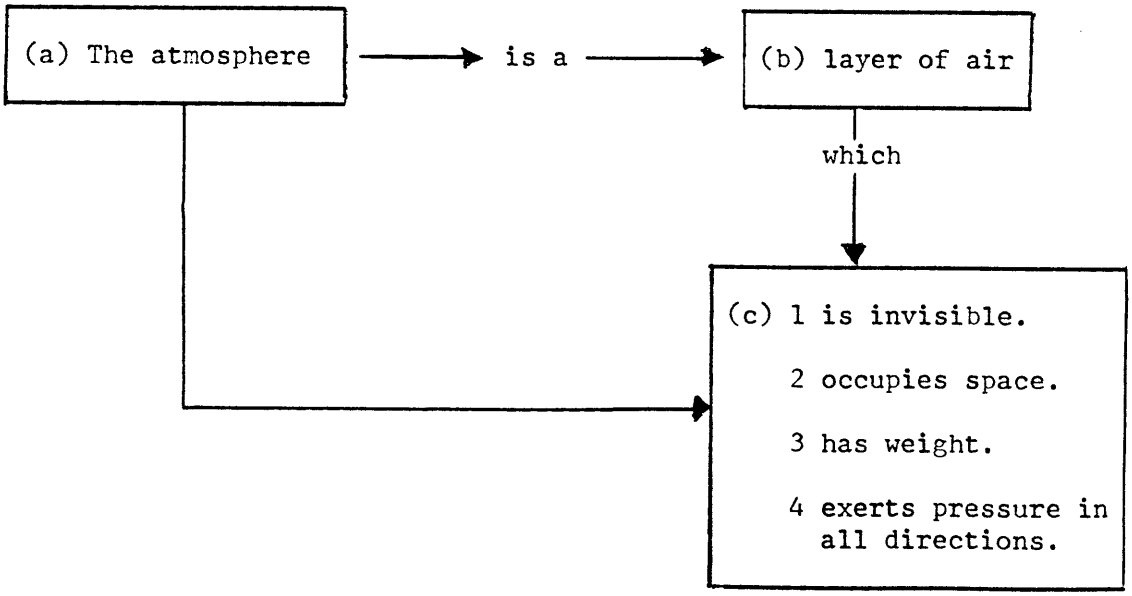
The idea is that the learner will infer from the passage that the diagram is to be completed in the following manner:



Just as in the text quoted above in Selinker's et al study, steps (a) and (b) of the solution require the retrieval of implicit information from sentence 3 and 4, since there is no explicit information in the text to this effect. I suggest that in order to do that, the learner has to go through the following inductive process working his way backward from sentence 4:

> Visible substances occupy space and have weight.
>
> Air occupies space and has weight.
>
> *Therefore air is a visible substance.
>
> But given sentence 3 (i.e. Air is invisible), we get:
>
> Air is an invisible substance.

In fact, given the information provided in sentence 1 and 2, it would be possible, and even more likely, that the learner would use the term "the atmosphere" for (a) and "a layer of air" for (b) to complete the diagram in the following way:



While this substitution may be accepted as another possible and ligitimate solution, it is not what the authors have in mind, and

it nevertheless creates some confusion for the learner. An explicit way of dealing with the same information, and which would eliminate such confusion, would simply be to alter sentence 3 to read:

"Air is an invisible substance and therefore it cannot be seen."
or "Air is a substance which is invisible and therefore it cannot be seen."

Another example of the use of the implicit or discovery approach, typical of the "English in Focus" series, is the section dealing with "Paragraph Writing", where the learners are asked to construct sentences with the help of groups of words, phrases,and cohesive devices, and then write the sentences in a logical order to build a paragraph. The section given on pages 8 and 9, for examples, presents two types of problems. The first is related to sentence building. This can be illustrated by considering the following set of group of words given in the exercise to be joined using some additional material provided and omitting words in italics (underlined here):

"4 SO MUCH/THAT/TOTAL WEIGHT OF THE/SURROUNDING/AMOUNTS TO
there is a lot of air
the atmosphere surrounds the earth
the atmosphere weighs many million million tonnes"

Although the authors deal with the first three sets of sentences as examples, it is not clear to the learner in this case, and in fact in many other cases dealing with this type of exercise, where he is supposed to place some of the additional material given. In the above example, one can only assume that the authors

bank on the 'chance' that the learner will 'discover' the connection between the phrase "TOTAL WEIGHT OF THE" and "the atmosphere" to construct the required phrase "the total weight of the atmosphere." Otherwise, there is nothing to indicate where the additional phrase is to be placed, especially as it does not, in this case, replace another phrase in italics (underlined in our case). Using an explicit approach, this step can be conveyed by using a set of dots to indicate where the additional material which is not replacing words in italics is to be placed. Thus, the three sentences should be presented in the following form:

"there is a lot of air _ _ _
_ _ _ _ the atmosphere surrounds the earth
the atmosphere weighs many million million tonnes"

The second problem in this type of language exercise is related to the task of building a paragraph by arranging the constructed sentences in a logical order. The learners, however, are not told what that order is. In the case of the "Paragraph building" exercise [p.9], for example, an explicit approach to this particular task would be to provide the learner with the instruction that sentences in an EST text dealing with experimentation are usually organised in the following way:

A. General observations.
B. Experimentation: i. Directions
ii. Statement of results.
iii. Conclusions.
C. Further observations and implications.

Similarly, the "Paragraph building" task of arranging the constructed sentences dealing with classification of compounds [p.20-21] could be dealt with more effectively in an explicit manner by providing the learner with the general principle of arranging the sentences according to their degree of generalisation. In other words, the sentences which introduce the topic or the general class come first, followed by those dealing with the class members, followed by descriptions or examples of those members in turn, just as has been discussed earlier in Chapter Five in dealing with the Language (Discourse) tasks.

As far as the grammar teaching is concerned, it is fair to say that the "Focus" series in general and "English in Physical Science" in particular do provide a certain amount of focus on structural rules (e.g. on pages 33, 46 and 62). However, the presentation of those rules is not always sufficiently explicit. The authors deal with the impersonal passive, for instance, by presenting a set of sentences in the four main tenses in the active and their passive versions [p.18] with the hint that "passive sentences contain some form of the verb 'to be' together with a past participle." [p.17]. The assumption is that the learner is either an advanced learner who has already acquired his basic grammar (an assumption held by Allen and Widdowson, 1974, in their capacity as editors of the "English in Focus" series also), and therefore he only needs to be reminded implicitly of the passive transformation, or that he has not learnt this point of grammar sufficiently at the previous stage, and presenting it in this way would help him to modify and/or confirm his knowledge in an inferential manner. As far as the situation in Bahrain is concerned, the fact is very little

efficient language teaching takes place at the previous stage (i.e. in the primary and intermediate schools) for a number of reasons, the most serious ones being first, the depressingly low standard of teachers both in their ability to use the English language and their pedagogical training, and secondly, the lack of appropriate teaching materials to suit the local learner. Other factors, such as the traditional teaching methods employed in certain classes and the rigid relationship between the teaching process and the examination system, also have serious consequences on the learning process and eventually on students' standards in the target language. All this means that in our attempt to introduce the Bahraini learners to EST materials at the secondary stage we cannot take it for granted that these learners have had sufficient language training. Consequently, the teaching of grammar have to be explicitly dealt with, and thus the scant treatment of the passive transformation of the main four tenses given in "English in Physical Science" above will have to be replaced by a more thorough and explicit presentation in the same manner discussed under "Principle Learning" section in dealing with the Language (Grammar) tasks in the previous chapter (see page 211).

Another example where conscious learning may be utilised in learning certain patterns is in understanding noun compounds, an item dealt with in "English in Physical Science", [p.48]. After stating that "Many grammatical relationships are possible in Noun + Noun constructions" and exemplifying how those relationships can be shown by paraphrasing, the authors ask the learner to write paraphrases for a list of noun compounds to show their

"grammatical meaning". Thus, the learner is left to discover the grammatical relationship in each noun compound with no basis to build his answers on. I would like to suggest that a more effective approach, which is in line with the explicit teaching model advocated in this study, would be to relate those compound nouns to the concepts they deal with which would then offer the learner a better access to their grammatical relationships. This can be presented in a tabular form as follows:

Concept	Paraphrase	Examples of noun compound
purpose	(used) for	test tubes, water tank
content	contains	milk carton, nickel alloy
substance	made of/from	cardboard carton, butter cake
operation	works by	steam engine, gas oven
cause	caused by	mercury poisoning, food contamination
shape	look(s) like	bell jar, horseshoe magnet
relation	of	electron theory, boiling point

From this table the learner will be able to extract grammatical relationships and write paraphrases such as:

i. a water tank = a tank which is used for water.

ii. a milk carton = a carton which contains milk.

iii. a gas oven = an oven which works by gas.

iv. a bell jar = a jar which looks like a bell.

I would not like to claim that this is a conclusive table, but rather that it represents an attempt to show how certain

grammatical structures can be taught more explicitly by using, in this case, a conceptual approach to aid understanding and practice, especially as we are dealing here with adult learners with a developed set of concepts which can, and should, be utilised in foreign language learning.

Another case where an explicit rule is essential for solving the language task presented is in the "Grammar" Exercise A in Unit 5 [p.61] which deals with the use of the relative clause "a preposition + which". The authors explain that such clauses are formed in the following way:

> "The production of a gas -substances would burn more fiercely in this gas than in air- was discovered by Joseph Priestley in 1774.
> = The production of a gas in which substances would burn more fiercely than in air was discovered by Joseph Priestley in 1774."

I think the learner needs to be told also that the preposition he should use with "which" is to be found in the sentence to be connected by the use of a relative clause.

In so far as the second strategy is concerned, i.e. the need for recurrent data and practice material at reasonable intervals, this seems to be fulfilled, to some extent, in "English in Physical Science" but only with regard to certain communicative acts of EST discourse (e.g. "Expressing definitions and generalization" which is dealt with in the first three units). However, this is not achieved in the case of the grammatical structures focused on in the textbook. The use of the '-ing'

clause, for instance, is dealt with in Unit 3 but it is not until Unit 7 that the structure is dealt with again in an elaborated form. Similarly, defining and non-defining relative clauses are taught in Unit 3 but relative clauses with prepositions are not introduced until Unit 5. I suppose the authors' argument would be that the pattern practice is related to the type of structure highlighted in the reading text and therefore such a gap may be inevitable. The counter argument, however, is that since the authors take the view that EST teaching material should not necessarily use authentic scientific texts but rather have to use specially constructed texts in order to be able to foreground the discourse acts and grammatical structures we would want to introduce at different stages in the course [Widdowson, 1976], then it follows that those texts should be written and organised in a way to create a sequential pattern in dealing with and practising those linguistic features. In the case of "English in Physical Science" that practice can ideally be provided in the "Sentence building" exercises, something which is achieved in this textbook but not sufficiently enough. The recurrent practice of the language data taught, at least as far as the Bahraini learner is concerned, will have to be greater. To provide an example from "English in Physical Science", in the "Grammar" section in Unit 1 [p.6-7] the authors teach the conditional sentences and then provide a number of sentences for practice. They, however, do not use the opportunity to provide maximum practice in using the structure in the "Sentence building" section [p.9], since that section contains only one conditional sentence. A practical modification to this section in this respect would be, for example, to alter the format of sentence 4

to read:

"SO MUCH/THAT/IF/SURROUNDING/IT/AMOUNT TO
there is a lot of air
we weigh the atmosphere which surrounds the earth
the atmosphere will weigh many million million tonnes"

Thus producing the sentence:

"There is so much air that if we weigh the atmosphere surrounding the earth it will amount to many million million tonnes."

Similarly, sentence 7 and 8 could be modified to read:

"7 IF/THAT/IT/SLIGHTLY HEAVIER/THAN IT WAS/WHEN/IT
you weigh the inner tube
you will find this
the inner tube is heavy
there was no air in the inner tube

8 ,/IT/AND THEN
take a deflated inner tube from a bicycle tyre
weigh the inner tube on a pair of balances
inflate the inner tube"

The two groups of words, which are supposed to be arranged as 8 followed by 7, will produce the following text:

"8 Take a deflated inner tube from a bicycle tyre, weigh it on a pair of balances and then inflate the inner tube.

7 If you weigh the inner tube you will find
that it is slightly heavier than it was
when there was no air in it."

A similar case exists with regard to the use of the present participle and the past participle as modifiers (e.g.'lubricating oil' and 'lubricated bearing') in Unit 5 [p.62], where some sentences in the "sentence building" section [p.63] could be modified to offer further practice in the use of this pattern. Sentence 3, for instance, could be altered to read:

"FLOATING/WITH ITS/AND/SUSPENDED/AND/IT
put the needle near the magnet
the north pole of the needle is near the north pole of the magnet
release the needle"

Thus producing the sentence:

"Put the floating needle with its north pole near
the north pole of the suspended magnet and
release it."

