THE INTERACTION OF STUDENT MOTIVATION AND TEACHER BEHAVIOUR UPON ACADEMIC PERFORMANCE

Adrian M. Fordham

A thesis submitted for the degree of Doctor of Philosophy in the Australian National University

July 1977
This thesis is based upon original research conducted by the author as a research scholar in the Research School of Social Sciences of the Australian National University, February 1974 to July 1977.

Adrian M. Fordham
This study is concerned with learning as it typically occurs in classrooms. It draws upon the cognitive psychological theories of Piaget, the needs-press model of human behaviour of Murray and various understandings of social interaction that are evident in recent works of sociologists such as M.F.D. Young, Berger and others. In so doing, an interactive perspective is adopted and school-based learning is viewed within an interactive framework that represents a synthesis of both cognitive and social aspects of knowledge construction. Within this framework are proposed two models of learning, one associated with achievement-orientated behaviour and the other with intrinsic-motivated behaviour. The research study employed a non-experimental, (short-term) longitudinal design and examined the teacher's presentation of a section of the Biological Science: Web of Life curriculum to senior students in both independent and government schools of the Australian Capital Territory. Tests were administered to measure the students' knowledge of prerequisite concepts necessary for an understanding of the section of curriculum under consideration; following the teacher's presentation of the curriculum, approximately seven weeks later, the students' knowledge of both the details of the curriculum and an integrated understanding of the curriculum were measured. While the curriculum was being taught, the researcher assessed the learning goals presented by the teacher and the properties of the learning environment likely to facilitate the arousal of intrinsic motivation. These assessments included a variety of procedures, including teaching observations, student interviews and student questionnaires. Evidence from each of these sources was used by the researcher to rate the learning environment on each of three dimensions, viz., emphasis on integration, emphasis on specific detail and facilitation of intrinsic motivation. Questionnaires were used to assess both the achievement press of the school and the students' levels of achievement motivation and intrinsic motivation. Both multiple regression and analysis of variance procedures were used in the data analysis. The
student interview and teacher observation data generated insights into the dynamics of the classroom situation which enabled the researcher to better explain the results of the analyses. These results support the overall interactive perspective adopted in this study, and both the achievement-orientated and intrinsic-motivated models of learning that have been proposed.
## CONTENTS

<table>
<thead>
<tr>
<th>ABSTRACT</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>TABLES</td>
<td>viii</td>
</tr>
<tr>
<td>FIGURES</td>
<td>x</td>
</tr>
</tbody>
</table>

### CHAPTER 1: TOWARDS AN INTERACTIVE PERSPECTIVE

I Studies of Teaching 2
II Aptitude-Treatment Interaction Studies 4
III The Constructivist Interpretation of Interaction 9
IV The Social Construction of Knowledge 14

### CHAPTER 2: THE APPLICATION OF PIAGETIAN PRINCIPLES TO SCHOOL-BASED LEARNING

I An Interpretation of Cognitive Structures 19
II Development and Learning - an Unnecessary Distinction? 22
III Learning and Development - Provoked or Spontaneous? 25
IV Intrinsic Motivation and Structural Change 27
V Piagetian Psychology and Classroom Practice 35

### CHAPTER 3: LEARNING AS AN ACHIEVEMENT-ORIENTATED ACTIVITY

Introduction 41
I Murray's Needs-Press Constructs 42
a) The concept of need 42
b) The concept of press 43
II Needs-Press Interaction 46
III The Needs-Press Model and the Educational Context 50
IV Need for Achievement and Academic Performance 51
V On Specifying the Goals of Learning 53

### CHAPTER 4: THEORY AND DESIGN

I Cognitive Readiness, Learning and Structural Change 59
II Intrinsic-Motivated Learning and the Curriculum 62
III Achievement-Orientated Learning and the Curriculum 63
IV The Research Design - An Overview 66
## CHAPTER 5: METHODS AND MEASURES

**Introduction** 68

### I Towards Defining a Sample 69

- **a) Phase One** 69
- **b) The Web of Life: an overview** 70
- **c) Living in Water and Living on Land** 72
- **d) The student-teacher sample** 73

### II The Measurement of Student Characteristics 74

- **a) Cognitive readiness** 74
  - **i) Identification of necessary prerequisite structures** 74
  - **ii) The construction of the cognitive readiness test** 75
  - **iii) Administration of the cognitive readiness test** 76
- **b) Academic performance as structural change** 77
  - **i) The measurement of isolated structures** 77
  - **ii) The measurement of integrated structures** 77
  - **iii) Administration of the achievement test** 78
- **c) Need for achievement** 79
- **d) Intrinsic motivation and student interest in biology** 80

### III Assessing the Learning Environment 81

- **a) A general introduction** 81
- **b) A consensual knowledge of the classroom** 85
  - **i) Participant observation, interviews and the lived-in experience** 86
  - **ii) The rating of learning environments** 89
  - **iii) The reliability of rating the learning environments** 90
- **c) Measuring the arousal of achievement motivation** 94

### IV The Biology Students and Classroom Perceptions Questionnaire 94

### V Summary of the Methods and Measures 95
CHAPTER 6: RESULTS - PART A: THE LEARNING OF SPECIFIC DETAIL

I The Achievement-Orientated Model of Learning and Student Performance on the Guide Questions Scale
   a) The achievement-orientated model - a three-way interaction model of learning
   b) Cognitive readiness and the achievement-orientated model of learning

II The Intrinsic-Motivated Model of Learning and Student Performance on the Guide Questions Scale
   a) Cognitive readiness and the intrinsic-motivated model of learning with respect to the learning of special detail
   b) The interaction between intrinsic motivation and the facilitation of its arousal
   c) Intrinsic motivation, interest in biology and student performance on the Guide Questions scale

III The Classroom Environment and Novelty of Response

CHAPTER 7: RESULTS - PART B: AN INTEGRATED KNOWLEDGE OF THE CURRICULUM

I Student Performance on the Problems Scale and the Achievement-Orientated Model of Learning
   a) The interaction between press, motivation and goal specification
      i) The 4-way interaction and student performance
      ii) The interaction of press, motivation, emphasis on specific detail
      iii) The interaction of press, motivation, emphasis on integration
      iv) The interaction between the specification of particular learning goals
      v) The derivation of an overall model
b) Cognitive readiness and its interaction with press, motivation and goal specification

1) The 3-way interaction of cognitive readiness, emphasis on specific detail and emphasis on integration
2) The interaction of cognitive readiness and achievement press
3) The interaction of cognitive readiness and achievement motivation

II The Intrinsic-Motivated Model of Learning and Student Performance on the Problems Scale

a) The interactions of cognitive readiness and intrinsic motivation, facilitation of intrinsic motivation and student interest in biology

b) The main effects of facilitation of intrinsic motivation and interest in biology upon student performance

CHAPTER 8: DISCUSSION OF RESULTS

I The Achievement-Orientated Model of Learning

a) The learning goals specified by the teacher and the students' learning activities

b) Achievement press, achievement motivation, goal specification and student performance

1) The effect of achievement press upon student learning

2) The relevance of the learning goals to the Higher School Certificate examination

3) An interpretation of the interactions of achievement press, achievement motivation and goal specification operative in the classroom

4) Cognitive readiness and the accommodation-assimilation model

II The Intrinsic-Motivated Model of Learning

a) Intrinsic motivation and its arousal

b) Cognitive readiness and the intrinsic-motivated model of learning
<table>
<thead>
<tr>
<th>CHAPTER 9: THEORETICAL REVIEW</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Learning and the Construction of Knowledge</td>
<td>166</td>
</tr>
<tr>
<td>II The Interactive Perspective and Learning</td>
<td>172</td>
</tr>
</tbody>
</table>

### APPENDICES

**APPENDIX 5:** This Appendix contains the Cognitive Readiness Test, the Achievement Test and the Biology Students and Classroom Perceptions Questionnaire, as well as statistical details associated with the construction of each of these measures. Also included in this Appendix are examples of researcher's notes, teacher behaviour and student interview data | 180 |

**APPENDIX 6:** Statistical details of the analysis examining the guiding propositions related to student performance on the Guide Questions scale | 265 |

**APPENDIX 7:** Statistical details of the analyses examining the guiding propositions related to student performance on the Problems scale | 281 |