Finally, the application of the third strategy, i.e. to provide the learner with tasks similar to those given in the practice period first before moving to novel tasks, means that the exercises should first provide sentences identical to the ones dealt with in the examples before other types can be introduced. This is essential for consolidating the data taught before introducing a need for manipulating that data to suit novel contexts. This can be illustrated by considering "Grammar" Exercise A in Unit 2 in "English in Physical Science" [p.17], which deals with forms of definitions. Since the example provided

is:

"A thermometer is an instrument which is used for measuring temperatures."

the exercise should then offer the learner sentences which are structurally identical to the given example. The following are some possibilities:

i. a barometer /an instrument/ is used for measuring atmospheric pressure.

ii. a microscope /an instrument/ is used for observing small objects.

iii. a micrometer /a tool/ is used for measuring diameters.

iv. a catalyst /a chemical/ is used for speeding up a chemical process.

This perhaps can be related to the notion of grading in general ELT pedagogy which usually advocates an approach of gradual presentation of language data according to "difficulty". In our case, however, the gradual presentation and practice is related to "familiarity" with the structure of the tasks. This is in fact a more appropriate way to deal with grading of language data since it is dubious whether there is a uniform criterion for establishing "difficulty", and whether that "difficulty" is to be related to linguistic, conceptual, or sociolinguistic (i.e. use) aspects.

To end this discussion it would perhaps be fitting to say that what I have tried to do here is basically to show where any discrepancy exists between the learning style of the Bahraini

learner, as defined by the outcome of both the analyses of the classroom interaction and the results of the experiments on the one hand, and the manner in which current EST material is presented on the other, and to suggest certain ways in which that material will have to be modified to be in line with the teaching/learning strategies prevalent in the Bahraini context. The question which we obviously have to face at some stage, however, is: How do we prepare our students to deal with the type of EST discourse usually presented in general science textbooks which have not been conditioned to suit the learning style of the non-native learner, and may therefore foreground a set of learning strategies which might be considered alien as far as that learner is concerned? I think this is an issue which will have to be considered at the next stage, and may accordingly require the use of a modified approach which would achieve a gradual approximation to the type of skills required to deal with EST discourse at large. In this respect, perhaps Sharwood Smith's approach [1981] of presenting language data on a two dimentional model dealing with varying degrees of 'elaboration or conciseness' and 'explicitness or intensity' is a particularly useful one to achieve that approximation. At this stage, however, and for the time being our priority should be to establish the basis on which more complex learning tasks can be built. In the current learning context this can only be achieved through the teaching and learning of language data in an explicit manner.

Finally, perhaps it should be recognised that in a controversial area of enquiry such as language learning investigations are neither adequate nor conclusive, and further research will always be needed to validate, consolidate, and update our earlier

findings. With regard to the present study two areas are perhaps worth further investigation. First, since the tests used here dealt with discrete items, a useful area of investigation would be to compare the learners' achievement under the two learning conditions, i.e. Guided Discovery and Principle Learning, using an integrative type of test which would include other language skills, particularly productive ones, such as spoken English and paragraph writing.

Secondly, as the practice period was comparatively short, further research might address itself to the question of how learners under the two learning conditions would behave in longer learning sessions. Would the Principle Learning group strengthen or even maintain its favourable results? Would the difference disappear? Or would the Guided Discovery group surpass the Principle Learning group? In behavioural terms, this would entail studying the learners' ability to adjust to the cognitive emphases as conceived of in the learning context. Naturally, this would mean the use of testing items and procedures different to those discussed in the present study, and would perhaps require a longitudinal type of research.

APPENDIX 1

A Summary of Bellack's Coding System

(1) SPEAKER: indicates source of utterance

Teacher (T); Pupil (P); Audio-Visual Device (A)

(2) TYPE OF PEDAGOGICAL MOVE: refernce to function of move

Initiatory Moves

Structuring (STR): sets context for subsequent behaviour by launching or halting-excluding interaction

Soliciting (SOL): directly elicits verbal, physical, or mental responses; coded in terms of response expected

Reflexive Moves

Responding (RES): fulfills expectation of solicitation: bears reciprocal relation only to solicitation

Reacting (REA): modifies (by clarifying, synthesizing, expanding) and/or rates (positively or negatively); occasioned by previous move, but not directly elicited; reactions to more than one previous mode coded REA

Not Codable (NOC): function uncertain because tape is inaudible

(3) SUBSTANTIVE MEANING: reference to subject matter topic

(4) SUBSTANTIVE-LOGICAL MEANING: reference to cognitive process involved in dealing with the subject matter under study

Analytic Process: use of language or established rules of logic

Defining — General (DEF): defining characteristics of class or term with example of items within class explicitly given

Defining — Denotative (DED): object referent of term

Defining — Connotative (DEC): defining characteristics of class or term

Appendix 1 (continued)

Interpreting (INT): verbal equivalent of a statement, slogan, ophorism, or proverb

Empirical Process: sense experience as criterion or truth

Fact-Stating (FAC): what is, was,or will be without explanation or evaluation; account, report, description, statement of event or state of affairs.

Explaining (XPL): relation between objects, events, principles; conditional inference; cause-effect; explicit comparison-constrast; statement of principles, theories, or laws

Evaluative Process: set of criteria or value system as basis for verification

Opining (OPN): personal values for statement of policy, judgment or evaluation of event, idea, state of affairs; direct and indirect evaluation included

Justifying (JUS): reasons or argument for or against opinion or judgment

Logical Process Not Clear (NCL): cognitive process involved not clear

(5) NUMBER OF LINES IN 3 AND 4 ABOVE

(6) INSTRUCTIONAL MEANINGS: reference to factors related to classroom management

Assignment (ASG): suggessted or required student activity; reports, tests, readings, debates, homework

Material (MAT): teaching aids and instructional devices

Person (PER): person as physical object or personal experiences

Procedure (PRC): a plan of activities or a course of action

Statement (STA): verbal utterance, particularly the meaning validity, truth, or propriety of an utterance

Logical Process (LOG): function of language or rule of logic;

Appendix 1 (continued)

reference to definitions or arguments, but not presentation of such

Action — General (ACT): performance (vocal, non-vocal, cognitive, or emotional) the specific nature of which is uncertain or complex

Action — Vocal (ACV): physical qualities of vocal action

Action — Physical (ACP): physical movement or process

Action — Cognitive (ACC): cognitive process, but not the language or logic of a specific utterance; thinking, knowing, understanding, listening

Action — Emotional (ACE): emotion or feeling, but no expression of attitude or value

Language Mechanics (LAM): the rules of grammar and/or usage

(7) INSTRUCTIONAL-LOGIC MEANING: reference to cognitive processes related to the distinctly didactic verbal moves in the instructional situation

Analytic situation

Defining-General (DEF)

Defining-Denotative (DED)

Defining-Connotative (DEC)

Interpreting (INT)

Empirical Process: see (4) above

Fact-Stating (FAC)

Explaining (XPL)

Evaluative Process

Opining (OPN): see (4) above

Justifying (JUS): see (4) above

Rating: reference to metacommunication; usually an evaluative reaction (REA)

Appendix 1 (continued)

Positive (POS): distinctly affirmative rating

Admitting (ADM): mild or equivocally positive rating

Repeating (RPT): implicit positive rating when statement (STA) is repeated by another speaker; also for SOL to repeat vocal action (ACV)

Qualifying (QAL): explicit reservation stated in rating; exception

Not admitting (NAD): rating that rejects by stating the contrary; direct refutation or correction excluded

Negative (NEG): distinctly negative rating

Positive/Negative (PON): SOL requesting positive or negative rating

Admitting/Not Admitting (AON): SOL asking to permit or not permit procedure or action

Extra-logical Process: SOL expecting physical action or when logical nature of verbal response cannot be determined

Performing (PRF): asking, demanding, explicit directive or imperative

Directing (DIR): SOL with or without stated alternatives; asking for directive, not permission for specific action

Extra-logical Process Not Clear (NCL): extra-logical process involved not clear

(8) NUMBER OF LINES IN 6 AND 7 ABOVE

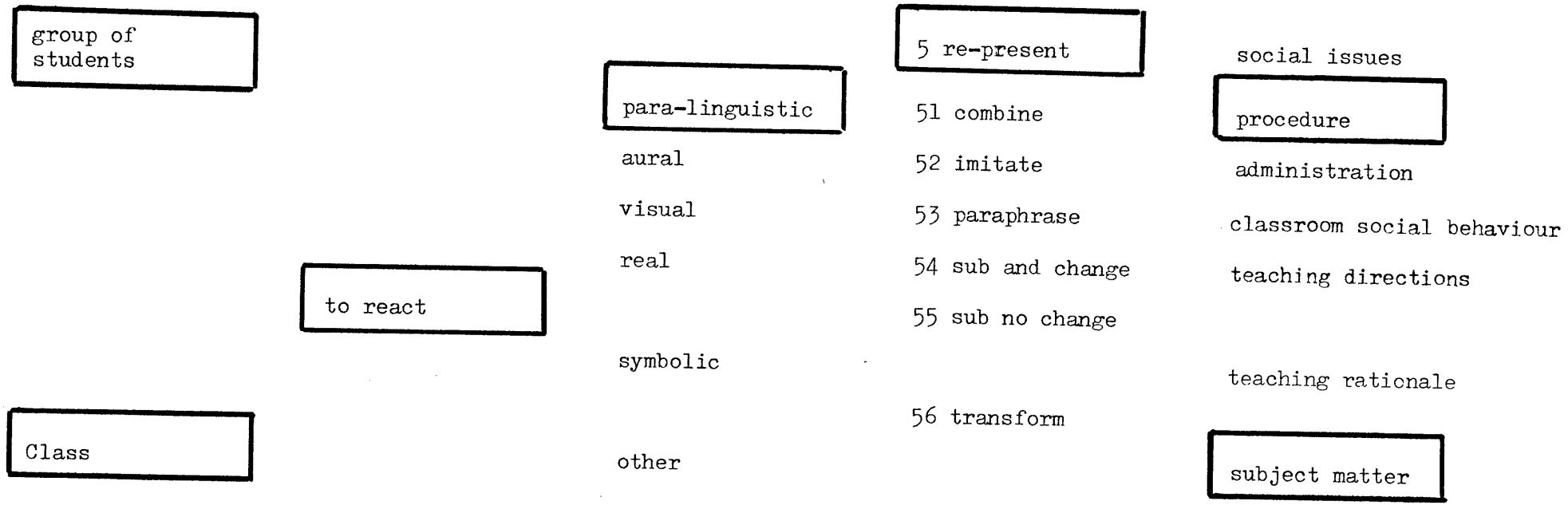
[From Bellack, A., H. Kliebard, R. Hyman, and F. Smith, 1966, "The Language of the Classroom", Teachers College Press, Columbia University, p.38-40.]

APPENDIX 2

Fanselow's Five Characteristics of Communications in Settings.

1. Who communicates?	2. What is the pedagogical purpose of the communication? *	3. What mediums are used to communicate content?	4. How are the mediums used to communicate areas of content?**	5. What areas of content are communicated?**
teacher	to structure	linguistic	1 attend	language systems
		aural		contextual
		visual	2 characterize	grammatical
				literary
			21 differentiate	
		ideogram		meaning
			22 evaluate	
		transcribed		mechanics of writing
		writing	23 examine	
			24 illustrate	sound
individual student	to solicit	other	25 label	segmental
		non-linguistic	3 present	supra-segmental
				speech production
		aural	31 call words	unclassified
		visual	32 change medium	life
		real	33 question	
		representational	34 state	formula
		schematic	4 relate	imagination
	to respond	symbolic	41 explain	personal
		other	42 interpret	public
				skills

APPENDIX 2 (continued)

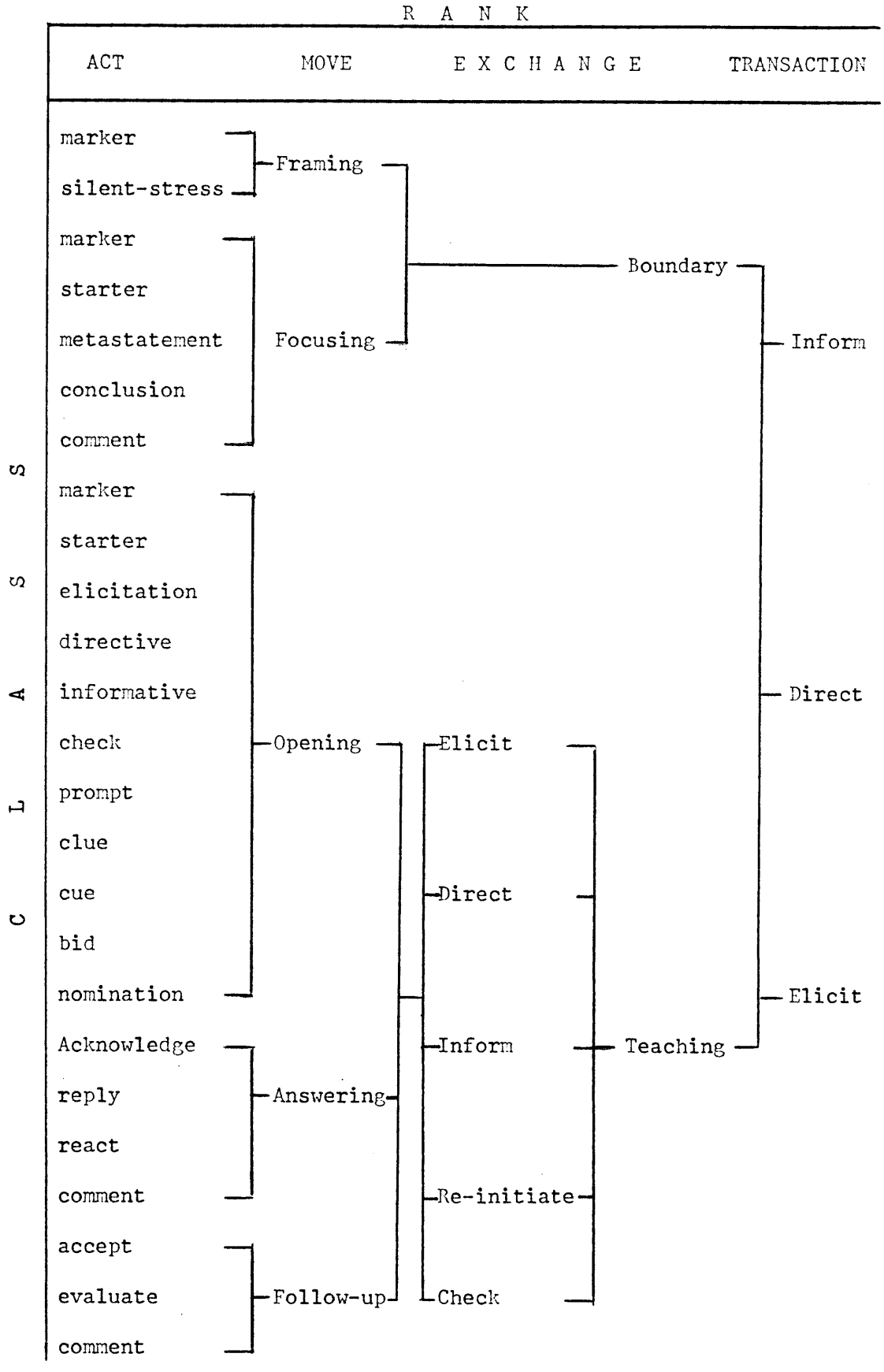


* these four pedagogical purposes are from Bellack.
** the uses and areas of content are presented alphabetically.

(From Fanselow, J., 1977, "Beyond Rashomon - Conceptualizing and Describing the Teaching Act", in TESOL Quarterly, Vol. 11.1, p. 17 - 39.)

APPENDIX 3

A Summary of Sinclair and Coulthard's System



[From Sinclair,J., and R. Coulthard, 1975, "Towards an Analysis of Discourse", Oxford University Press.]

APPENDIX 4

Flanders' Interaction Analysis Categories (FIAC)

Teacher Talk	Response	1. Accepts feeling. Accepts and clarifies an attitude or the feeling tone of a pupil in a non-threatening manner. Feelings may be positive or negative. Predicting and recalling feelings are included. 2. Praises or encourages. Praises or encourages pupil action or behaviour. Jokes that release tension, but not at the expense of another individual; nodding head, or saying "Um hm?" or "go on" are included. 3. Accepts or uses ideas of pupils. Clarifying, building or developing ideas suggested by pupil. Teacher extensions of pupil ideas are included but as the teacher brings more of his ideas into play, shift to category five.
		4. Asks questions. Asking a question about content or procedure, based on teacher ideas, with the intent that a pupil will answer.
	Initiation	5. Lecturing. Giving facts or opinions about content or procedures; expressing his own ideas, giving his own explanation, or citing an authority other than a pupil. 6. Giving directions. Directions, commands, or orders to which a pupil is expected to comply. 7. Criticizing or justifying authority. Statements intended to change pupil behaviour from nonacceptable to acceptable pattern; bawling someone out; stating why the teacher is doing what he is doing; extreme self-reference.
Pupil Talk	Response	8. Pupil-talk- response. Talk by pupils in response to teacher. Teacher initiates the contact or solicits pupil statement or structures the situation. Freedom to express own ideas is limited.
	Initiation	9. Pupil-talk - initiation. Talk by pupils which they initiate. Expressing own ideas; initiating a new topic; freedom to develop opinions and a line of thought, like asking thoughtful questions; going beyond the existing structure.
Silence		10. Silence or confusion. Pauses, short periods of silence and periods of confusion in which communication cannot be understood by the observer.

[From Flanders,N., 1970, "Analysing Teaching Behaviour", Addison-Wesley, p.34.]

APPENDIX 5

Chemistry:	Code No.
T: In previous lessons we took some(1) of the properties	70
of certain elements,(2) and we said that one of these	70
properties(3) is the size of the atoms, the size of	51
what?(4). The atoms and the ions. We've finished from	51
the size of the atoms.(5) We begin now to take the	70
size of the ions.(6) We want to know what we mean by	70
the positive ion(7) and the negative ion. The	70
positive ion,(8) what does it mean? An atom which has	70
lost(9) an electron. Any atom which loses(10) an	53,53
electron or more, we call it an ion* what?(11)	41
Ss: Positive*.(12)	81
T: Any atom which gains an electron or more,(13) we call	43
it an ion* what?(14).	43
Ss: Negative*.(15)	83
T: Negative*. Therefore if we take, for example,(16) an	30
atom of sodium, an atom of what? Sodium(17) Na, Na.	54
The atomic number for sodium is what?(18)	41
Ss: Eleven.(19)	81
T: So the atomic number for sodium is eleven.(20) That	30
means the number of electrons is how many?(21)	43
Ss: Eleven.(22)	83
T: The number of electrons is eleven. O.K.(23) This	30
means the number of electrons which rotate around the	
nucleus are how many?(24)	43
Ss: Eleven(25)	83
T: Eleven. If I draw the electronic(26) structure of a	30

	sodium atom, I find a nucleus,(27) this is, for example, what? A nucleus. The first(28) shell, how many electrons are there in it?(29)	53 54 43
Ss:	Two. (30)	83
T:	Two electrons. So this is a shell and there are two what? (31)	41
Ss:	Electrons. (32)	81
T:	The second shell, how many electrons are there in it? (33)	43
Ss:	Eight. (34)	83
T:	Eight electrons. So this is the second shell,(35) and in it are the eight what? Electrons.(36) Four, five, six, seven, eight.(37) The third shell, how many electrons are there in it?(38)	30 51 51 43
Ss:	One. (39)	83
T:	One electron. So this is the third shell and there are one electron in it.(40) If we draw the electronic structure(41) of a potassium atom. Potassium is K, (42) or a magnesium atom, an atom of what? (43) Magnesium. Magnesium is Mg.(46) What's the atomic number for magnesium?(45)	30 70 53,53 53 43
Ss:	Twelve. (46)	83
T:	Twelve. So the atomic number is twelve.(47) This means that the number of electrons which rotate around(48) the nucleus are how many?(49)	30 43,43
Ss:	Twelve. (50)	83
T:	Twelve. We draw the nucleus,(51) we draw what?(52) The nucleus. The first shell, how many electrons are there in it? (53)	30,70 43

Ss: Two. (54) 83

T: Two electrons. So this is one and at the same(55) time two. The second shell, how many electrons are there in it?(56) 30 43

S: Eight electrons. (57) 83

T: Eight electrons. So this is a shell,(58) and one, two, three, four(59),five, six, seven, eight. So the third shell,(60) how many electrons are thre in it?(61) 30 51 51 43

Ss: Two. (62) 83

T: Two electrons. So here(63) are two electrons. So this is one, and at the same(64) time this is one. We also draw(65) the electronic structure of an aluminium atom.(66) Aluminium is Al.(67) 30 51 70 70,53

Ss: Thirteen. (68) 83

T: The atomic number for aluminium is what?(69) 41

Ss: Thirteen. (70) 81

T: Thirteen. So one, three.(71) So the number of the electrons which rotate(72) around the nucleus, how many electrons?(73) 30 43 43

Ss: Thirteen. (74) 83

T: Thirteen. So you draw a nucleus.(75) The first shell, how many electrons are there in it?(76) 30 43

Ss: Two. (77) 83

T: Two electrons. So this is the shell, and in it(78) are one, two. The second shell... (79) 30 43

Ss: Eight (80) 83

T: How many electrons are there in it? (81) 41

Ss: Eight electrons. (82) 81

T: Eight electrons. so this is one,(83) two, three, 30

four, five, six,(84) seven, eight. The third shell, how many electrons are there in it?(85) 51 43

Ss: Three. (86) 83

T: Three electrons. So this is a nucleus,(87) and in it there are one, two, three.(88)## ##(89) There are three what? Electrons. O.K.(90) Pay a little attention. We come to the sodium atom.(91) The sodium atom, when it loses the electrons,(92) when it loses the third shell electrons,(93) this shell goes away,(94) at the same time this shell goes away.(95) How many shells remain?(96) 30 51,01 51 70 53 53 53,51 43

Ss: Two shells. (97) 83

T: So the sodium atom in this case changes into what?(98) 43

S: An ion. (99) 83

T: Into an ion. The ion is Na,(100) and it has how many positive charges?(101) 53 43

Ss: One. (102) 83

T: One positive charge. What's the meaning of a positive charge?(103) 42

Ss: It's lost one electron.(104) 82

T: It's lost one electron. This means the number(105) of protons is more than the number of electrons by how many?(106) 30 43

Ss: One. (107) 83

T: The number of protons is more than the number of electrons by how many?(108) 41

Ss: One. (109) 81

T: One. O.K. Since the number of protons(110) has become 30

more than the number of electrons by one,(111) what happened to the attraction power between the protons and electrons?(112) 43 43

S: It decreased. (113) 83

T: The attraction power increased.(114) The attraction power increased. Since the attraction power(115) has increased, what happens to the radius of the atom?(116) 30 51 43

S: The atom shrinks. (117) 83

T: The atom shrinks, so what decreases? (118) 43

Ss: Its radius. (119) 83

T: What decreases? (120) 41

Ss: Its radius. (121) 81

T: Now let's suppose we come to the magnesium atom.(122) The outer shell has how many electrons?(123) 70 43

Ss: Two. (124) 83

T: It loses two electrons. The two electrons go away.(125) It changes into what? (126) 53,43

Ss: An ion. (127) 83

T: A positive ion. Mg, which is positive.(128) How many positive charges has it got? (129) 30 43

Ss: Two charges. (130) 83

T: Two positive charges. What's the meaning(131) of two positive charges? (132) 30 42

Ss: _ _ _ _ _ (133) 01

T: The number of protons is more than the number of electrons by how many? (134) 43

Ss: Two. (135) 83

T: By two. What happened to the attraction power? (136) 43

Ss: It increased. (137) 83

T: The attraction power increased.(138) What happened to 30
the radius of the atom?(139) 43

Ss: It decreased. (140) 83

T: To the radius of the ion? It decreased. In this
case(141) it decreased. We come to the aluminium 30
atom.(142) How many in the outer shell?(143) 70,43

Ss: Three. (144) 83

T: It loses the three electrons. Now it's lost(145) the 53
three. It's changed into what?(146) 43

Ss: An ion. (147) 83

T: A positive ion. Al.(148) How many positive charges 30
has it got?(149) 43

Ss: Three. (150) 83

T: Three positive charges. One, two, three.(151) What's 30
the meaning of three positive charges? Heh?(152) 42

S: It lost three electrons. (153) 82

T: It lost three electrons,or the number of protons(154) 30
is more than the number of electrons by how many?
Three.(155) What happened to the attraction 53
power?(156) 43

Ss: It increased. (157) 83

T: The attraction power increased.(158) What happened to 30
the radius of the atom?(159) 43

Ss: It decreased. (160) 83

T: The radius of the atom decreased.(161) So this means 30
that it changed into what?(162) 43

Ss: An ion. (163) 83

T: So if we come to see the ion,(164) it's an atom, it's 70
what? An atom(165) which has lost what? An electron 53

	or more.(166) It might be one electron, it might be	53
	two electrons,(167) it might be three electrons.	53
	O.K.(168) What happened to the radius of the	53
	ion?(169)	41
Ss:	It decreased. (170)	81
T:	The radius of the ion decreased.(171) The radius of	30
	the ion decreased. So(172) the positive ion	51
	forms(173) # # as a result of(174) # dissociation	53,53
	# (175) of an electron # or(176) # more.(177)	53,53,53
Ss:	_ _ _ _ _ (178)	01
T:	As a result of dissociation of an electron(179)	51
	# # #(180) # # # (181)	01,01
S:	Loss, sir. (182)	83
T:	Dissociation means loss. Dissociation means what?	
	Loss.(183) As a result of dissociation of an	30
	electron(184) or more from what?(185) The atom. From	51,51
	what? The atom,(186) and the ion #(187) charges	51,53
	#(188) are less or more than (189) the size of	53,53
	the atom # (190) from which it resulted,(191) from	53,53
	which it resulted.(192)	51

Appendix 5 (continued): Interaction Analysis Matrix.