**BIBLIOGRAPHY** | 297 |
# TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1</td>
<td>The Seven Classroom Activities Scales Contained with the Biology Activities Checklist</td>
<td>91</td>
</tr>
<tr>
<td>5.2</td>
<td>The Measures Contained within the Biology Students and Classroom Perceptions Questionnaire</td>
<td>95</td>
</tr>
<tr>
<td>5.3</td>
<td>A Summary of the Research Design</td>
<td>96</td>
</tr>
<tr>
<td>6.1</td>
<td>Multiple Regression Analysis, using Dummy Variables for the Explanation of Student Performance on the Guide Questions Scale from Emphasis on Specific Detail, Achievement Press and Achievement Motivation</td>
<td>102</td>
</tr>
<tr>
<td>6.2</td>
<td>Correlations of Student Performance on the Guide Questions Scale with the Independent Variables and Interactive Terms of the Achievement-Orientated Model of Learning</td>
<td>103</td>
</tr>
<tr>
<td>6.3</td>
<td>Multiple Regression Analyses for the Prediction of Student Performance on the Guide Questions Scale from Emphasis on Specific Detail, Achievement Press and Cognitive Readiness</td>
<td>105</td>
</tr>
<tr>
<td>6.4</td>
<td>Correlation of Student Performance on the Guide Questions Scale with those Variables Involved in the Interaction of Intrinsic Motivation with its Arousal</td>
<td>112</td>
</tr>
<tr>
<td>6.5</td>
<td>Correlation Matrix between Variables Comprising the Intrinsic-motivated Model of Learning and Student Performance on the Guide Questions Scale</td>
<td>113</td>
</tr>
<tr>
<td>6.6</td>
<td>Numbers of Students using Particular Examples as Sources of Evidence for the Biological Concept of Diffusion</td>
<td>115</td>
</tr>
<tr>
<td>6.7</td>
<td>Types of Examples used to Illustrate either Plant or Animal Adaptation</td>
<td>116</td>
</tr>
<tr>
<td>6.8</td>
<td>Correlation between Percentage of Novel Responses in a Class and Ratings of Learning Environment</td>
<td>117</td>
</tr>
<tr>
<td>7.1</td>
<td>Stepwise Multiple Regression to Test the Significance of the Interaction between the Specification of both Learning Goals in the Explanation of Student Performance on the Problems Scale</td>
<td>123</td>
</tr>
<tr>
<td>7.2</td>
<td>Stepwise Multiple Regression using Dummy Variables in a 4-term Regression Model to Explain Student Performance on the Problems Scale</td>
<td>128</td>
</tr>
<tr>
<td>Section</td>
<td>Page</td>
<td></td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>7.3 The Interaction of Achievement Press and Cognitive Readiness upon Student Performance on the Problems Scale</td>
<td>132</td>
<td></td>
</tr>
<tr>
<td>7.4 The Regression Slopes upon Student Performance on the Problems Scale for Intrinsic Motivation, Facilitation of Intrinsic Motivation and Interest in Biology at each Level of Cognitive Readiness</td>
<td>137</td>
<td></td>
</tr>
<tr>
<td>7.5 The Main Effects of Interest in Biology and Facilitation of Intrinsic Motivation upon Student Performance on the Problems Scale after Controlling for the Effect of Cognitive Readiness</td>
<td>139</td>
<td></td>
</tr>
</tbody>
</table>
FIGURES

Figure

6.1 The 3-way interaction of the Student's Level of Achievement Motivation, the Achievement Press of the School and the Teacher's Specification of the Learning Goal Emphasis on Specific Detail, upon Student Performance on the Guide Questions Scale 100

6.2a The Regression Surface Representing the Interaction of the Student's Level of Cognitive Readiness and the Achievement Press of the School, upon Student Performance on the Guide Questions Scale 106

6.2b The Regression Surface Representing the Interaction of the Student's Level of Cognitive Readiness and the Teacher's Emphasis on Specific Detail, upon Student Performance on the Guide Questions Scale 108

7.1 The 3-way Interaction of the Student's Level of Achievement Motivation, the Achievement Press of the School and the Teacher's Emphasis on Specific Detail, upon Student Performance on the Problems Scale 121

7.2 The 2-way Interaction of the Teacher's Specification of both the Learning Goals, Emphasis on Integration and Emphasis on Specific Detail, upon Student Performance on the Problems Scale 124

7.3 The Regression Surface Representing the Interaction of the Teacher's Specification of both the Learning Goals, Emphasis on Integration and Emphasis on Specific Detail, upon Student Performance on the Problems Scale 126

7.4 The 3-way Interaction of the Student's Level of Cognitive Readiness and the Teacher's Specification of both the Learning Goals, Emphasis on Integration and Emphasis on Specific Detail, upon Student Performance on the Problems Scale 131

7.5 The 2-way Interaction of the Student's Levels of Achievement Motivation and Cognitive Readiness upon Student Performance on the Problems Scale 134
Chapter 1
TOWARDS AN INTERACTIVE PERSPECTIVE

This thesis is concerned with a theory of educative learning. It focuses on students, teachers and the classroom as it attempts to unravel relationships that may be important in explaining how students learn material dealt with in everyday curricula.

Such an endeavour is, of course, not new. Educational research has often been directed towards discovering relationships inherent in learning situations and yet there seems to have been little advancement in our knowledge of the determinants of school learning. This is reflected in the view, agreed by Hoetker and Ahlbrand (1969) that teaching practices now differ little from those at the turn of the century. For example, in 1911 Thorndike wrote that the members of the teaching profession 'were showing signs of a violent reaction against the uniformity of methods that for so long clutched and mechanized the schools' (Thorndike, 1911, cited in Glaser, 1972). Sixty years later Piaget's view is somewhat sobering: 'those old education conceptions ... have thereby imprisoned them [teachers] in their present lowly status' (Piaget, 1970). It is against this background of the failure of educational research to elucidate the determinants of school-based learning and consequently to influence classroom practices that we must begin 'to unravel the relationships'.

It is not my purpose to examine extensively the vast body of contemporary literature associated with learning and teaching. Adequate reviews can be found in Travers (1973), Rosenshine (1971), Berliner and Cahen (1973) and Dunkin and Biddle (1974). A perusal of the literature will, however, lead to three conclusions that are of interest:

(i) the major thrust of educational research is of a psychological orientation, employing both its theoretical constructs and methodological procedures

(ii) two issues have dominated the literature viz. the study of teaching behaviour as a means of predicting student performance, and the aptitude–treatment interaction
analyses of the learning situation. An independent theory of teaching is the basis of the former, whereas a common learning-teaching theory is reflected in the latter.

(iii) many studies have claimed to be involved with classroom interaction. The use of this term has been ambiguous and at times totally inappropriate.

Although the psychological bias of educational research is still present, there is evidence of a broadening awareness of the relevance of other perspectives such as the sociological and the epistemological. Again, there is a gradual reorientation away from the traditional psychological variables of learning theory to a much broader conceptualisation of the learning-teaching process. To this end, the excellent collection of papers 'Knowledge and Control' (ed. M.F.D. Young, 1971) examines implications of a sociology of knowledge for classroom practices, and illustrates an emergent perspective; for example, both the papers by Esland and Keddie emphasise an essential interrelatedness between teacher and student which is not to be found in those studies derived from a theory of teaching.

Following a short examination of both the theoretical and methodological bases of those studies derived from theories of teaching, this initial chapter will develop an understanding of classroom interaction that will be useful in the generation of a model of school-based learning. In so doing it will be argued that much of the aptitude-treatment interaction literature is theoretically deficient and that a broader conceptualisation of interaction is necessary to understand the processes that characterise the teacher-student relationship.

I. Studies of Teaching

Research into teaching behaviour as a predictor of student behaviour has tended to differentiate the act of teaching from that of learning. Teaching is seen as a distinctive phenomenon, conceptually independent of learning and to be studied without reference to learning processes. Gage, for example, argues that:

... theories of learning are inherently irrelevant to problems of instruction ... while theories of learning deal with ways an organism learns, theories of teaching deal with the ways a person influences an organism to learn (Gage, 1964).
B.O. Smith is somewhat more direct: 'techniques one thing and learning quite another' (Smith, 1961). This tendency towards an independent theory of teaching grew stronger throughout the 1960s and early 1970s, and is highlighted by the development of highly sophisticated teacher observation techniques.

However, many of these observational instruments were not, in fact, derived from theory. Of seventy-three category systems analyzed by Rosenshine and Fürst (1973) only fifteen could claim any theoretical meaning and for most this was rather tenuous. It was this lack of a necessity for a theory base which led to the rapid proliferation of highly diverse studies into teacher behaviour as a means of predicting student performance; this was paralleled by a dramatic increase in the number of teacher observation instruments. This is not surprising for it is a theory base which determines what the researcher is going to look at in the classroom, and how he is to interpret what he sees: in other words, it gives meaning to teacher behaviour.

This lack of theory-building has often been replaced by a preoccupation with methodology. However, it is interesting to note that there have been no major changes in methodology over the last forty years, although, of course, statistical procedures have become much more highly sophisticated. This apparent paradox is quite easily resolved when one considers that it is changes in theoretical perspectives which bring about changes in methodology. And so it is for this reason that observational studies in which measures of teacher behaviour are correlated with measures of pupil development have changed little, e.g. 423 measures of teacher behaviour are still being correlated with fifteen different measures of pupil growth to yield 5,599 correlations of which 644 were significant at the 10 per cent level or better (Brophy and

---

1 Category systems are probably the major form of teacher observation instruments, although their importance is now declining.

2 As a result, review articles generally conclude that there has been little advancement in the state of our knowledge into how teacher behaviour affects student behaviour, and plead for a greater conceptualisation of the teaching process (e.g. Rosenshine and Fürst, 1973).
Eversion, 1973, reported in Nuthall, 1974). Such studies, based upon a static methodology and lacking theoretical relevance, can only yield empirical generalisations that cannot be formulated in general terms with respect to cognitive or other internal processes. McClellan (1971) puts it succinctly: 'As explanatory tools they are valueless'.

To summarise these studies, teaching behaviour is seen as a set of complex stimuli which affect student growth along particular dimensions; little emphasis is placed on the student regarding the importance of intrapersonal or mediating variables in the analysis of behaviour; there have been no major methodological changes in the study of teaching as a distinctive phenomenon; and finally, there has been a preoccupation with methodology and a lack of theoretical insight. This last feature is evident in Nuthall's criticism:

By taking for granted that the criteria of good scientific procedure and data analysis are well-established and beyond dispute, we have been led into asking the wrong kinds of questions and searching for the wrong kinds of answers (Nuthall, 1974).