Category	10	20	30	41	42	43	44	51	52	53	54	60	70	81	82	83	84	85	90	01	Total
10																					
20																					
30					2	14		8		2	1		3								30
41														8							8
42															2					1	3
43						4										34					38
44																					
51						5		5		2			3							3	18
52																					
53				2		5		2		16	1					1				1	28
54				1		1															2
60																					
70						3		1		5			5								14
81			5			2							1								8
82			2																		2
83			23	5	1	3				3			1								36
84																					
85																					
90																					
01						1		2					1			1				1	6
Total			30	8	3	38		18		28	2		14	8	2	36				6	193

APPENDIX 6

Biology:	Code No.
T: The role of the biological enzyme,(1) pay attention,	70
(2) in the chemical reactions(3) which take place	60,70
inside the human body.(4) As we notice, the	70
digestive(5) system in the human being consists of(6)	53,53
the alimentary canal and the subsidiaries of the	
alimentary canal.(7) The alimentary canal begins with	53
the mouth, then the throat,(8) then the oesophagus,	53
the stomach,(9) the duodenum, the small intestine(10)	53,53
then the large intestine, the rectum,(11) and the	53
anus. And the subsidiaries of the alimentary	
canal(12) are naturally the liver, the liver	53
gland,(13) and the pancreas, in addition to the(14)	53,53
salivary glands which are situated in the mouth.(15)	53
Let's see the role of the digestive process(16) and	70
the process of the enzymes which takes place(17) in	70
the human body.(18) There are three digestive	70
processes(19) in the digestive system of the human	53
being.(20) The first stage in the digestive	53
process(21) is the one which takes place in the	53
mouth.(22) We call this number one, the oral(23)	53,54
digestion. # (24) There's another digestion which	54
takes place(25) in another area, that area is..(26)	53,44
S: The stomach. (27)	84
T: The stomach, so we call it the gastric digestion.(28)	30
# # # (29) # # # (30) # # # (31) And	01,01,01
there's a third area(32) where almost the last	53

digestion takes place,(33) which is the small intestine,(34) and we call this digestion.. (35) 53 53,44

Ss: The intestinal digestion. (36) 84

T: # # #(37) # # #(38) We begin first with the action of the enzymes(39) which are situated in the mouth, and by which(40) the digestion of food substances is accomplished.(41) We know that the mouth contains six salivary glands,(42) and the function of the salivary glands is to(43) secrete saliva to soften the food substance.(44) The salivary glands produce saliva, and saliva(45) contains a special enzyme which is(46) the ptyalin enzyme. So the function (47) of this enzyme is to change starchy(48) substances only into substances of a simpler(49) composition; sugar materials(50) which we call... (51) 01,01 70 70 70 53 53 53 53 53 53 53 53,53 44

S: Wheat sugar. (52) 84

T: Wheat sugar. So first,(53) we'll talk about the oral digestion.(54) The oral digestion, the first thing is that(55) only starchy substances are digested in the mouth.(56) # # #(57) # # #(58) # So starch # (59) plus water # by means of(60) a special enzyme, which we call? (61) 30 70 53 53,01,01 53,53 44

Ss: Ptyalin. (62) 84

T: Ptylin, # # (63) starchy substances are changed into? (64) 30 43

S: Wheat sugar. (65) 83

T: Into wheat sugar. # (66) # # The wheat sugar,(67) what did we call it?(68) 30,44 44

S: Starchy substances. (69) 84

T: Heh? (70) 10

S: Maltose. (71) 84

T: Like maltose. # # (72) # # # (73) And maltose, 30,01
as we notice, heh?(74) 43

S: Glucose and glucose. (75) 83

T: Glucose and glucose, which means that it's of
a dual(76) molecular structure.(77) Only that the 30,53
starchy(78) substance is partially and not wholly 53
digested.(79) This means the starchy substance is 53
digested(80) by the ptylin enzyme which is 53
present(81) in the salivary glands, and changes 53
into(82) wheat sugar, which is(83) maltose. # Only 53,53
this(84) takes place in the mouth. As for(85) the 53,53
digestion in the stomach,(86) it differs completely 53
from the digestion in the mouth.(87) Secondly, the 53
gastric # (88) digestion. # (89) The gastric 70,70
digestion. As we notice,(90) after the process of 53
whole mastication(91) of the food substance has been 53
accomplished,(92) and has been held in the mouth,(93) 53,53
it descends to the throat,then to the(94) oesophagus. 53
The oesophagus is a muscular tube,(95) which has 53
special muscles which are capable of(96) expanding 53
and contracting in order to push(97) the food 53
substance from the throat(98) until it reaches the 53
stomach.(99) And the oesophagus does not perform a 53
digestive process(100) nor has any effect on the food 53
substance. It's only(101) a connecting area between 53
the throat and the stomach.(102) As soon as the food 53
substance reaches the stomach,(103) the stomach is 53

agitated(104) by secreting a special hormone, which 53
we call, heh?(105) 44

S: Gastric. (106) 84

T: Gastric, gastric hormone. # (107) # # #(108) # 30.01
During the secretion(109) of this hormone, its 53
function is to agitate(110) the inner wall of the 53
stomach(111) to secrete the gastric juice.(112) This 53,53
gastric juice, heh,(113) of what nature?(114) 43,43

S: Hydrochloric acid. (115) 83

T: Yes, hydrochloric acid,(116) which means that it's of 30
an acidic effect.(117) So it's of an acidic effect 53
because of the existence(118) of hydrochloric acid. 53
So(119) the gastric juice contains a special 53
enzyme.(120) This enzyme performs its effective 53
duty(121) in the acidic environment. It doesn't 53
perform(122) the duty of any other enzyme in this 53
environment.(123) So the acidic enzyme is for 53
changing (124) or breaking down of the molecules 53
of(125) protein substances, and it changes them(126) 53,53
into substances of a simpler composition.(127) We 53
call this enzyme? (128) 44

S: Pepsin. (129) 84

T: Pepsin. It changes protein(130) # substances(131) 30,53
into(132) # proteose # (133) 53,53

S1: Glucose. (134) 83

S2: And peptide. (135) 83

T: And into peptide. (136) # # It changes the 30
protein(137) substance into proteose(138) and peptide 51,51
through the effect of the special enzyme,(139) the 51
pepsin enzyme. # (140) # # The pepsin enzyme.(141) 51,51

So in that case does a total(142) or a partial digestion take place? (143) 53 42

S: Partial. (144) 82

T: Partial, that's to say it changes the protein substance(145) into a substance of a simpler composition.(146) But if we said a total digestion, what substances(147) would the protein substance change into?(148) 30 53 43 43

S: Amino acids. (149) 83

T: Into amino acids, and we've said that the amino acids(150) result from protein substances. But we've talked about(151) them changing into proteose and eventually changing into(152) peptide through the effect of the existing(153) enzyme which is the pepsin enzyme.(154) There's another enzyme # (155) called rennine enzyme, and it exists always(156) plentifully in children's stomachs.(157) The function of this enzyme is to change milk(158) protein, which contains caseinogen,(159) into casein,because this enzyme(160) the rennine enzyme, changes caseinogen into casein. (161) So milk protein # (162) # # contains (163) caseinogen (164) which changes into... (165) 30 51 51 51 51 53 53 53 53,53 53,51 51,51 41

Ss: Casein. (166) 81

T: Into casein # # (167) through the effect of the rennine enzyme.(168) # # # (169) There are many questions(170) which a lot of people posed(171) in relation to how the stomach can digest large quantities(172) of food substances with strength 30 51,01 53,53 53

because of the existence of this very(173) effective	53
juice and which is always available(174) in the	53
stomach, why doesn't the stomach(175) digest itself?	53
Scientists(176) were provoked by this process, and	53
they observed (177) that the stomach can digest	53
itself(178) if its wall isn't healthy,(179) that's to	53,53
say, if an inflammation or a scratch occurs(180) in	53
any of the stomach walls(181) then this enzyme	53
affects this(182) sensitive area and thus(183) it	53,53
starts the process of digesting(184) a part of the	53
stomach, and this is what we call(185) a gastric	54
ulcer. And naturally a person(186) eats many food	54
substances(187) which irritate the inflammation of	53
this ulcer,(188) and especially food substances which	53
contain(189) acids, such as oranges, lemons, and so	53
on,(190) these worsen the gastric ulcer.(191) For	54,53
this reason the doctor orders the person(192) to keep	53
off the inflammatory things or(193) food substances	53
like oranges,(194) lemons, or citric substances.(195)	53,54

Appendix 6 (continued): Interaction Analysis Matrix.

Category	10	20	30	41	42	43	44	51	52	53	54	60	70	81	82	83	84	85	90	01	Total
10																	1				1
20																					
30						1	1	3		5										3	13
41														1							1
42															1						1
43						2										4					6
44							1										7				8
51				1				8		2										1	12
52																					
53					1	2	6	1		89	4		3			1				1	108
54										3	2									1	6
60													1								1
70										5		1	6								12
81			1																		1
82			1																		1
83			5													1					6
84	1		6																	1	8
85																					
90																					
01						1				4			2							4	11
Total	1		13	1	1	6	8	12		108	6	1	12	1	1	6	8			11	196

APPENDIX 7

Physics:	Code No.
T: O.K. Open the book(1) page # #(2)# # #(3)	60,60,01
and read problem number 14 (4) and think about it.	60
# #(5)# # #(6)# # #(7) What's the	60,01,01
ratio, what's required is the ratio(8) of the	70
length(9) of an air column closed from one of its	70
ends,(10) to an air column open at both ends,(11)	70,70
when the closed air column produces(12) its third	70
resonance and the open column produces(13) its fourth	70
resonance, affected(14) by the vibration of the same	70
tuning fork (15)# # #(16)# # #(17)# #	70,01,01
# (18) I want to find the ratio between(19) # the	01,70
length of the(20) closed air column #(21) when it	70,70
produces its third resonance(22) affected by a tuning	70
fork # (23) # and the length of the open(24) air	70,70
column when it produces(25) its fourth resonance	70
affected by the vibration(26) of the same fork.	70
# #(27) # What's required is the ratio(28)	70,70
because # you're not given the speed of sound(29)	53
or the vibration of the affecting fork,(30) therefore	53
in this case # #(31) you won't be able to find the	53
length of the closed(32) air column # #(33) how	53,53
much it is exactly #(34) nor the length of the open	53
air column exactly,(35) but we can find the ratio(36)	53,53
between their lengths # #(37) O.K. Let's think	53
together. #(38) Heh, # the one over there. (39)	70,60
# # #(40) I have the same affecting(41) fork,	01,70

	I use it to affect(42) a closed air column and an open	70
	air column.(43) O.K. er, when the air(44) # column	70,53
	produces(45) # # a tone equals to(46) the tone	53,53
	of the affecting fork, (47) # # # (48) er, we	53,01
	measure it by the shortest(49) length of an air	53
	column producing resonance(50) with this fork #(51)	53,53
	we've learned about resonance in the closed air(52)	70
	column # and I affect (53) the air column by a	70
	certain fork(54) # # so you strike the fork(55)	70,70
	and bring it near to the opening of the column #(56)	70
	and you change the length of the air column, and	
	we've said this before, (57) until resonance	70
	occurs, (58) and when resonance occurs, (59) the	70,53
	frequency of the air column(60) will be equal to the	53
	frequency of the affecting fork.(61) O.K. The length	53
	of the air column(62) where the first resonance(63)	53,53
	occurred,this is what we call the shortest length(64)	53
	of a closed air column, # (65) and there's a	53
	relationship between its length(66) and the length of	53
	the wave.(67) What's the relationship between the	53
	shortest length(68) of a closed air column and the	43
	length of thg resulting wave?(69) A closed air column	43
	and the length of the resulting wave?(70) We've seen	43
	this before. Heh? # (71)	10
S:	(W) equals four (L). (72)	83
T:	I'm saying the relationship between(73) the shortest	30
	length of a closed air column,(74) and let its length	53
	be (L), and the length of(75) the resulting wave,	53
	what's the relationship between them?(76)	43

S1: A quarter of (L). (77) 83

S2: (L) equals. (78) 83

S1: A quarter of (W). (79) 83

T: Yes, the shortest length of a closed air column (80) 30
equals a quarter of a wave. And from that(81) we knew 53
that the length of the resulting wave.. (82) 53

Ss: Four (L). (83) 83

T: Four (L). O.K.(84) er, this (L), considering that(85) 30,53
it's the shortest length of a closed air column(86) 53
producing resonance, and we said that(87) # if you 53
change the length of the air column(88) after hearing 53
the resonance,(89) the resonance will disappear, but 53
it returns once more(90) when the length of the air 53
column becomes(91) how many times in relation to(92) 43,43
its first length? Heh, how many times.(93) 43

S: _ _ _ _ _ _ _ (94) 01

T: Three times the length of the first air column(95) 30
which produced the first resonance. And if I
change(96) the length of the column which has 53
produced the second resonance,(97) the second 53
resonance will disappear, but(98) by continuously 53
changing the length through increase,(99) the 53
resonance will return once more when the length of
the(100) air column becomes how much in relation to 53
the first length?(101) 43

S: Five times as much. (102) 83

T: Five times as much. And we knew from this(103) that 30
there's a ratio between the lengths of the air(104) 53
columns which produce resonance with(105) the same 53
fork if the column(106) is closed. What's this 53

ratio?(107) 43

S: _ _ _ _ _ (108) 01

T: You've said it. The one which produces the second resonance(109) is three times the length of the first 30
air column.(110) And when the third resonance 53
occurs,(111) the length of the air column is five 53
times(112) the length of the first air column, and so 53
on.(113) So what's the ratio?(114) 53,42

S: One to three. (115) 82

T: One to three to five. O.K.(116) From the general wave 30
equation(117) which is applied in the case of 53
resonance(118) in the closed air columns,(119) I've 53,53
got the length of the wave four (L).(120) The general 53
wave equation(121) is (S) equals (F) by (W),(122) and 53,53
we've known from this that (S) equals(123) (F) by 53
four (L). O.K.(124) This is the equation which we 53
apply(125) in the case of closed air columns(126) And 53,53
We've said that this means the shortest(127) length 53
of a closed air column producing.. (128) 53

Ss: Resonance. (129) 83

T: Resonance. And when it produces resonance(130) # # 30
#(131) er, the first, when the first resonance 01
occurs,(132) this is the strongest resonance we 53
hear.(133) The second resonance is weaker, and the 53
third is weaker.(134) From this relationship I'll be 53
able to(135) find the length of the shortest air 53
column(136) producing resonance, which is resonance 53
number what?(137) 43

S: One. (138) 83

T:	Number one. After I've found(139) the length of the	30
	shortest air column(140) at which resonance occurs,	53
	and this is the first resonance,(141) we can after	53
	that by knowing this ratio and so on,(142) calculate	53
	the length of the air column(143) at which the second	53
	resonance occurs,(144) and the third and the fourth,	53
	and so on.(145) This means, to find the length of the	53
	air column(146) at which the third,or the fourth(147)	53,53
	or the fifth resonance occurs,(148) I must first	53
	know(149) the length of the air column at which the	43
	resonance number what occurs?(150)	43
Ss:	First. (151)	83
T:	And I can get this by the equation.(152) This means,	70
	from this equation I'll know the shortest(153) length	53
	of an air column producing the first resonance.(154)	53
	O.K. With regard to # (155) the open air column, #	43
	which is(156) applied in the case of open air	43
	columns, heh? (157)	43
S:	(S) equals (F) by two (L). (158)	83
T:	(S) equals (F) by two (L). O.K.(159) As (L) here	30
	stands for?(160)	43
S:	The length of the air column. (161)	83
T:	Yes, at which what resonance occurs? (162)	43
S:	The first. (163)	83
T:	The first. (L) in this equation,(164) or in this one,	30
	means(165) the length of the air column at which(166)	53,53
	the first resonance occurs. # (167) And because	53
	there are lengths at which(168) second, third, and	53
	fourth resonance occur,(169) then the length at which	53
	the first resonance occurs(170) is what we call the	53

shortest length(171) of air column. Here closed,(172) 53,53
in this relationship, and here open. O.K.(173) In the 53
light of this(174) our purpose is to find the ratio 70
between(175) the length of the closed air column(176) 70,70
at which the third resonance occurs,(177) and the 70
length of the open air column (178) at which the 70
resonance number what occurs?(179) 43

Ss: The fourth. (180) 83

T: The fourth. O.K. If we've (181) known the ratio 30
between # (182) the lengths of the air columns 70
which produce(183) resonance with the same fork,(184) 70,70
this is in the case of the closed columns,(185) and 70
we've mentioned before, when we were studying
resonance(186) in the open air columns,(187) the 70,70
ratio between the lengths of the air(188) columns 70
which are open, the lengths(189) of the open air 70
columns which produce resonance with(190) the same 70
fork, this ratio, we've mentioned it before,(191) is 53
one to two to three to four, and so on.(192)# So if 53
you get(193) the length of the open air column at 53
which(194) the first resonance occurs # (195) then 53,53
very simply, we can calculate(196) what the length of 53
the open air column is at which(197) the second 53
resonance occurs. It'll be double, heh? (198) 43

Ss: The first. (199) 83

T: The first. And what's the length of the open air(200) 30
column at which the third resonance occurs?(201) 43

Ss: Three times as much. (202) 83

T: Three times as much, and the fourth resonance?(203) 43

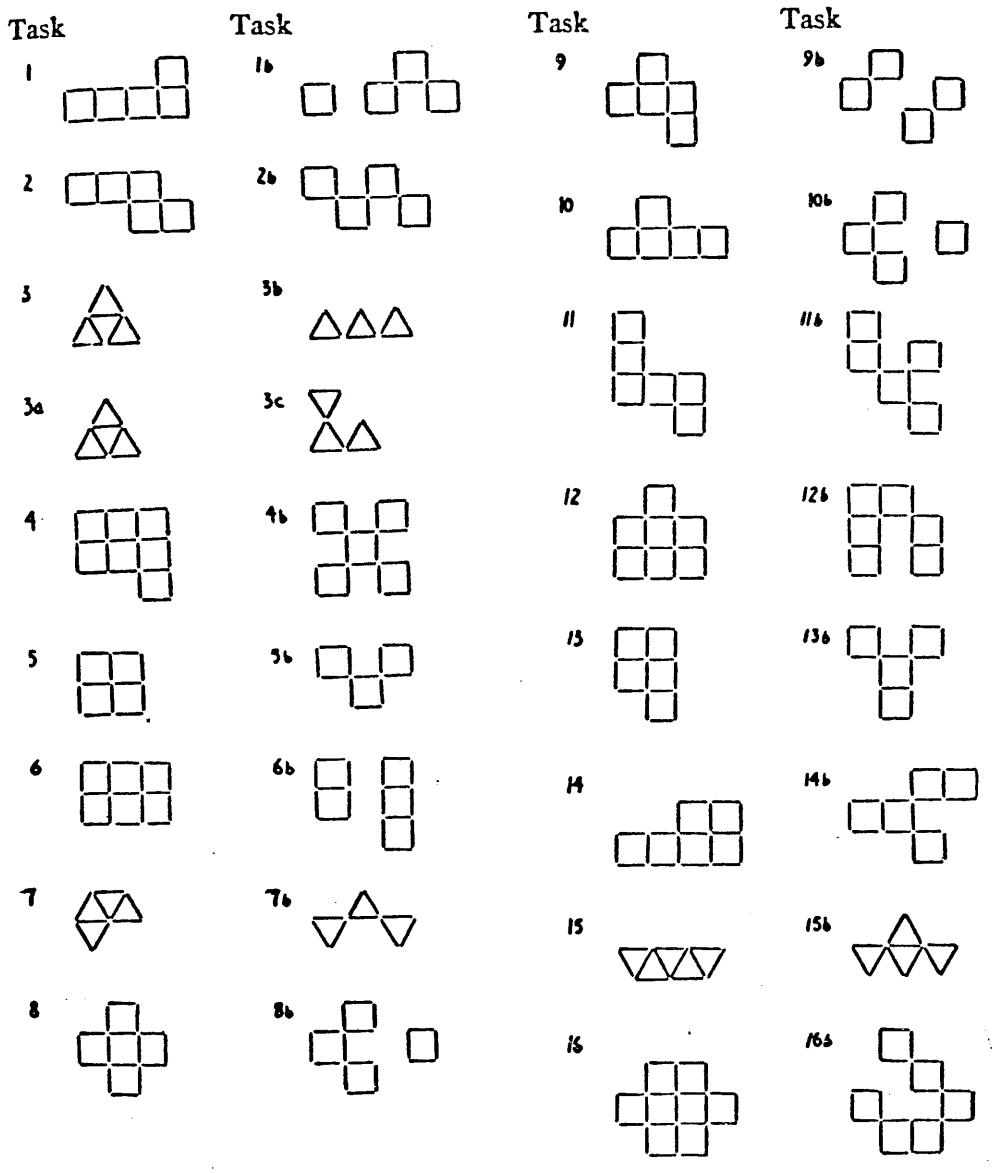
Ss:	Four times as much. (204)	83
T:	Four times as much. O.K. So in the light of this(205)	30
	er, we want to calculate the ratio(206) between the	70
	length of the closed air column(207) at which the	70
	third resonance occurs,(208) and the length of the	70
	open air column(209) at which the fourth resonance	70
	occurs,(210) under the effect of the same tuning	70
	fork.(211) This means, the fork I used to affect the	70
	closed(212) column is the same as the one I use for	70
	the open column.(213) So what do I do? # Heh,(214)	70,70
	what do we do? Let's think together on the	
	blackboard.(215)	70

Appendix 7 (continued): Interaction Analysis Matrix.

Category	10	20	30	41	42	43	44	51	52	53	54	60	70	81	82	83	84	85	90	01	Total
10																1					1
20																					
30						2				9			2							1	14
41																					
42															1						1
43	1					7										11				2	21
44																					
51																					
52																					
53					1	9				75			3			2				1	91
54																					
60												2								3	5
70						1				5		1	45							2	54
81																					
82			1																		1
83			11			2							1			2					16
84																					
85																					
90																					
01			2							2		2	3							3	12
Total	1		14		1	21				91		5	54		1	16				12	216

Appendix 8

Katona's Match Tasks



(From Katona, G., 1940, "Organizing and Memorizing: Studies in the Psychology of Learning and Teaching", Columbia University Press, p.79).

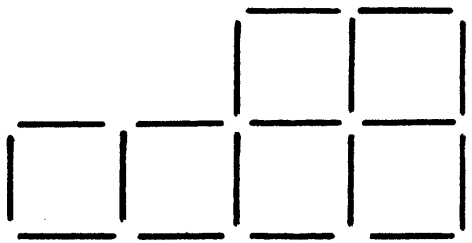
APPENDIX 9

NAME: الاسم :

GROUP: المجموعة :

TASK 14

المطلوب : تكوين ٥ مربعات من المربعات الستة المرسومة أدناه بتغيير أماكن ٣ أضلاع فقط .



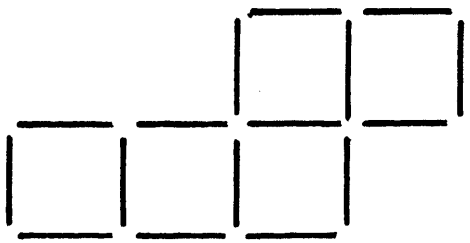
Instruction: Make five squares out of the six squares by changing the position of three sides.

NAME: الاسم :

GROUP: المجموعة :

TASK 16

المطلوب : تكوين ٤ مربعات من المربعات الخمسة المرسومة أدناه بتغيير أماكن ضلعين فقط .



Instruction: Make four squares out of the five squares by changing the position of two sides.

APPENDIX 10.

NAME _____ GROUP _____

TEST A: (18 minutes)

Arrange the sentences in each task in a logical order. Write only the sentence number in the order you choose in each case.

TASK 1

1. Organic acids contain carbon and often come from growing things, like fruit.
2. Acids can be divided into two groups; organic acids and inorganic acids.
3. An acid is a compound containing hydrogen which can be replaced by a metal.
4. Citric acid is an organic acid.
5. Hydrochloric acid is an inorganic acid.
6. Inorganic acids do not contain carbon and are usually prepared from non-living matter.

ANSWER:

TASK 2

1. Most substances may be changed from one state into another.
2. Matter may exist in three states: solid, liquid, and gas.
3. Gases have no definite volume and no shape.
4. They take on the shape of the container which they are in.
5. Solids have a definite volume and shape.
6. Liquids have a definite volume and no shape.
7. Matter is the name given to everything which has weight and occupies space.

ANSWER:

TASK 3

1. There is only one electron in the hydrogen atom.
2. The atom is a system.
3. The nucleus is the centre of the atom and consists of protons and neutrons.
4. There are seven electrons in the nitrogen atom and eight in the oxygen atom.
5. It consists of a nucleus and one or more electrons.
6. The electrons move around the central nucleus.