The attempts to generate a theory of teaching independent of learning have not gone unchallenged: they have been seen as a study of the means without reference to the ends (e.g. Komisar, 1968; Scheffler (1960). As McClellan (1971) explains:

... teaching must be characterised as a more or less conscious set of means directed either toward ends external to the teaching situation or toward ends-in-view embedded within the act itself. The analytical structure used to describe teaching must, as a consequence, address both means and ends pari passu.

Central to McClellan's research strategy would be a relatively sophisticated treatment of learning which focused attention on those aspects of teaching behaviour that were theoretically most likely to influence school-based learning. In this regard during the late 1960s a group of studies emerged which were derived from a consideration of both teaching practices and learner characteristics. These were to be known as aptitude-treatment interaction (ATI) studies.

II. Aptitude-Treatment Interaction Studies

The research question underlying the ATI studies was basically:
'Given this set of learner characteristics, what is the best way to tailor instruction to this type of learner' (Berliner and Cahen, 1973). In contrast to the previous studies, the role of the student became central in the generation of a theory of teaching. However, attempts to relate student characteristics such as personality variables, attitudes and interest variables as well as general ability measures, with an ideal method of teaching in order to produce a specified academic performance were markedly unsuccessful. This is evidenced by the comprehensive reviews reporting detailed analyses of ATI studies (e.g. Bracht, 1970; Cronbach and Snow, 1969). Only somewhat more encouraging is the review by Berliner and Cahen (1973) who conclude that significant interactions were not a rare occurrence but hasten to add that there were 'many cases where interactions were not confirmed and findings of interaction were contrary to the hypotheses that guided the study'. And in those instances where significant interactions were found, similar interactional studies often yielded quite contradictory results (Cronbach, 1975).

An examination of these studies leads one to conclude that there are much the same underlying problems as were evident in the previous studies, viz. problems relating to the methodology employed and the theoretical bases used to generate interactive hypotheses.

Many studies failed to establish theoretical links between aptitudes and treatment in the explanation of academic performance; indeed studies often were not even directed at the formulation of theoretical principles (e.g. Golberg, 1973). Bracht (1970) is correct when he says that experimenters usually first identified alternative treatments and then through trial-and-error sought those student variables that might interact with the treatment.

---

3 Golberg (1973) is an excellent example. The aim of the research project was to discover those personality characteristics of college students which predisposed them towards a particular form of instruction, compared to another: an extensive battery of personality tests was administered yielding over 350 trait measures and four methods of instruction were used. The ratio of significant interaction effects to the number expected by chance was only 4 to 3.
ATI studies of this sort fail to have any theoretical significance. Why has there been a general lack of theoretical formulation in ATI research, when this need is a recurrent theme in review articles? (e.g. Salomon, 1971). Possibly there are two major reasons.

Firstly, the descriptive aptitude - or more recently, trait - treatment interaction is highly misleading if one is concerned with school-based learning. Researchers have tended to ignore the implicit assumption that the traits under study are theoretically relatable to learning processes: in most studies traits are conceived quite independently of learning processes. Central then to ATI research there needs to be a theoretical understanding of the processes involved in learning as a means of defining those traits most likely to be influenced by instructional differences. A consequence would then be the realisation that different learning processes may be involved in learning a particular task in comparison to another (Ausubel, 1968). This would result in the task itself being theoretically related to both trait and treatment and capable of interacting with both. Such an understanding of classroom learning is beginning to emerge, particularly in those studies initiated by Di Vestra (e.g. Di Vestra, Sanders, Schultz and Weener, 1971; Di Vestra, 1972). Secondly, there has been a lack of emphasis upon the interactional nature of aptitude-treatment interaction research. For example, in Goldberg's study already cited, the student is treated as a complex of independent and unrelated aptitudes placed in an instructional situation. Nowhere is any attempt made to link the student theoretically with his environment and there is no evidence to suggest that the personality variables under consideration are conceived as interacting in some dynamic, theoretically determinable, manner with the learning situation. Authors of such studies employed the term interaction in a purely statistical sense and often the analysis of an interactive effect was an afterthought (Bracht, 1970).

---

4 See Cronbach and Snow (1969, 1976) for a full discussion on the problem of ATI research.
Fortunately, however, there have been the exceptional studies that are derived from a relatively sophisticated interactionist perspective of the person and his environment and employing aptitudes theoretically related to learning processes. The importance of learning styles and their relation to particular forms of instruction has been noted (Sperry, 1972). In this regard, the cognitive complexity models of differing levels of conceptual complexity among students (Hunt, 1972) and differing types of belief systems held by students (Harvey, 1973) are important advances in searching for those aptitudes likely to be affected by changes in the learning environment. The studies originating from Atkinson's model of motivation and reported by McKeachie and his colleagues (e.g. McKeachie, Milholland, Mann and Isaacsan, 1968) that consider the motivation of the students, the arousal cues of the teaching situation and the apparent difficulty of the task fit very well the ATI concept as it was intended by Cronbach and Snow (1969):

(a) the role of motivation as a facilitator of learning, increasing attention and persistence and decreasing distractability is clearly evident (Feather, 1961; Kight and Sassenrath, 1966);

(b) the environment is seen as a source of arousal cues, the specification of which is theoretically determined by the motive under study; and

(c) the task to be learnt is not seen as independent of the learner; rather it is characterised in terms of the learner's perception of its difficulty.

It is this type of study where the characteristics of the student are relevant to the processes of learning and the environment is seen as interacting in a meaningful manner, that one would expect to find aptitude-treatment interactions. To a lesser extent, the studies attempting to provide evidence for interactions between anxiety and structured-unstructured treatments (e.g. Dowaliby, 1971; Grimes and Allinsmith, 1961) and anxiety and inductive-deductive treatments (e.g. Tallmadge and Shearer, 1971) may be of use. However, the conceptualisation of treatments in these studies often remains imprecise, possibly because the construct anxiety fails to differentiate clearly those teaching behaviours most
likely to interact with it. An example of the aptitude or trait clearly defining those specific teaching behaviours that are theoretically relevant is the re-analysis by Beswick and Tallmadge, in the light of curiosity theory, of Tallmadge and Shearer's earlier data (Beswick and Tallmadge, 1971; Tallmadge and Shearer, 1969).

Common then to a small group of ATI studies is a different notion of interaction - one based on the view that behaviour is an outcome of the relationship between the person and his environment. One of its points of origin can be found in the field theory of Lewin, which emphasises the interactive nature of the person and the environment (e.g. Lewin, 1936). He argues that:

Every scientific psychology must take into account whole situations i.e. the state of both person and environment. This implies that it is necessary to find methods of representing person and environment in common terms as part of one situation (Lewin, 1936: p.12).

Essential to interaction is a quality of wholeness '... part of one situation ...' that is reminiscent of Gestalt psychology. Further it is not a static wholeness but rather represents a dynamic interrelatedness; this is seen in Lewin's conceptualisation of behaviour as the product of a field of forces or vectors, originating within both the individual and the environment.

Interaction as it is being developed in this section is best viewed against traditional trait psychology and its counterpart the more recent behavioural position. Bowers' review article analyses the emergence of behaviourism, or in his terms 'situationism' as a reaction against a model of man emphasising personological determinants (Bowers, 1973). However, Bowers argues, the metaphysical and methodological biases of situationism have resulted in undue attention to behavioural change as opposed to behavioural stability. It is, as it were, the methodology guiding the research question to be asked. Yet, for Bowers, the alternative is not a return to trait psychology but rather a conceptualisation of man interacting with his environment such that 'situations are as much a function of the person as the person's behaviour is a function of the situation' (Bowers, 1973).
This discussion highlights the two vital aspects of interactionism viz. the environment as a function of the person and then, the person being a function of the environment. Of course some areas of psychological theorising may require more emphasis to be placed upon one aspect than another; however, the concept of interaction will remain central to the theory. The needs-press model of Murray (1938) is a good example. Basic to this model is a thema which may be defined as 'the dynamical structure of a single creature-environment interaction' (Murray, 1938: p.42). Yet Murray places greater emphasis in his writings on the person being a function of the environment '... at every moment, an organism is within an environment which largely determines its behaviour' (Murray, 1938: p.39). While this latter statement may appear to reflect a reductionist position, similar to the neobehaviourists, the essential point remains that the intra-organismic variables, this case being needs, cannot be reduced to a direct function of the environment at some earlier point of time; further, behaviour can only be explained by a consideration of the interaction of both person and environment, or in Murray's term, by reference to a thema.

The Lewinian thesis that the environment comes to be transformed by the person further enriches the conceptualisation of interaction. Such a formulation focuses on the indissociability of the person and his environment: no longer does the person react to some 'objective' reality but he actively constructs his own world and acts within it. This basic principle runs throughout the writings of Jean Piaget on genetic epistemology and cognitive development and dominates the works of the symbolic interactionists such as Berger and Luckman. The discussion will now focus on this constructivist interpretation of interaction.

III The Constructivist Interpretation of Interaction

For Piaget, a person's construction of reality is a function of his means and methods of knowing it. This basic interaction between a knowing subject and a knowable reality is fundamental to Piaget's theory of cognitive development. The relationship is not one of interplay between two independent forces; rather the relationship between the knower and the known is one of interdependence and it is theoretically inconceivable for Piaget to
dissociate one from the other. Knowledge of the real world then is not a static quality but rather represents a dynamic relation whereby something in the external world is not known until the knowing person interacts with it and constructs it as an object of knowledge (Furth, 1969). Further, as Furth points out, the known real world resides neither solely in the person nor in some external reality but 'is constructed by the subject as an indissociable subject-object relation' (Furth, 1969).

The process of knowing reality is basically one of action upon it: 'I only know an object to the extent to which I act upon it' (Piaget, reported in Inhelder, 1970). Action may comprise either:

1) a physical type of activity aimed at simply abstracting information from some aspect of reality; or
2) a logico-mathematical type of activity whereby cognitive operations are brought to bear on some aspect of reality, and the acquisition of knowledge itself results from a reflective abstraction upon those actions.

In this manner the person constructs a picture of his world as a dynamic structure, not only possessing elements of form but also possessing an inherent interrelatedness.

This interdependence of the knowing person and his knowledge of reality is reflected in two complementary aspects of action: i) assimilative activity which transforms the external world into a reality corresponding to the person's existing structures of knowing; and ii) accommodative activity which transforms the person's internal knowing structures according to the particular characteristics of the environment (Furth, 1969).

Both features of action should be thought of as simultaneous and indissociable as they operate within both logico-mathematical and physical activity. Piaget (1954) stresses the inseparability of accommodation and assimilation:

Accommodation of mental structures to reality implies the existence of assimilating schemata apart from which any structure would be impossible. Inversely, the formation of schemata through assimilation entails the utilisation of external realities to which the former must accommodate, however crudely (Piaget, 1954: pp.353-54).
It is this basic accommodation-assimilation process of action that unifies the person with his environment, and out of which the person constructs his knowledge of the world. This, then, is what Piaget means by the term 'interaction'.

Such a constructivist view of interaction has particular implications concerning the notion of objectivity. For objectivity in the Piagetian sense is a process of objectification where the person is constantly active in elaborating structures and in decentreing or changing his focus of attention (Piaget, 1972a). Objectivity is not attained, at once, but as the person gradually becomes less egocentric in thought, he begins to focus his attention on reality from different perspectives and from another person's point of view. Hence Piaget would speak of the person building up, or constructing, objective knowledge rather than conceiving of knowledge as being a copy of some external reality.

Throughout the discussion so far there has been the implication that interactionism, in this Piagetian sense, can be viewed in contrast to either a nativist or behaviourist interpretation of cognitive development. But the issue is not as clear-cut as one might assume and it is instructive to examine the threads of argument that have emerged. For these not only indicate a restrictive aspect of interaction but also clarify the overall importance of interaction in Piaget's theory of cognitive development.

While Piaget accepts the role of maturation in development and consequently rejects the nativist notion that cognitive structures are preformed and become operational at birth, he also rejects the maturationist view that cognitive structures, while being genetically programmed, gradually emerge over time (e.g. Piaget, 1971a). He sees the role of maturation to be one of guiding, rather than controlling, the development of cognitive structure:

... maturation as regards cognitive functions ... simply determines the range of possibilities at a specific stage. It does not cause the actualisation of the structures. Maturation simply indicates whether or not the construction of a specific structure is possible at a specific stage. It does not itself contain a preformed structure, but simply opens up possibilities - the new reality still has to be constructed (Piaget, 1971a).
The implication is that interaction is not an open affair but possesses a 'limiting number of degrees of freedom'. Interaction has a restrictive aspect. But this is not surprising when one remembers that the underlying mechanism of interaction involves the accommodation-assimilation model, itself regulating the degree of structural change possible. However, Beilin (1971a) argues that since these functional invariants of accommodation and assimilation are preformed, Piaget's interactionism is consequently reducible to a maturationist, or even nativist, position. Piaget (1971a) contends, on the other hand, that such reductionism fails to encapsulate the full meaning of a constructivist interpretation of interaction. For when cognitive structures are reconstructed on a superior plan of thought, elements are not merely lifted from an inferior level. Rather, cognitive reorganisation results in a completely unique structure, characterised by a novel set of operational properties. It is thus by focusing attention on the explanation of emergent structures, structures that are not preformed either in the external world or in the genetic makeup of the person, that an interactionist perspective is necessary (Piaget, 1971a).

To summarise this Piagetian interpretation of interactionism, it is characterised by the indissociability of the person and his environment. Emphasis is placed on interaction as a means of developing knowledge of one's surroundings; this is achieved by the knowing subject constructing his knowledge of reality. However, interaction is a restricting concept whereby the construction of objects-as-known is constrained by the cognitive structures already formed in the person and basic invariant cognitive processes.

Piagetian psychology, as described above, is concerned with the growth of knowledge as an interaction between the person and

---

5 This argument is similar to that found on p.9 with regard to Murray's needs-press model. In that instance, behaviour could only be explained by reference to the interaction of needs and press, the theme, and could not be reduced to being a direct function of either the environment or the person.
his experience, be it either logico-mathematical or physical. However, this work is primarily concerned with school-based learning and as such must consider interaction within a particular social situation, i.e. a classroom and school.

What then is the relationship between social experience and the Piagetian model of knowing? As with physical experience it can have no effect unless this experience can be assimilated and integrated into a person's knowing structure (Inhelder and Piaget, 1958). This has particular implications for an understanding of social experience, for now social activity becomes a reflection of logico-mathematical activity:

As for the collective operations which enter into social interchange (intellectual, etc.) and into co-operation, they are exactly the same as those on which the co-ordination of actions in general depends: combinations, intersections, order, correspondence, etc. (Beth and Piaget, 1966).

Piaget argues here that social experience can only be known within a logico-mathematical framework and that knowing structures of a social origin must be operationally congruent with those derived from both physical and logico-mathematical experience. This is, essentially, a reductionist view of social experience and it is for this reason that Piaget has so little discussed its role in the person's construction of knowledge.

Recently there has emerged a new sociological perspective that focuses on the social aspect of reality construction, and one where social experience is central. It represents an orientation away from a traditional sociological theory-base and a movement into a symbolic interactionist and phenomenological analysis of the sociology of knowledge. The discussion of the social nature of reality construction that follows should not be confused with those studies generally involved with the interactions between classroom climate, teaching behaviour and learning (e.g. Walberg, 1970), and employing sociological variables.\

6 Such studies employ the interaction concept in much the same way as the ATI studies already discussed.
IV The Social Construction of Knowledge

This emerging perspective in sociology can be seen as a reaction against the predominant behavioural identity that has underpinned much sociological research (Brittan, 1973) and the traditional objectivist view of human knowledge which it finds 'fundamentally dehumanising' (Berger and Pulberg, 1965). Its position vis-a-vis behaviourism and objectivity is clearly similar to Piagetian epistemology and therefore it is not surprising that this conceptualisation of a person's knowledge of reality closely resembles the Piagetian model of knowing. For the 'new' sociologists, such as Berger and Luckman (1973), Holzner (1972) and others, the construction of reality originates in the thoughts and actions of the members of a society and is maintained by such action. Further, interaction has a restrictive sense similar to that resulting from the synthesis of the Piagetian notions of structuralism and constructivism:

Reconstructed present and reinterpreted past are perceived as a continuum extending forwards into a projected future (Berger and Kellner, 1964).

However, this sociological perspective is concerned with the social aspect of reality construction and argues that interaction is shaped by the social context in which it occurs. For example, the interaction between two persons such as a teacher and student is governed largely by a whole complex of rules and norms of which both are aware; these norms and rules are socially constructed and may be either situation specific or more universalistic (Silverman, 1974). As a consequence there is a build-up of socially approved knowledge that has been legitimated by these rules and norms of society and is shared by its members.

This new perspective also affirms that persons assign meanings

---

7 This incorporates a wide range of sociological models including ethnomethodology, social phenomenology, symbolic interactionism.

8 A similar view appeared recently in the Piagetian literature where Walkerdine and Sinha argued that 'objects exist in a functionally and experientially defined framework [i.e. the context of the use to which the objects are put]. Function is both socially and culturally defined' (reported in Modgil and Modgil, 1976). However, such an understanding of social experience is still quite common in the Piagetian literature.
to situations and to the actions of others and respond in accordance with these meanings. Meanings imply more than is suggested by Piaget's model of knowing. Kultgen (1975) refers to meanings in the following way: 'The heart of meaning is the agent's intention, but intentions entail beliefs and motives and these, the whole gamut of subjective life'. It is these meanings that constitute Berger and Kellner's 'reconstructed present', 'reinterpreted past', and 'projected future' in the above quotation. As a result action arises out of a 'system of expectations' that is a product of the person's past experiences and which defines his perception of the probable reaction of other persons to his action. This relation between subjective meaning and action is clearly evident:

Action is social ... by virtue of the subjective meaning attached to it by the acting individual, it takes account of the behaviour of others and is thereby orientated in its course (Max Weber, 1947).