ANSWER:

Appendix 10 (continued)

TASK 4

1. The insect's abdomen contains its digestive and reproductive organs.
2. The head contains the insect's brain, eyes, and mouth.
3. There are three pairs of legs and two pairs of wings.
4. The body of an insect consists of three main parts.
5. The thorax is the central part of the body and it bears the legs and wings.
6. They are the head, the thorax, and the abdomen.

ANSWER:

TASK 5

1. There are two types of substances: elements and compounds.
2. Compounds are composed of molecules which have more than one type of atom in them.
3. All molecules are composed of atoms.
4. Elements are composed of molecules which have only one type of atom in them.
5. Water and acids are examples of compounds.
6. Hydrogen and oxygen, for example, are elements.
7. Substances consist of small parts called molecules

ANSWER:

TASK 6

1. This structure, and the light materials used make the building move without breaking.
2. It is made of heavy materials.
3. The parts are woven together, like a basket.
4. In one kind of building the parts are made of light, flexible materials.
5. The other kind of building is like a strong box in structure.
6. Some of the bad effects of earthquakes in towns can be prevented by making two kinds of buildings.

ANSWER:

APPENDIX 11.

NAME _____ GROUP _____

TEST B: (18 minutes)

Arrange the sentences in each task in a logical order. Write only the sentence number in the order you choose in each case.

TASK 1

1. There are three types of blood vessels: arteries, veins, and capillaries.
2. Arterial blood is bright red and contains oxygen.
3. Capillaries are tiny vessels.
4. Arteries are large tubes which carry blood to all parts of the body.
5. Veins are narrow tubes and have thin walls.
6. Blood circulates in the body through the vessels.

ANSWER:

TASK 2

1. Organic foods can be divided according to their function into two types: those which give us energy and those which build the cells of the body.
2. Cell-building foods are proteins.
3. Food is essential for the growth of the body.
4. Energy-giving foods are carbohydrates and fats.
5. There are two types of food substances: organic foods and inorganic foods.
6. Inorganic foods consist of iron, calcium and phosphorous.

ANSWER

TASK 3.

1. An acid is a compound of hydrogen which burns wood, paper, cloth and skin.
2. A salt is a substance formed when a metal takes the place of hydrogen in an acid.
3. Compounds can be divided into a number of different classes.
4. A special class of bases is called alkalis.
5. A base consists of oxides and hydroxides of metals.
6. Alkalis form soapy solutions which are used for cleaning.
7. The most important ones are: acids, bases, and salts.

ANSWER:

Appendix 11 (continued)

TASK 4

1. Vertebrates are animals which have backbones.
2. Dogs, cats, and snakes are examples of vertebrates.
3. Animals can be divided into two groups: vertebrates and invertebrates.
4. Worms and insects are examples of invertebrates.
5. Invertebrates are animals which do not have backbones.
6. There are two types of living things: animals and plants.
7. Vertebrates are divided into five classes: fish, amphibians, birds, reptiles, and mammals.

ANSWER

TASK 5

1. The sun is the centre of the solar system.
2. Some planets have satellites.
3. It is called the moon.
4. The solar system consists of a star (the sun), the planets and a number of bodies, such as satellites.
5. The earth has one satellite.
6. There are nine planets in all and they revolve around the sun.

ANSWER:

TASK 6

1. One kind is called outside calipers.
2. The other kind is called inside calipers.
3. They can be used to measure diameters of metal bars or tubes.
4. They are used to measure inside, or internal, diameters.
5. There are two kinds of calipers.
6. Calipers are instruments which are used for measuring the dimensions of small objects.
7. They are used to measure outside, or external, diameters.

ANSWER:

APPENDIX 12.

NAME _____ GROUP _____

TEST C: (18 minutes)

Arrange the sentences in each task in a logical order. Write only the sentence number in the order you choose in each case.

TASK 1

1. There are three types of blood vessels: arteries, veins, and capillaries.
2. Arterial blood is bright red and contains oxygen.
3. Capillaries are tiny vessels.
4. Arteries are large tubes which carry blood to all parts of the body.
5. Veins are narrow tubes and have thin walls.
6. Blood circulates in the body through the vessels.

ANSWER:

TASK 2

1. A lizard is a reptile but a frog is an amphibian.
2. Vertebrates are animals which have backbones.
3. A cow is a mammal, but a duck is a bird.
4. Cold-blooded animals consist of reptiles, amphibians, and fish.
5. A shark is an example of fish.
6. Warm-blooded animals consist of mammals and birds.
7. Vertebrates are divided into warm-blooded animals and cold-blood animals.

ANSWER:

TASK 3

1. Natural water is the water we get from rivers, the ground, or rain.
2. It is produced in industry.
3. Man-made water is called pure water and is made up of only hydrogen and oxygen.
4. There are two types of water in nature: man-made water and natural water.
5. Therefore it is not good for drinking.
6. It usually contains dissolved elements.

ANSWER:

Appendix 12 (continued)

TASK 4

1. Monobasic acids have only one replaceable hydrogen atom in each molecule.
2. Hydrochloric acid is a monobasic acid, but sulphuric acid is dibasic.
3. Dibasic and tribasic acids have two or three replaceable hydrogen atoms in each molecule.
4. The hydrogen in an acid is replaceable by a metal.
5. They are monobasic acids or dibasic and tribasic acids.
6. Acids can be divided into classes according to the number of atoms in each molecule which a metal can replace.

ANSWER:

TASK 5

1. The insect's abdomen contains its digestive and reproductive organs.
2. The head contains the insect's brain, eyes, and mouth.
3. There are three pairs of legs, and two pairs of wings.
4. The body of an insect consists of three main parts.
5. The thorax is the central part of the body and it bears the legs and wings.
6. They are the head, the thorax and the abdomen.

ANSWER:

TASK 6

1. Vitamin E is found in butter, and vitamin K is found in some vegetables.
2. Water-soluble vitamins are vitamin B and vitamin C.
3. Fat-soluble vitamins are vitamins A, D, E and K.
4. Vitamin B is found in milk and meat, and vitamin C is found in fresh fruit and vegetables.
5. Vitamins can be divided into two groups: those which are fat-soluble and those which are water-soluble.
6. Vitamins A and D are found in milk.

ANSWER:

APPENDIX 13.

NAME _____ GROUP _____

TEST A: (18 minutes)

Complete the passive sentences. Use the past participle given at the end of each sentence.

1. Active: We form some salts from hydrochloric acid.

   Passive: Some salts _____ from hydrochloric acid. (formed)

2. Active: We call these salts chlorides.

   Passive: These salts _____ chlorides. (called)

3. Active: We may change a liquid into a solid by cooling.

   Passive: A liquid _____ into a solid by cooling. (changed)

4. Active: Man has discovered many sources of energy.

   Passive: Many sources of energy _____. (discovered)

5. Active: We cannot see air.

   Passive: Air _____. (seen)

6. Active: In the Past man produced heat by burning trees.

   Passive: In the past heat _____ by burning trees. (produced)

7. Active: We use different methods for heating now.

   Passive: Different methods _____ for heating now. (used)

8. Active: We may heat chemicals by using a bunsen burner.

   Passive: Chemicals _____ by using a bunsen burner. (heated)

9. Active: Earthquakes have killed many people all over the world.

   Passive: Many people all over the world _____ by earthquakes. (killed)

10. Active: We examine small objects under the microscope.

    Passive: Small objects _____ under the microscope. (examined)

11. Active: Frank Whittle invented the jet engine in 1941.

    Passive: The jet engine _____ in 1941 by Frank Whittle. (invented)

12. Active: Drake drilled the first oil well in 1859.

    Passive: The first oil well _____ in 1859 by Drake. (drilled)

APPENDIX 14.

NAME _____ GROUP _____

TEST B: (18 minutes)

Complete the passive sentences. Use the past participle given at the end of each sentence.

1. Active: We use a thermometer to measure temperature.

   Passive: A thermometer _____ to measure temperature (used)

2. Active: The brain controls our movements.

   Passive: Our movements _____ by the brain. (controlled)

3. Active: We may change a solid into a liquid by heating.

   Passive: A solid _____ into a liquid by heating. (changed)

4. Active: We can feel the pressure of air.

   Passive: The pressure of air _____. (felt)

5. Active: In the past man made weapons from stone.

   Passive: In the past weapons _____ from stone. (made)

6. Active: Man has tried many methods to control pollution.

   Passive: Many methods _____ to control pollution. (tried)

7. Active: We should keep acids in a safe place.

   Passive: Acids _____ in a safe place. (kept)

8. Active: We use hydrogen in balloons because it is lighter than air.

   Passive: Hydrogen _____ in balloons because it is lighter than air. (used)

9. Active: Newton discovered gravity in the seventeenth century.

   Passive: Gravity _____ in the seventeenth century by Newton. (discovered)

10. Active: We have known most metals for many years.

    Passive: Most metals _____ for many years. (known)

11. Active: Someone invented the pump 300 years ago.

    Passive: The pump _____ 300 years ago. (invented)

12. Active: We fix a fuse in most electrical instruments for safety.

    Passive: A fuse _____ in most electrical instruments for safety. (fixed)

APPENDIX 15.

NAME _____ GROUP _____

TEST C: (18 minutes)

Complete the passive sentences. Use the past participle given at the end of each sentence.

1. Active: Frank Whittle invented the jet engine in 1941.

   Passive: The jet engine _____ in 1941 by Frank Whittle. (invented)

2. Active: We examine samll objects under the microscope.

   Passive: Small objects _____ under the microscope. (examined)

3. Active: We have used the atomic energy to produce electricity.

   Passive: The atomic energy _____ to produce electricity. (used)

4. Active: Faraday made many discoveries in chemistry.

   Passive: Many discoveries _____ in chemistry by Faraday. (made)

5. Active: We can heat the mixture.

   Passive: The mixture _____. (heated)

6. Active: We heated the mixture.

   Passive: The mixture _____. (heated)

7. Active: We should keep acids in a safe place.

   Passive: Acids _____ in a safe place. (kept)

8. Active: Man has tried many methods to control pollution.

   Passive: Many methods _____ to control pollution. (tried)

9. Active: We may prepare oxygen by mixing potassium chlorate with manganese oxide.

   Passive: Oxygen _____ by mixing potassium chlorate with manganese oxide. (prepared)

10. Active: We place the mixture in a test tube.

    Passive: The mixture _____ in a test tube. (placed)

11. Active: We heat the mixture.

    Passive: The mixture _____. (heated)

12. Active: The have heated the mixture.

    Passive: The mixture _____. (heated)

BIBLIOGRAPHY

I. GENERAL:

ADAMSON, D., 1977, "From Memorisation to Language Functions", in S. Holden (Ed.), 1977, "English for Specific Purposes", Modern English Publications, p.42-44.

ALLEN, J., 1975, "English, Science and Language Teaching: The 'Focus' Approach", in EDUTEC 9, p.28-35.

ALLEN J. and H. WIDDOWSON, 1974, "Teaching the Communicative Use of English", in IRAL, Vol. 12.1, p.1-21.

ALLWRIGHT, R., 1980, "Turns Topics, and Taks: Pattern of Participation in Language Learning and Teaching", in D. Larsen - Freeman (Ed.), 1980, "Discourse, Analysis in Second Language Research", Newbury House, p.165-187.

AMIDON, E. and J. HOUGH, (Eds.), 1967, "Interaction Analysis: Theory, Research, and Application", Addison-Wesley.

AMIDON, E. and N. FLANDERS, 1963, "The Role of the Teacher in the Classroom", Amidon & Associates.

ANDERSON, H., 1939, "The Measurement of Domination and of Socially Integrative Behaviour in Teachers' Contacts with Children", in Child Development, Vol. 10, p.73-89.

ANDERSON, J. and R. BINGMAN, 1969, "Recording Teacher and Pupil Verbal Inquiry Behaviours in Classrooms: A Technical Manual for Observers", in A. Simon and E. Boyer (Eds.), 1970, "Mirrors for Behaviour", Supplement Vol. A, p.1-37.

ARRAYED, J., 1980, "A Critical Analysis of School Science Teaching in Arab Countries", Longman.

ASCHNER, M., 1961, "The Language of Teaching", in B. Smith and R. Ennis (Eds.), 1961, "Language and Concepts in Education", Rand McNally, p.112-126.

ASCHNER, M., 1963, "The Analysis of Verbal Interaction in the Classroom", in A. Bellack, (Ed.), 1963, "Theory and Research in Teaching", Teachers College, Columbia University, p.53-78.

The Association for Science Education, 1979, "Alternatives for Science Education".

AUSTIN, J., 1962, "How to do Things with Words", Oxford University Press.

BAILEY, L., 1975, " An Observational Method in the Foreign Language Classroom: A Closer Look at Interaction Analysis", in Foreign Language Annals, Vol. 8.4, p.335-344.

BARNES, D., 1971, "Language in the Secondary Classroom", in D. Barnes, J. Britton, and H, Rosen (Eds.), 1971, "Language, the Learner and the School", (Revised Edition), Penguin, p.11-77.