However, meanings are not private affairs since they are commonly shared by two or more persons in a social situation. And so interaction can be described as a sharing, or negotiation, of these meanings and a resultant 'intersubjective sharing of reality' (Brittan, 1973). This notion of shared meanings and interpretations within social experience represents the crux of the symbolic interactionist and social phenomenological understandings of reality. When individuals are sharing meanings, the shared meanings represent a total which is greater than its constituent elements (Keesing, 1974). And it is at this point that this sociological understanding of interaction can best be seen in contrast to Piagetian constructivism. Now social experience has a unique role to play in the construction of reality for emphasis is placed upon the relationship between those persons who hold or share common understandings of situations. The intersubjective sharing of meanings is seen as an essential part of this social experience and one which cannot be reduced to individualistic mental constructions. Consequently the location of these shared meanings is to be found not in the minds of individuals but as Clifford Geertz (1973), the anthropologist, has argued between the minds of the individuals.

What then is the relationship between the Piagetian notion of interaction and the understanding of interaction described above? Esland (1971) sees them both as being characterised by a 'pre-
occupation with subjective experience and its composition, in which man is represented as an active rather than a passive creature in the creation of his own objects'. But the various sociological and anthropological perspectives go further and place the person within a social environment that possesses its own universals of process, structure and organisation (Keesing, 1974). This conceptualisation of social experience is far more sophisticated than a Piagetian one and as a result the role of social experience in the construction of knowledge becomes much more profound. For its raises questions of legitimation and points to the constraining influence of social experience; it focuses on the dialectic relationship between consciousness and socially-approved knowledge (Esland, 1971); it points to a re-interpretation in what is considered generally to be a person's stock of knowledge; and above all it emphasises the inter-subjective nature of reality construction. Yet it would be unfortunate to see each epistemology as mutually excluding the other in the analysis of human interaction for each is concerned with different aspects of experience, whether it be social, physical or logico-mathematical. Perhaps Esland's (1971) attempt to incorporate Piagetian epistemology within a sociology of knowledge is a possible example of a more realistic approach to the understanding of human interaction.

This discussion of interactionism can now be brought to a close. It should be remembered that it arose out of need to derive an understanding of interaction that may be applicable to classroom research.

Interaction is used freely throughout the literature on teaching and learning. It is defined in Chaplin's Dictionary of Psychology as:

... a relationship between systems such that events taking place in one system influence events taking place in the other (Chaplin, 1968).

This, I would argue, is the simplest and least theoretically satisfying meaning of the concept and, unfortunately, the one that prevails throughout much of the teaching-learning literature. Many of the ATI studies remain at this pretheoretical level of conceptualising interaction. A few ATI studies moved beyond this limiting notion of interaction: to them, the influence of one
system upon another was theoretically determinable. McKeachie's studies were mentioned in this regard (e.g. McKeachie et al., 1968). Implicit in these studies is an understanding of interaction as the combination of two conceptually independent systems, such as need and press. This led to a third understanding of interaction where both systems were seen as being conceptually interdependent. More specifically, a person's knowledge of reality was considered to be very much a function of the self and interaction was defined in a constructivist sense. Construction implies action and action was seen to occur within physical, logico-mathematical and social experience.

I would argue that these latter two interpretations of interaction are most relevant to the study of school-based learning. And of these the constructivist notions of interaction are far more exciting and rewarding in developing an overview of the learning processes that occur when teachers are teaching and students learning. However, this is not meant to indicate the unimportance of the former interpretation; on the contrary, interaction as conceived in terms of press and need must play an important role in any such study.

In the following chapters the Piagetian model of knowing is discussed within the context of learning and development. It will be suggested that the Piagetian distinction between learning and development is detrimental to an understanding of how students learn. Rather, an attempt to integrate learning within the students' knowing of reality is seen as a necessary consequence of an interactionist perspective. However, the student is placed within a social situation and the latter discussions of interaction will be useful in relating the teaching process with that of learning. The meanings attributed to teacher behaviour will, in particular, be seen as important influences of learning outcomes. Finally, the entire social experience of the school will be seen to interact with the needs of students as they participate in the goal-directed activity of learning.
An interactionist perspective to school-based learning has not been typical of the educational literature related to teaching and learning. However there is beginning to emerge a body of research and discussion focusing on the applicability of Piagetian epistemological principles to learning. This tendency has been paralleled by the development of curricula claiming to reflect Piagetian stage theory, based on the concept of the 'active' child, and whose purpose is directed towards an arousal of curiosity and consequent cognitive growth.1 Entire school programs are being created to put Piaget's theory into practice2 and Piagetian psychology is tending to dominate educational psychology courses for teachers-in-training, and at the expense of psychometric approaches to education.

The appropriateness of the Piagetian model for an investigation into student learning requires some critical examination. For while it may appear appropriate, as evidenced by the above-mentioned curricula, many educational psychologists such as Aelbi and Ausubel have questioned the usefulness of its concepts to education (Aelbi, 1970; Ausubel, 1968, 1971). Firstly in this chapter the concept of structure, so basic to cognitive psychology, will be interpreted within the Piagetian framework and from this an understanding of cognitive structure that is applicable to student learning will be derived. This in turn will raise the question of whether the distinction between structures developed and structures learnt is theoretically useful. Finally, the discussion will focus on the dynamics of structural growth and consequent implications for a theory of school-based learning.

1 In Australia, both the Biological Science Curriculum Studies program and the Australian Science Education Program would be typical (see, for example, Dale, 1975).
2 Furth and Wachs' (1974) 'school for thinking' is a fine example.
I An Interpretation of Cognitive Structures

Interaction, in the Piagetian sense, implies a linking of structuralism with constructivism: the person assimilates his world as a function of internal cognitive structures and differentiates these accordingly. In the earlier discussion and throughout the following, the concept of cognitive structure dominates. It is now time to interpret this term cognitive structure and to assess its usefulness in the development of a model of school-based learning.

Cognitive structures are fundamental to the psychology of thought and yet to quote Kessen 'the definition of the nature and dimension of cognitive structure remains perhaps [its] most irksome and persistent problem' (Kessen, 1971). Further, its usefulness as a construct is not without controversy. Malcolm (1971), for example, refers to theories employing cognitive structures as 'mythologies of inner guidance systems' and of no more explanatory worth than the behaviourist model that they have replaced. Notwithstanding, cognitive structures remain central to the interactionist perspective of Piaget. What then to Piaget and his colleagues mean by 'cognitive structure'?

Basic to the notion are the characteristics of an organised totality, an enduring stability and internal dynamism. Flavell (1971a) offers the most basic meaning of the concept to include an inter-relationship between at least two elements in such a way as to produce a totality characterised by stability and applicability; cognitive structures are not merely temporary organisations of elements related in some arbitrary and varying way. Furth (1969) defines a structure as 'the interrelatedness of parts within an organised totality' and thereby focuses on its general form.

It is Piaget, though, who offers the most precise definition of what constitutes a structure (Piaget, 1971b). It is characterised by three necessary properties, viz., wholeness, transformation and self-regulation. Because of wholeness, structures are more than mere aggregates of elements independent of the complexes in which they enter: they possess an inherent integration or totality. However, structures are not static and their dynamic nature is derived from the second characteristic. Structures are systems of transformations which interrelate structural elements.
Finally, such transformation rules are directed towards the self-maintenance of the structure - 'the transformations inherent in the structure never lead beyond the system but always engender elements that belong to it and preserve its laws' (Piaget, 1971b). As a result structures are maintained in a state of equilibrium throughout interaction. And what constitutes the elements in Piaget's structuralism? The elements are not simply the content aspect of knowledge: rather Piaget considers them to be abstractions from, or actions on, content as perceived. Consequently cognitive structures, according to Piaget, are universal constructs and applicable to all bodies of knowledge.

This emphasis on form to the neglect of content has been discussed by Ginnsburg and Opper (1969) and more recently challenged by Kessen (1971). However, it is Bart and Smith (1974) who, in their attempt to reformulate cognitive structure within an idiosyncratic cognitive developmental framework, introduce content as an integral part of structure. For them the basic entities of cognitive structure are elements, processes and rules. Elements are essentially contents that are attended to and thought of; processes are the cognitive actions performed on these elements; and the rules are the overriding relations among the processes that confer stability. By interpreting what have been traditionally the inputs and outputs of cognitive structures as functional entities of the structures themselves, Bart and Smith have made Piaget's theory of cognitive development much more applicable to an explanation of individual patterns of development and to learning itself. Pascual-Leone's (1970) analysis of the Piagetian conservation tasks comes close to this understanding of cognitive structure. He postulates a central processor or mental space (M space) which together with operative elements transforms

---

3 Piaget (1971b) gives as examples in his treatement of sensori-motor intelligence, order relations, subordinations and correspondences.

4 Examples of processes are cognitive operations such as classification and seriation (Bart and Smith, 1974).

5 An example of rules would be the I.N.R.C. group that characterises formal operational thought.
and co-ordinates more basic elements. The operative elements are the rules that characterise cognitive functioning and are equivalent to what Piaget, above, has labelled transformations; the basic elements are the items of information with which a person is familiar.

The recent importance placed upon the person's knowledge of content, apparent also in papers by Inhelder (1972) and Langer (1975), results from attempts both to explain why particular individuals reach certain operational levels before others and to accelerate structural growth in general. It also coincides with a major theoretical statement made by Furth (1973) on the nature of a person's experience. Furth, in that paper, argues that in any interaction of a person with his environment there is always a particular aspect that remains novel and unrepeatable; secondly, there is always a generalisable aspect that is common to all other individuals. The former he referred to as 'particular' experience and the latter as 'species-specific' experience. However, as Furth pointed out 'a species-typical experience is never lived or observed but is always incorporated within a particular experience'. And it is this biological inseparability of species-specific experience from particular experience that prevents the construction of cognitive structures that are highly generalisable and free of content.

Briefly then, the Piagetian emphasis on form rather than content results from both a consideration of structuralism that is generalisable across disciplines and an attempt to elaborate a set of universal cognitive operations. Cognitive structures, however, may also be conceived of as possessing a content aspect which although conceptually independent of inherent organisational properties remains an essential structural component. This content aspect results from the person interacting with an environment that is always, to some degree, particular. It is this latter understanding of cognitive structure which is the more useful in the study of school-based learning and which will be used throughout this work.

6 These represent, in the Piagetian theory of cognitive development, major periods in the structural development of the individual, e.g. concrete-operational level.
II Development and Learning – an unnecessary distinction?

How then does a person construct his knowledge of the world in the form of cognitive structures? We might ask, for example, whether a person's understanding of time, causality, etc. is constructed in the same way as a student's understanding of a Shakespearian sonnet or biological evolution. Piagetian epistemology has been concerned primarily with the former, whereas this work is concerned with the latter. Yet if Piagetian psychology is being legitimately translated into educational practice then it should be possible to establish those of its concepts most appropriate to an understanding of school-based learning. Already one such concept, cognitive structure, has been discussed, and in the following sections both the role of experience and intrinsic motivation will be considered. For the moment the traditional Piagetian distinction between development and learning will be considered, for it is this distinction that underlies Inhelder, Sinclair and Bovet's (1974) comment that 'Piaget's theory and the extensive experimentation attached to it can be applied to educational practice only in a very indirect way'.

This section will argue that it is indeed possible to interpret learning within a developmental framework and that the Piagetian distinction is better considered as one between two possible forms of learning activities, each of which characterises a student's interaction with both his school as well as his general environment. In this way Piagetian psychology can be more meaningfully related to those learning activities that characterise schooling.

Furth's (1974) paper is an important interpretation of the Piagetian learning-development dichotomy, based again on his differentiation between 'species' experience and 'particular' experience:

... development ... (a) is a joint function of the species-specific possibilities for acquiring new structures and of the individual's experience of the species environment ["species experience"], (b) derives its information primarily from feedback from the subject's actions on the environment ... (d) leads to a restructuring on a higher plane of species behavioral structures.
... learning ... (a) is a joint function of species-specific available structures, and of the individual's experience of a particular environment ["particular experience"], (b) derives its information primarily from the properties of the environment, ... (d) leads to special applications or to a cumulative increase in the range of application of available structures (Furth, 1974).

This represents the Piagetian position that development is the growth of cognitive structures by the process of reflective abstraction and the consequent elaboration of the internal organisation of these structures; learning, on the other hand, results in a new structure by extending the field of application of previous ones, thereby maintaining the intrinsic transformational characteristics of those structures already formed. The emphasis on application of pre-existing structures in learning is clearly evident:

Learning seems to be in many cases merely the extension to new content matter of structures already formed or in the process of formation (Piaget, 1959).

Two comments are warranted.

Firstly, Beilin (1971b) points out that learning activities such as problem-solving and abstract thinking involve the co-ordination and integration of previous structures in the production of a new structure. Such co-ordination and integration is not merely a process of abstraction from the properties of the environment but also from data (i.e. experience) generated by the mental activity of the person himself. And is this not close to the conceptualisation of development described by Furth above? Beilin would certainly argue that learning involves more than the application of previous structures to novel instances of physical experience. This raises the possibility that during such co-ordination and integration of structures, new structures may emerge that are characteristically different not only in content but also in internal organisation. Of course, Beilin would not

---

7 The experimental studies of Greco (1969) and Pascual-Leone (1969) have illustrated the two forms of learning described above. Greco was able to distinguish a learning that represented an assimilation of reality to the subject's structures, with the distortions that are apt to result from such assimilation; secondly, he describes a structural learning which consists of a re-elaboration of structures which are at first
deny that the more typical learning activity is simply one of directly applying pre-existing cognitive structures 8 to new situations. Such a theoretical interpretation of learning by Beilin clearly contrasts with that of Piaget (e.g. 1959). 9

Secondly, as noted earlier, development occurs in a particular environment and results in the construction of a particular reality. The result of development is a knowledge of reality that is comprised of a highly interrelated and hierarchically evolved network of concepts or knowing activities. Furth (1969), for example, describes the way in which we come to understand a particular instance of reality:

... understanding a certain phenomenon invariably implies an indefinite multitude of active schema, including the most particular that is accommodated to the task at hand, as well as the most general that carries with it logical necessity.

This 'end-product' of the process of co-ordination and integration of cognitive structures contrasts to that which results from the application of already existing structures to novel situations. Structures formed in this latter manner are not integrated within the totality of intellectual structures - they remain quite isolated, lack stability, permanency and generality (Ginsburg and Opper, 1969; Piaget, 1964).

Bringing both these ideas together I would suggest that it is theoretically more useful to distinguish two forms of accommodative activity that can characterise structural growth, viz. an activity which results in a well-integrated knowledge of reality and another which produces a more isolated and discrete set of knowing structures. Each of these may characterise a student's interaction with his

(Footnote 7 from previous page)

disparate and incomplete. In a similar fashion, Pascual-Leone (1969) distinguishes learning that involves the incorporation of new information into an old structure and learning that integrates two previously formed structures. The former is similar to Piaget's differentiation and the latter to reciprocal assimilation.

8 Those cognitive structures that are already formed will be referred to as 'pre-existing' cognitive structures throughout this work.

9 e.g. 'In a word, learning relates to the content of the schematism while the generalisable character of its form does not result from learning ...' (Piaget, 1959).
classroom and more general environment and be referred to as learning. However, Piaget argues that such an interpretation of development and learning fails to take into account the differential roles of both experience and motivation in each. In this regard he distinguishes between common everyday experience and the more contrived types of experience such as are found in classroom learning situations. The relationship between each of these forms of experience and the above interpretation of 'learning' will now be discussed to ensure that this interpretation can be applied to the school situation.

III. Learning and Development - provoked or spontaneous?

The development of knowledge, for Piaget, is a spontaneous affair that is not readily pliable to the whim of the researcher; however learning is 'provoked by situations ... provoked by a psychological experimenter; or by a teacher with respect to some didactic point' (Piaget, 1964). This had led to a large number of studies directed at manipulating the experience of the child so that the development of particular structures may be accelerated. Research by Engelmann (1967a, 1967b, 1971) is typical of many of the studies that attempt to teach logical operations, largely through the use of external reinforcement. They represent very much an expository-didactic approach to teaching and hence any effect on structural reorganisation and integration which results in the acceleration of cognitive development could have far-reaching implications for curricular design and assessment. In the main, studies of this sort have been largely unsuccessful and are often difficult to interpret, particularly in the area of generalisability of effects. For example, it is difficult to assess how much generalisation is required following the training sessions before a stable effect can be established.

As Flavell (1963) claims, the overall failure of such attempts to affect the rate of acquisition of conservation and cognitive structures in general is a sort of indirect validation of Piaget's

---

10 Piaget (see Furth, 1969) does in fact refer to development as learning in the broad sense, but with the implication that such learning cannot result from typical classroom experience or, for that matter, particular experience.
assertion that development is in fact a spontaneous affair and quite distinct from learning.

Yet the lack of success may be due to the methodology employed by such studies and what may be required is a re-orientation away from the traditional empiricist learning paradigm. Greco (1969) points out in discussing the interpretive difficulties of many of the conservation studies that it is only from studies that closely examine the learning process will one be able to decide whether structural change has occurred in contrast to mere storing of information. This emphasis on learning studies reflecting the psychological mechanisms that are necessary for structural change is evident in the research of Inhelder, Sinclair and Bovet (1974). Their conclusion should be noted: 'In many cases, development was clearly speeded up, and concepts were attained in a relatively short time'. While the authors remain extremely cautious as to the generality and stability of the cognitive structures so formed, their research suggests that well-integrated cognitive structures could result from a person's interaction with a particular and defineable set of experiences in a contrived situation. Further, a reading of 'Science of Education and the Psychology of the Child' (Piaget, 1970) hints that Piaget himself accepts that particular educational experiences might influence the students' growth of cognitive structures. With regard to the formal-operational adolescent he suggests that:

> Our schools owe it to themselves to develop and direct such capacities (i.e. formal operational thought) in order to use them in the development of the experimental attitude of mind ...

It appears then that the distinction between development as solely a naturalistic process and learning as more of a provoked activity results from what typically occurs rather from what of necessity must occur.

What sort of educational environment then is necessary to develop in students an integrated knowledge of their learning experiences, and one congruent with their overall knowledge of reality? To answer this question requires an understanding of the dynamic or motivational aspect of structural growth.

The following section examines the Piagetian concept of intrinsic motivation and certain of its limitations before reaching an understanding of intrinsic motivation which is useful in
defining those characteristics of the learning environment most appropriate for the development of integrated knowledge. Only brief mention will be made of the role of extrinsic motivation in the growth of cognitive structures in this section; Chapter 3 will be concerned with that relationship.