BATES, M., 1978, "Writing 'Nucleus'", in R. Mackay and A. Mountford (Eds.), 1978, "English for Specific Purposes", Longman, p.78-96.

BATES, M. and A. DUDLEY-EVANS, 1974, "Notes on the Introductory English Course for Students of Science and Technology at the University of Tabriz", in ELT Documents 74/4, ETIC, British Council, p.12-18.

BELLACK, A., H. KLIEBARD, and F. SMITH, 1966, "The Language of the Classroom", Teachers College, Columbia University.

BIDDLE, B., 1967, "Methods and Concepts in Classroom Research", in Review of Educational Research, Vol. 37.3, p.337-357.

British Council (Bahrain) and Education and Science Division (London), 1974, "Education Profile-Bahrain".

British Council English-Teaching Information Centre, 1974, "English Language Teaching Profile. Area: Lower Gulf States. Countries: Bahrain, Oman, Qatar, United Arab Emirates (UAE)."

British Council English-Teaching Information Centre, 1978a, "The Foreign Language Learning Process", An Occasional Paper, British Council.

British Council English-Teaching Information Centre, 1978b, "English for Specific Purposes", ELT Documents, No.101, British Council.

BROOKES, B., 1959, "The Teaching of English to Scientists and Engineers", in R. Quirk and A. Smith (Eds.), 1959, "The Teaching of English", Secker and Warburg, p.133-163.

BRUMFIT, C., 1977, "Common Sense about ESP", in S. Holden (Ed.), 1977, "English for Specific Purposes", Modern English Publications, p.71-72.

BRUNER, J., 1960, "Individual and Collective Problems in the Study of Thinking", in Annals New York Academy of Science, Vol. 91, p.22-37.

BRUNER, J., 1961, "The Act of Discovery", in Harvard Educational Review, Vol. 31.1, p.21-32.

BRUNER, J., 1966, "Toward a Theory of Instruction", Harvard University Press.

BURT, M., H. DULAY, and M. FINOCCHIARO,(Eds.), 1977, "Viewpoints on English as a Second Language", Regents Publication.

CAMPBELL, R. and R. WALES, 1970, "The Study of Language Acquisition", in J.Lyons (Ed.), 1970, "New Horizons in Linguistics", Penguin, p.242-260.

CANDLIN, C.N., J.M. KIRKWOOD, and H.M. MOORE, 1978, "Study Skills in English: Theoretical Issues and Practical Problems", in R. Mackay and A. Mountford (Eds.), 1978, "English for Specific Purposes", Longman, p.190-219.

CARROL, J. B., 1964, "Language and Thought", Prantice-Hall.

CARROL, J.B., 1965, "The Contributions of Psychological Theory and Educational Research to the Teaching of Foreign Languages", in the Modern Language Journal, Vol. 49.5, p.273-281.

CHAMBERLAIN, R., and M. FLANAGAN, 1978, "Developing a Flexible ESP Programme Design", in British Council English-Teaching Information Centre, "English for Specific Purposes", ELT Documents, British Council, p.36-55.

CHASTAIN, K., 1970, "A Methodological Study Comparing the Audio-Lingual Habit Theory and the Cognitive Code-Learning Theory — A Continuation", in The Modern Language Journal, Vol. 54.4, p.257-266.

CHASTAIN, K., 1971, "The Audio-Lingual Habit Theory Versus the Cognitive Code-Learning Theory: Some Theoretical Considerations", in R. Lugton and C. Heinle (Eds.), 1971, "Toward a Cognitive Approach to Second Language Acquisition", Centre for Curriculum Development, p.11-121.

CHASTAIN, K. and F. WOERDEHOFF, 1968, "A Methodological Study Comparing the Audio-Lingual Habit Theory and Cognitive Code- Learning Theory", in The Modern Language Journal, Vol. 52.5, p.268-279.

CHEONG, L. K., 1976, "Trends in the Linguistic Study of English for Science and Technology", in J. C. Richards (Ed.) 1976, "Teaching English for Science and Technology", Singapore University Press. p.3-17.

CHIU, L., 1972, "A Cross-Cultural Comparison of Cognitive Style in Chinese and American Children", in International Journal of Psychology, Vol. 7.4, p. 235-242.

COLE, L., 1940, "The Teacher's Handbook of Technical Vocabulary", Public School Publishing.

COOK, V., 1971, "The Analogy between First- and Second-Language Learning", in R. Lugton and C. Heinle, (Eds.), 1971, "Toward a Cognitive Approach to Second Language Acquisition", The Centre for Curriculum Development, p.99-109.

CORBLUTH, J. D., 1975, "English? - or 'Special English'?", in ELT Journal, Vol. 29.4, p.277-286.

COULTHARD, M., 1977, "An Introduction to Discourse Analysis", Longman.

COWAN, J. and Z. SARMAD, 1976, "Reading Performance of Bilingual Children According to Type of School and Home Language", in Language Learning, Vol. 26.2, p.353-376.

CURTIS, F., 1938, "Investigations of the Vocabularies in Textbooks of Science for Secondary Schools", Ginn and Co.

DELAMONT, S., 1976, "Interaction in the Classroom", Methuen.

DELAMONT, S. and D. HAMILTON, 1976, "Classroom Research: A Critique and a New Approach", in M. Stubbs and S. Delamont (Eds.), 1976, "Explorations in Classroom Observation", John Wiley, p.3-20.

DHAIF, H., 1976, "Some Aspects of Teaching English in Technical Schools in Bahrain", unpublished Associateship Report, University of London Institute of Education.

DHAIF, H., 1977, "A Functional Approach to Teaching English in Bahraini Technical Schools", unpublished M.A. Dissertation, University of London Institute of Education.

DIENES, Z., 1959, "The Growth of Mathematical Concepts in Children Through Experience", in Educational Research, Vol. 2.1, The National Foundation for Educational Research in England and Wales, Newnes Educational Publication, p.9-28.

DILLER, K., 1976, "Criteria for Adapting Language Teaching Methods to the Learning Styles and Abilities of Students", in G. Nickel (Ed.), 1976, "Proceedings of the Fourth International Congress of Applied Linguistics", Vol. 3, Hockschul Verlag, p.341-351.

DOYLE, W., 1979, "Classroom Effects", in Theory into Practice, Vol. 18.3, p.138-144.

DUDLEY-EVANS, A., C.SHETTLESWORTH, and M. K. PHILLIPS, 1976, "The ESP Materials of the University of Azarabadegan, Tabriz, Iran", in J. C. Richards (Ed.), 1976, "Teaching English for Science and Technology", Singapore University Press, p.163-181.

EDWARDS, P. J., 1974, "Teaching Specialist English (with Special Reference to English for Nurses and Midwives in Nigeria)", in ELT Journal, Vol. 28.3, p.247-252.

FANSELOW, J. F., 1977, "Beyond Rashomon - Conceptualizing and Describing the Teaching Act", in TESOL Quarterly, Vol.11.1, p.17-39.

FIELDER, M., 1975, "Bidirectionality of Influence in Classroom Interaction", in Journal of Educational Psychology, Vol. 67.6, p.735-744.

THE FINANCIAL TIMES, 1976, "Financial Times Survey: Bahrain", 10 February.

FLANDERS, N., 1960, "Teacher Influence, Pupil Attitudes, and Achievement", Co-operative Research Project No.397, U.S. Office of Education.

FLANDERS, N., 1970, "Analysing Teaching Behaviour", Addison-Wesley.

FLANDERS, N., 1972, "Interaction Analysis and Inservice Training", in A. Morrison and D. McIntyre (Eds.), 1972, The Social Psychology of Teaching", Penguin, p.63-74.

FLOOD, W., 1957, "The Problem of Vocabulary in the Popularisation of Science", Oliver and Boyd.

FREUDENSTEIN,R., 1977, "Interaction in the Foreign Language Classroom", in M. Burt, H. Dulay, and M. Finnocchiaro (Eds.), 1977, "Viewpoints on English as a Second Language", Regents Publication, p.76-83.

GAGNÉ R., 1970, "The Conditions of Learning", Second Edition, Holt, Rinehart and Winston.

GAGNÉ, R. and L. BROWN, 1961, "Some Factors in the Programming of Conceptual Learning", in Journal of Experimental Psychology, Vol. 62.4, p.313-321.

GALLAGHER, J.,and M. ASCHNER, 1963, "A Preliminary Report on Analysis of Classroom Interaction", in Merrill-Palmer Quarterly, Vol. 9.3, p.183-194.

GARRY, R. and H. KINGSLEY, 1970, "The Nature and Conditions of Learning", Third Edition, Prentice-Hall.

GOODMAN, K. S., 1967, "Reading: A Psycholinguistic Guessing Game", in Journal of the Reading Specialist", Vol. 6.4, p.126-135.

GREENE, J., 1975, "Thinking and Language", Methuen.

HALLIDAY, M.A.K., McINTOSH, A., and P. STREVENS, 1964, " The Linguistic Science and Language Teaching", Longman.

HENN, T., 1951, "The Apple and The Spectroscope", Methuen.

HINELY, R. and G. PONDER, 1979, "Theory, Practice and Classroom Research", in Theory Into Practice, Vol. 18.3, p.135-137.

HITCHOCK, J., 1978, "Reading and Scientific English: Prospects, Problems, and Programmes in Iran", in M. Trimble, L. Trimble, and K. Drobnic (Eds.), 1978, "English for Specific Purposes: Science and Technology", English Language Institute, Oregon State University, p.9-52.

HUTCHINSON, T. and A. WATERS, 1980, "Communication in the Technical Classrrom: You Just Shove this Little Chappie in Here Like that", in ELT Documents Special, "Projects in Materials Design", British Council, p.7-37.

HYMES, D., 1967, "Models of the Interaction of Language and Social Setting", in Journal of Social Issues, Vol. 23.2, p.8-28.

HYMES, D., 1972, "On Communicative Competence", in J. Pride and J. Holmes (Eds.), 1972, "Sociolinguistics", Penguin, p.269-293.

INGLE, R. and A. TURNER, 1981, "Science Curricula as Cultural Misfits", in European Journal of Science Education, Vol. 3.4, p.357-371.

JENKINS, J., 1969, "Influence of Student Behaviour on Teacher's Self-Evaluation", in Journal of Educational Psychology, Vol. 60.6, p.439-442.

KAPLAN, R., 1966, "Cultural Thought Patterns in Inter-Cultural Education", in Language Learning, Vol. 16.1, p.1-20.

KATONA, G., 1940, "Organizing and Memorizing: Studies in the Psychology of Learning and Teaching", Columbia University Press.

KELLY, P., 1978, "Science, Life and Education", Chelsea College, University of London.

KIRKMAN, J., 1978, "How Common are 'Common Core' Words?", in ESPMENA Bulletin, Vol. 10, p.15-18.

KRASHEN, S., 1976, "Formal and Informal Linguistic Environments in Language Acquisition and Language Learning", in TESOL Quartely, Vol. 10.2, p.157-168.

KRASHEN, S., 1977, "The Monitor Model for Adult Second Language Performance", in M. Burt, H. Dulay, and M. Finocchiaro (Eds.), 1977, "Viewpoints on English as a Second Language", Regents Publication, p.152-161.

KRASHEN, S., 1978, "The Monitor Model for Second-Language Acquisition", in R. Gingras (Ed.)1978, "Second-Language Acquisition and Foreign Language Teaching", Centre for Applied Linguistics, p.1-26.

KRASHEN, S. and SELIGER, H., 1975, "The Essential Contributions of Formal Instruction in Adult Second Language Learning", in TESOL Quarterly, Vol. 9.2, p.173-183.

LABOV, W., 1972, "The Study of Language in its Social Context", in J. Pride and J. Holmes (Eds.), 1972, "Sociolinguistics", Penguin, p.180-202.

LACKSTROM, J., 1977, "The Comprehension of English for Science and Technology: Arguments and Definitions", in Studies in Language Learning, Vol. 2.1, p.45-66.

LACKSTROM, J., L. SELINKER, and L. TRIMBLE, 1973, "Technical Rhetorical Principles and Grammatical Choice", in TESOL Quarterly, Vol. 7.2, p.127-136.

MACKAY, R. 1975, "Languages for Special Purposes", in Edutec 3, p.24-33.

MACKAY, R., 1978, "Identifying the Nature of the Learner's Needs", in R. Mackay and A. Mountford (Eds.), 1978, "English for Specific Purposes", Longman, 1978, p.21-37.

MACKAY, R. and A. MOUNTFORD, (Eds.), 1978, "English for Specific Purposes", Longman.

MACKEY, W. F., 1977, "Polychronometry in Lesson Analysis", in M. Burt, H. Dulay, and M. Finocchiaro, (Eds.), 1977, "Viewpoints on English as a Second Language", Regents Publication, p.55-75.

MACMILLAN, M., 1976, "A Survey of Recent Trends in the Development of English Courses for Students of Science and Technology", in G. Wilson (Ed.), 1976, "Curriculum Development and Syllabus Design for English Teaching", Singapore University Press, p.41-50.

MAGE, T., 1978, "Contrastive Discourse Analysis: EST and SST", in M. Trimble, L. Trimble, and K. Drobnic (Eds.), 1978, "English for Specific Purposes: Science and Technology", English Language Institute, Oregon State University, p.154-166.

MAIER, N.R.F., 1930, "Reasoning in Humans: I.On Direction", in Journal of Comparative Psychology, Vol. 10, p.115-143.

MAIER, N.R.F., 1931, "Reasoning in Humans: II. The Solution of a Problem and its Appearance in Consciousness", in Journal of Comparative Psychology, Vol. 12, p.181-194.

McTEAR, M., 1976, "Potential Sources of Confusion in Foreign Language Lessons: The Rules of the Game", in G. Nickel (Ed.), 1976, "Proceedings of the Fourth International Congress of Applied Linguistics", Vol. 3, Hockschul Verlag, p.385-397.

MEHAN, H., 1979, "What Time is it Denise?: Asking Known Information Questions in Classroom Discourse", in Theory Into Practice, Vol. 18.4, p.285-294.

MEHAN, H. and H. WOOD, 1975, "The Reality of Ethnomethodology", Willey-Interscience.

MOSKOWITZ, G., 1971, "Interaction Analysis — A New Modern Language for Supervisors", in Foreign Language Annals, Vol. 5.2, p.211-221.

MOSKOWITZ, G., 1976, "The Classroom Interaction of Outstanding Foreign Language Teachers", in Foreign Language Annals, Vol. 9.2, p.135-157.

NEWELL, A., J. SHAW, and A. HERBERT, 1958, "Elements of a Theory of Human Problem Solving", in Psychological Review, Vol. 65.3, p.151-166.

NOBLE, C. and J. NOLAN, 1976, "Effect of Student Verbal Behaviour on Classroom Teacher Behaviour", in Journal of Educational Psychology, Vol. 68.3, p.342-346.

OGDEN, C. K., 1931, "Basic English Applied: Science", Kegan Paul.

OGDEN, C. K., 1932, "The ABC of Basic English", Kegan Paul.

OGDEN, C. K., 1942, "Basic for Science", Kegan Paul.

OPITZ, K., 1973, "Factor Control as a Strategy of Second/Third Language Teaching", in M. De Grève, M. Gorosch, C. Sandulescu, and F. Van Passel, (Eds.), 1973, "Modern Language Teaching to Adults: Language for Special Purposes", AIMAV, p.61-69.

PAYNE, R.M., 1975, "Who says What? The Rationale for Language Surveys in Preparing Language Materials for Special Purposes", in Edutec 9, p.24-27.

PERREN, G. (Ed.), 1969, "Languages for Special Purposes", CILT, Reports and Papers, No. 1.

PERREN, G. (Ed.), 1971, "Science and Technology in a Second Language", CILT, Reports and Papers, No. 7.

PERREN, G. (Ed.), 1974, "Teaching Languages to Adults for Special Purposes", CILT, Reports and Papers No. 11.

PHILLIPS, M. and C. SHETTLESWORTH, 1976, "Questions in the Design and Use of Courses in English for Specialised Purposes", in G. Nickel (Ed.), 1976, "Proceedings of the Fourth International Congress of Applied Linguistics", Vol. 1, Hockschul Verlag, p.249-264.

PHILLIPS, M., and C.SHETTLESWORTH, 1978, "How to ARM your Students: A Consideration of Two Approaches to Providing Materials for ESP", in British Council English-Teaching Information Centre, "English for Specific Purposes", ELT Documents, British Council, p.23-35.

PIT CORDER, S., 1973, "Introducing Applied Linguistics", Penguin.

POWERS, S., 1925, "The Vocabularies of High School Science Textbooks", in Teachers College Record, Vol. 28.

PRESSEY, L., 1924, "Vocabulary Lists in Fifteen School Subjects", Public School Publishing.

PRITCHARD, N., and R. CHAMBERLAIN, 1974, "Special Purpose English: Changing Approaches to English Language Teaching", in RELC Journal, Vol. 5.2, p.48-57.

RICHARDS, J.C., (Ed.), 1976, "Teaching English for Science and Technology", Singapore University Press.

RITCHIE, W. (Ed.), 1978, "Second Language Acquisition Research", Academic Press.

ROBINSON, P., 1980, "ESP (English for Specific Purposes)", Pergamon Press.

ROE. P., 1980, "Purposeful Language", a Paper Presented for the Conference "Education Arabia", Bahrain, 16-20 March, 1980.

SACKS, H., E. SCHEGLOFF, and G. JEFFERSON, 1974, "A Simplest Systematics for the Organization of Turn-Taking for Conversation", in Language, Vol. 50.4, p.697-735.

SELIGER, H., 1975, "Inductive Method and Deductive Method in Language Teaching: A Re-Examination", in IRAL, Vol. 13.1, p.1-18.

SELIGER, H., 1979, "On the Nature and Function of Language Rules in Language Teaching", in TESOL Quarterly, Vol. 13.3, p. 359-369.

SELINKER, L., L. TRIMBLE, and R. VROMAN, 1974, "Presupposition and Technical Rhetoric", in ELT Journal, Vol. 29.1, p.59-65.

SELINKER, L., R. TRIMBLE, and L. TRIMBLE, 1976, "Presuppositional Rhetorical Information in EST Discourse", in TESOL Quarterly, Vol. 10.3, p.281-290.

SHARWOOD SMITH,M., 1981, "Consciousness-Raising and the Second Language Learner", in Applied Linguistics, Vol. 11.2, p.159-168.

SIMON, A. and E. BOYER (Eds.), 1970, "Mirrors for Behaviour: An Anthology of Classroom Observation Instruments", Supplement, Vol. A & B.

SINCLAIR, J. and R. COULTHARD, 1975, "Towards an Analysis of Discourse", Oxford University Press.

SKINNER, B., 1957, "Verbal Behaviour", Appleton.

SMITH, B., 1963, "Toward a Theory of Teaching", in A. Bellack (Ed.), 1963, "Theory and Research in Teaching", Teachers College, Columbia University, p.1-10.

SMITH, B,, M.MEUX, J.COOMBS, D. EIERDAM, and R. SZOKE, 1962, "A Study of the Logic of Teaching", in A. Simon and E. Boyer (Eds.), 1967, "Mirrors for Behaviour", Vol. 4.

SMITH, B., M.MEUX, J.COOMBS, G. NUTHALL,and R. PRECIANS, 1967, "A Study of the Strategies of Teaching", in A. Simon and E. Boyer (Eds.), 1967, "Mirrors for Behaviour", Vol. 4.

SPENCER, J., 1973, "Language for Special Purposes: Teaching Rules or Learning Rules?", in M. De Grève, M. Gorosch, C. Sandulescu, and F. Van Passel, (Eds.), 1973, "Modern Language Teaching to Adults: Language for Special Purposes", AIMAV, p.37-43.

STEVENS, R., 1912, "The Question as a Measure of Efficiency in Instruction: A Critical Study of Classroom Practice", in A. Simon and E. Boyer (Eds.), 1970, "Mirrors for Behaviour", Vol. 14.

STREVENS, P., 1971, "English for Special Purposes: A Specialists Viewpoint", an A.U.B. Conference Paper, in ETIC Archives, British Council.

STREVENS. P., 1973, "Technical, Technological and Scientific English", in ELT Journal, Vol. 27.3, p.223-234.

STREVENS, P., 1977a, "New Orientations in the Teaching of English", Oxford University Press.

STREVENS, P., 1977b, "Special Purpose Language Learning: A Perspective", in Language Teaching and Linguistics: Abstracts, Vol. 10.3, p.145-163.

STREVENS, P., 1977c, "English for Special Purposes: An Analysis and Survey", in Studies in Language Learning , Vol. 2.1, p.111-135.

STUBBS, M., 1972, "Keeping in Touch — Some Functions of Teacher-Talk", Centre for Research in the Educational Sciences, University of Edinburgh.

STUBBS, M. and S.DELAMONT (Eds.), 1976, "Explorations in Classroom Observation", John Wiley.

SWALES, J., 1980, "The Educational Environment and its Relevance to ESP Programme Design", in ELT Documents Special, "Projects in Materials Design", British Council, p.61-70.

TABA, H., S. LEVINE, and F. ELZEY 1964, "Thinking in Elementary School Children", Co-operative Research Project No. 1574, U. S. Office of Education.

TICKOO, M., 1976, "Theories and Materials in EST: A View from Hyderabad", in J. C. Richards (Ed.), 1976, "Teaching English for Science and Technology", Singapore University Press. p.97-120.

THE TIMES, 1975, "A Special Report on Bahrain", 17 October.

TROWBRIDGE, D., 1974, "Science Teaching on the Roof of the World", in Science Teacher, Vol. 41.6, p.23-27.

WALKER, R. and C. ADELMAN, 1975, "A Guide to Classroom Observation", Methuen.

WEST, M., 1956, "The Gap: The Problem of the Approach to Technical and Scientific Reading", in ELT Journal, Vol. 10.4, p.153-157.

WIDDOWSON, H.G., 1968, "The Teaching of English Through Science", in J. Dakin, B. Tiffen, and H. G. Widdowson (Eds.), 1968, "Language in Education", Oxford University Press, p.115-175.

WIDDOWSON, H.G., 1971, "The Teaching of Rhetoric to Students of Science and Technology", in "Science and Technology in a Second Language", CILT Reports and Papers 7, p.31-40.

WIDDOWSON, H.G., 1972, "the Teaching of English as Communication", in ELT Journal, Vol. 27.1, p.15-18.

WIDDOWSON, H.G., 1973, "Directions in the Teaching of Discourse", in S. Pit Corder and E. Roulet (Eds.), 1973, "Theoretical Linguistic Models in Applied Linguistics", AIMAV, p.65-76.

WIDDOWSON, H.G., 1974a, "An Approach to the Teaching of Scientific English Discourse", in RELC Journal, Vol. 5.1, p.27-40.

WIDDOWSON, H.G., 1974b, "Literary and Scientific Uses of English", in ELT Journal, Vol. 28.4, p.282-292.

WIDDOWSON, H.G., 1975, "EST in Theory and Practice", in British Council English-Teaching Information Centre, "English for Academic Purposes with Special Reference to Science and Technology: Problems and Perspectives", An ETIC Occasional Paper, British Council, p.1-13.

WIDDOWSON, H.G., 1976, "The Authenticity of Language Data", in J. Fanselow and R. Grymes (Eds.), 1976, "On TESOL '76", TESOL, p.261-270.

WIDDOWSON, H.G., 1977, "Exploration in Applied Linguistics", Oxford University Press.

WHITE, R., 1959, "Motivation Reconsidered: The Concept of Competence", in Psychological Review, Vol. 66.5, p.297-333.

WILKINS, D.A., 1972, "Linguistics in Language Teaching", Edward Arnold.

WILSON, G. (Ed.), 1976, "Curriculum Development and Syllabus Design for English Teaching", Singapore University Press.

WITKIN, H., P.OLTMAN, E. RASKIN, and S. KARP, 1971, "A Manual for the Embedded Figures Tests", Consulting Psychologists Press.

WOLFSON, N., 1981, "Compliments in Cross-Cultural Perspective", in TESOL Quarterly, Vol. 15.2, p.117-124.

WRAGG, E., 1970, "Interaction Analysis in the Foreign Language Classroom", in Modern Language Journal, Vol. 54.2, p.116-120.

WRIGHT, C. and G. NUTHALL, 1972, "The Relationships between Teacher Behaviour and Pupil Achievement in Three Experimental Elementary Science Lessons", in A. Morrison and D. McIntyre (Eds.), 1972, "The Social Psychology of Teaching", Penguin, p.293-309.

II. TEXTBOOKS:

AL-SHATHLY, A.F., 1976, "Physics: Sound", Daar Al-Márif.

AL-SAYED ESHARY,A.M., 1975, "Physics: The Properties of Matter and Heat", Daar Al-Márif.

ALLEN, J. and H. WIDDOWSON, 1974, "English in Physical Science", Oxford University Press.

BYRNE, D. and S. HOLDEN, 1976, "Insight", Longman.

CLOSE, R., 1965, "The English We Use for Science", Longman.

HERBERT, A.J., 1965, "The Structure of Technical English", Longman.

MEE, A., P. BOYD, and D. RITCHIE, 1973, "Science for the 70's" Book One, Second Edition, Heinemann.

MOFFATT, C.W.P., 1961, "Science German Course", Sixth Edition, University Tutorial Press.

PALMER, H. and H. HARMAN, 1940, "The Teaching of English to Soldiers", Longmans, Green and Co.

ROSENBERG-RODGERS,A., and E. HORWOOD, 1966, "German for Science Students", Second Edition, Iliffe Books.

SWALES, J., 1971, "Writing Scientific English", Nelson.