IV Intrinsic Motivation and Structural Change

The motivational aspect of cognitive development is the least elaborated in Piagetian theory, a fact which has led to an undue fixation of researchers on questions relating to stages, décalage, etc. (Flavell, 1963, 1971b; Kagan, 1966). In fact the publication Piaget and Inhelder: an equilibration (eds. Nodine, Gallagher and Humphreys, 1972) fails to elucidate the dynamic nature of development. And it is that concept which Furth (1969) deals with least clearly in his otherwise excellent publication. Possibly as a result, Ausubel concludes:

I would like to offer the subjective value judgement that motivational issues in cognitive functioning and development are not of the same order of intrinsic importance and theoretical saliency as some of the other psychological and epistemological issues ... (Ausubel, 1971).

The following section will interpret some of the recent comments upon possible motivational sources of cognitive change that may also be applicable to a study of school-based learning.

Structural growth leads towards the construction of stable structures; after all, a basic property of cognitive structures is self-regulation and consequent inherent tendency towards equilibrium (Piaget, 1960). This self-regulation is referred to as equilibration. Equilibration is a necessary and central concept of interaction, for it co-ordinates the influences of motivation and both physical and social experience (Piaget, 1960). At the structural level it is that factor which maintains internal equilibrium between the functional invariants of assimilation and accommodation by compensating for internal and external imbalances; in so doing, it leads to the development of more and more complex, integrated and stable structures (Furth, 1969; Mischel, 1971).

Although the concept pervades the entire Piagetian literature it is first systematically treated in Piaget (1957). In this

11 Although Flavell (1963) mentions that 'allusions' to it can be found in Piaget's earliest articles.
text he attempts to describe what instigates 'la marche à équilibre' and the steps it entails. Flavell (1963) summarises the four-step equilibration process as described by Piaget with respect to the development of conservation. Firstly, two incompatible events, or schemes are centred on singly and then together. The incompatibility of both schemes is then realised by the person

With the third strategy ... we meet with a new type of behaviour wherein the subject hesitates among the responses ... which thus marks the beginning co-ordination between the two ... (Piaget, 1957).

Finally, the incompatibility is resolved by a new structuring that transforms the organisational properties of the previous structures. This description of equilibration is thought to be typical of all cognitive growth. And to explain why the person moves in this particular direction Piaget invokes a probabilistic model: in any interaction certain behaviours appear more probable than others and these probabilities change in a predictable manner upon subsequent interactions.¹² In other words, Piaget is treating the equilibration process as one of adopting successive strategies for 'coping in more and more organised ways with cognitive perturbations or problems of increasing complexity' (Mischel, 1971). Yet is this a sufficient explanation of why development should occur at all? One might resort, in addition, to an initial premise of the sort 'there is an intrinsic need for cognitive organs or structures, once generated by functioning, to perpetuate themselves by more functioning,'¹³ and thereby introduce the concept of repeated or repetitive assimilation.¹⁴ This then becomes the energiser or motivating force and one that remains intrinsic to the cognitive structures themselves. Equilibration

¹² See Flavell (1963), pp.247-49, Piaget (1957), pp.13-84 for a complete discussion on this aspect of the equilibration model.

¹³ This is the position that Flavell (1963) ascribes to Piaget.

¹⁴ Flavell (1963) quotes Piaget: '... the principal motive power of intellectual activity ... the need to incorporate things into the subjects schemata' (Flavell, 1963: pp.79-80).
as a process of development is thus seen to be closely linked with assimilative activity (Piaget, 1959), whereas learning as has already been indicated can be considered conceptually tied to accommodation. Whatever resists assimilation to pre-existing cognitive structures generates conflict and thereby introduces an awareness of momentary disequilibrium: recognition of disequilibrium motivates the person to resolve the conflict.

This conceptualisation of the dynamic processes involved in development has led to a series of training studies that have used cognitive conflict as a means of accelerating structural growth. Of these, the most impressive theoretically have been those of Inhelder, Sinclair and Bovet (1974). By adopting an interactionist perspective emphasis is upon a cognitively active subject, and one whose pre-existing cognitive structures must be used as a basis for the elaboration of more complex structures. Inhelder et al. describe a cognitively active person as follows:

... being cognitively active does not mean that the child merely manipulates a given type of material; he can be mentally active without physical manipulation, just as he can be mentally passive while actually manipulating objects. Intellectual activity is stimulated if the opportunities for acting on objects or observing other people's actions or for discussions correspond to the subject's level of development.

Consequently wrong hypotheses and error in judgement should not be dismissed but rather such inadequate structures should be the very foundation of future constructions. Further, as Inhelder et al. (1974) point out, the training procedure needs to be sufficiently structured to both arouse conflict in the mind of the subject and enable him to resolve that conflict. The results of these researchers have confirmed the usefulness both of cognitive conflict and the recognition of that conflict as a model for generating cognitive development. However, the theoretical complexity of the equilibratory process, and of development in general, is evidenced by the instability of training effects between two successive post-tests: in certain cases an acquisition of the operative structure remained quite stable; in others there was either improvement or deterioration between the post-tests. The problem of both instability of effects and generalisability to novel situations beleaguerers training studies and has led to conflicting
views of their effectiveness (e.g. Kuhn (1974); Brainerd (1973). As Kuhn points out with respect to the equilibration process it is very difficult to simulate it in the laboratory, and to ensure that conflict producing methods do in fact produce conflict in the minds of the subjects. The studies by Inhelder et al. are an exception in this regard. They point to the distinct possibility that cognitive development may in fact be provoked by the careful arrangement of the person's experience - one that provides the person with a series of situations leading to numerous comparisons and conflicts between the person's predictions and actual situational outcomes.

Flavell (1971b) has discussed certain inadequacies of the Piagetian cognitive conflict model for development, and stresses that the experience of cognitive conflict 'requires the construction of some cognitive bridges which lead up to it and out from it'. For example, the person must not only be confronted with conflicting instances of reality, but he must also perceive them as conflicting; further, he must resolve this conflict in a meaningful manner, and one that will lead to a well-integrated knowledge of reality. Flavell further argues that it is just possible that what are conflict-producing experiences contrived in a laboratory situation are not in fact found in the normal lived-in environment. Research by Weitz (1973) demonstrated that certain propositions said to comprise formal operational thought could not be translated into environmental situations, certainly supports Flavell's contention that conflict-resolution conditions are hard to imagine for the development of adolescent thought as a 'structure d'ensemble'. This has led Flavell to conclude that 'there must be a number of them [developmental mechanism] operative, rather than a single one'.

Theodore Mischel (1971), from more of a philosophical perspective, has made a major contribution towards an understanding of why a person adopts successive strategies which may lead to the development of equilibrated thought structures. He suggests that Piaget's general account of equilibration is an analysis of the norms that govern typical everyday thinking, and that thinking (he uses the term 'directed thinking') cannot be described without appealing to these norms. Consequently the recognition of cognitive conflict is not to be construed as 'energising', in the typical
drive-reductionist sense of the word, but rather as a reason that justifies directed thinking. Ausubel (1971), in a somewhat similar vein, dissociates the need to know, the need to understand, etc. from traditional motivational theory and argues that such cognitive drives in fact are a result of the person adopting knowledge acquisition as a positive value.

Both these latter views reflect a change in conceptualisation of equilibration from being a necessary property of cognitive structures to more of the idea that it represents certain habits, or behavioural tendencies, that persons hold to varying degrees of intensity. These behaviours are related to seeking novelty, coping with conflict and assimilating new information in a manner consistent with previous learning. Further, satisfaction is contained within the activity itself:

There is an internal reinforcement through the pleasure of feeling satisfaction in having found a solution. But there is no external reinforcement, no means of objective control, no punishment nor recompense (Piaget, 1960).

Consequently reinforcement remains intrinsic to the task and derives from the process of cognitive development itself, rather than any external feedback from the environment as a result of that cognitive development. This view of motivation as being intrinsic to development is in clear contrast to the role of motivation usually seen to act in school-based learning: Furth (1974) and Piaget (1964) clearly emphasise an extrinsic model of reinforcement for this form of learning. Yet the reason for such a reinforcement model remains quite unclear. Perhaps one might conclude that it is a necessary consequence of treating learning as something that is provoked by the teacher; or perhaps it reflects an understanding of learning as it has often occurred in the past, being solely directed towards the construction of isolated structures of knowing. 15

15 This is reflected in Piaget's following statement on educational practice: 'if the aim of intellectual training is to form the intelligence rather than to stock the memory, and to produce intellectual explorers rather than mere erudition, then traditional education is manifestly guilty of grave deficiency' (Piaget, 1970).
This emphasis on both the role of cognitive conflict and the behavioural strategies employed for coping with conflict has led both Flavell (1963) and Aelbi (1970) to comment upon the close relationship between equilibration and theories of curiosity and exploratory behaviour (e.g. Berlyne, 1960, 1965). Berlyne (1965) himself has noted the similarity. However, Berlyne places the resolution of cognitive conflict very much within a tension reducing model of motivation:

... epistemic behaviour must generally be initiated by a specific dissatisfaction, and knowledge, which marks the successful completion of epistemic behaviour and supplies its reinforcement, can hardly be rewarding or even identifiable, apart from its power to assuage the original dissatisfaction (Berlyne, 1963).

Mischel (1971) and Ausubel (1971) argue most strongly against such a tension-reduction model of directed thinking, holding that the attainment of knowledge by its very nature is satisfying. Consequently novelty, conflict, incongruity and complexity do not act as aversive stimuli but rather are structural properties of the learning situation which facilitate the pursuit of knowledge. Yet curiosity theory has much in common with the Piagetian concept of equilibration. The emphasis on cognitive conflict, the person interacting with the environment and purposively seeking new information, the influence of prior knowledge on conflict generation, and the acquisition of knowledge are basic to both.

Conceptually, a much closer interpretation of curiosity theory is provided by Beswick's cognitive process theory of curiosity (Beswick, 1964, 1971, 1974 and Beswick and Tallmadge, 1971). There is an initial rejection of the role of traditional motivational theory in cognitive development. At one point Beswick (1964) argues that 'since the theory deals with a process ... it has dynamic aspects. This frees us from any need to postulate a drive state', and again 'it could well be that an adequate account of curiosity will eventually mean the disappearance of motivation as a technical term in psychology'. The similarity with both Ausubel (1971) and Mischel (1971) in this regard is clearly evident. Further the learning model proposed by Beswick is similar to that described above and undoubtedly the Piagetian notions of assimilation, accommodation and equilibrium were influential. And the
definition of curiosity as an individual's readiness or predisposition to seek, maintain and resolve conceptual conflicts resembles the dynamic processes that characterise the person's interaction with his environment as he constructs his knowledge of reality. Finally, the reinforcement remains intrinsic to the acquisition of knowledge itself: 'this cognitive style or strategy is associated with an ambivalent expectation of excitement which terminates in a pleasurable integration of a signal with a category system' (Beswick, 1971).16

Yet it goes further than the Piagetian model. For by taking account of both intrapsychic, in particular, and situational variability it helps in establishing those 'cognitive bridges' that Flavell (1971b) feels are missing from equilibratory theory. The notions of openness and orderliness become basic to the concept of curiosity. The curious person must be sufficiently open to assimilate new aspects of the environment but remain sufficiently discriminating to focus on those aspects that are most likely to create a state of conflict. Orderliness will then be the tendency to resolve conflict by an integration of the new experience into the cognitive structures of the person in a meaningful manner, and one that requires a certain tolerance of conflict and ambiguity. Consequently the predisposition to create, maintain and resolve cognitive conflicts becomes a function of both the openness and orderliness of the person. Is such openness and orderliness any more than the norms suggested by Mischel (1971) to account for the process of directed thinking? Mischel is unclear as to the origin of such norms, commenting only that they possess certain survival values for society. His next comment is interesting: 'but these matters are at a different level: one does not typically solve problems or remove inconsistencies in one's

---

16 A signal is defined as a stimulus in the most general sense and includes both covert events of thought and emotion and external events which activate sensory receptors. A category system is equivalent to a cognitive map of experiences that have been assimilated and transformed (Beswick, 1964). Hence in the Piagetian model, signals are equivalent to a particular known event and category system to the totality of cognitive structures.
thinking in order to survive' (Mischel, 1971). The distinct impression left to the reader is that such norms are externally imposed upon the person and their locus of control is firmly implanted in the general society. However, it is quite clear that orderliness and openness are to be regarded as dispositional properties that directly influence the process of learning, emanating from the person rather than being imposed from outside. In this way Beswick has been able to develop a general theory of curiosity that is directed towards individual variability and in so doing has focused attention on individual differences in intrinsic motivation. This contrasts with the general tendency to explain individual differences in cognitive development solely in terms of extrinsic needs, conceptually independent of the intellectual activities in which they engage and consequently not seen as the concern of Piagetian theory (e.g. Flavell, 1963).

It is now possible to bring together the ideas that have been expressed in this chapter and to see where they lead in an understanding of learning as it commonly occurs in the classroom. A fundamental duality runs throughout. Firstly, there is the distinction between the form and content aspects of cognitive structures; then there appears a differentiation between development and learning, and the underlying dynamic processes of intrinsic and extrinsic motivation; finally, all such ideas could be related to an identification of a species experience as separate from particular experience. Consequently cognitive development was seen to deal largely with the construction of the organisational properties of cognitive structure brought about by equilibratory processes, acting within a species experience and resulting in a highly interrelated and hierarchically order totality. Learning, on the other hand, was more directed towards the content aspects of cognitive structures, brought about by extrinsic reinforcement and resulting in isolated cognitive structures that lack stability and generality. While being conceptually separable, in practice both are tightly interwoven. However this strict Piagetian

17 In his original formulation Beswick (1964) discusses the relationship of orderliness and openness to Freudian theory and in particular sublimated scoptophilia and egocoping mechanism.
interpretation was seen to raise problems. It was suggested that cognitive structures are quite idiosyncratic affairs and consequently do possess content aspects; what is generalisable are the rules and transformations by which such elements are related. The emphasis on learning as accommodative activity being essentially a process of extending the field of application of already formed structures was considered misleading as it often involves integration, reorganisation and co-ordination of structures. The restriction of learning to an underlying process of extrinsic motivation was more the result of a very restricted notion of learning and one that is not necessarily characteristic of the classroom. Finally, the equilibration process itself was seen to be deficient as a mechanism accounting for cognitive change, and an interpretation within a cognitive strategy or style framework as a means of generating and resolving cognitive conflict seemed more suitable.

V Piagetian Psychology and Classroom Practice

The interactionist perspective that was developed in the opening chapter and now elaborated in the context of Piagetian cognitive development can finally be applied to the classroom situation. However, it must be firstly pointed out that there is no direct application of Piagetian principles to educational practices, a view supported by Inhelder et al. (1974). Boyle (1975, quoted in Modgil and Modgil, 1976) describes the relationship between Piagetian psychology and classroom practice in the following manner:

Piaget's work provides the teacher with a comprehensive conceptual framework in terms of which he can analyse his techniques, and evaluate their outcomes. In this it is valuable, but it would be a mistake to regard it as anything more.18

18 Unfortunately many educators, and in particular curriculum developers, have failed to realise the lack of generalisability of concepts relating to cognitive development; rather, texts have been written with very little, if any, comment upon the validity of applying Piagetian principles to education. In this regard Boyle (1975, above) continues: 'the almost religious ethos of the writings of those of Piaget's followers who can do him nothing but harm by falsely attributing to his influence changes that have come about as a result of other influences, and

(Continued on next page)
Many of the difficulties that arise are due to the problems that have been raised above. For example, the notion that learning involves the acquisition of simple facts in the form of isolated structures no longer appears applicable to many modern curricula. And added to these, are assumptions that must be made as to the nature of classroom reality. Is it basically the same as in common, lived-in reality and out of which Piagetian theory is developed? Philip Jackson's (1968) *Life in Classrooms* would suggest that it is not.\(^{19}\) From another perspective one must ask whether the implementation of Piagetian principles into but a singular classroom is not subsumed into the total school experience and proves quite valueless. Then there is the basic assumption that the process of intrinsic motivation which applies to the development of concepts of time, causality, etc. will in fact facilitate *within a very much shorter time span*\(^{20}\) an understanding of concepts such as photosynthesis and meiosis. With this said, it is possible to derive a set of implications from cognitive theory, which is heavily dependent on Piaget's writings, for classroom practices:

A. The interactive perspective places the student in a unique relationship with his learning environment. Consequently the student's knowledge of concepts that are dealt with in the curriculum will be quite idiosyncratic. Concepts are no longer absolute but must be construed as knowing activities that reflect a student's construction of that particular experience or event, and which reflect prior experiences. Even definitions themselves should not be thought of as being simply a copy of what appears

(Footnote 18 from previous page)

by recommending educational practices that, whilst they may be good in themselves, have only the most tenuous connection with Piaget's work'.

19 'As members of crowds, as potential recipients of praise or reproof, and as persons on institutional authorities - students are confronted with aspects of reality that at least during their childhood years are relatively confined to the hours spent in classrooms' (Philip Jackson, 1968).

20 Ausubel (1968), in opposing the overuse of inquiry based curricula and discovery learning procedures, argues that the time needed to learn concepts by means of intrinsic motivation is far greater than is available in the typical classroom organisation.
in a textbook; rather, they too are constructed and will incorporate quite idiosyncratic meanings that may be attributed to the constituent concepts. This is in contrast to the often held belief that concepts should be known by students in some absolute and clearly definable manner, having both a uniform intensive aspect and a precisely defined set of examples by which the concept is known. By emphasising this role of cognitive structures as knowing activities it points to the artificial nature of imposing categories such as concepts, principles and rules, which pervade much of the learning literature.

B. Since knowledge is constructed within an assimilation-accommodation model, the role of pre-existing cognitive structures is fundamental to learning in two respects:

(i) those operations (i.e. rules and transformations) that characterise the cognitive structures will determine how the student will co-ordinate, re-organise and integrate the concepts being studied. And it must be realised that particularly with adolescents this may well vary from one body of knowledge to another. Consequently an adolescent student who is at the formal operational level of thinking in mathematics could in fact have great difficulty in perceiving inherent relationships of a similar operational level that may characterise a discussion in art. This implies that when an adolescent is faced with an unfamiliar body of knowledge, such knowledge should be presented in a rather 'concrete' manner. However, one might expect that with increasing familiarity, such an adolescent would apply cognitive operations to that

---

21 This aspect of formal operational thought, in particular, is not discussed by educators although Piaget's statement (1972b) is quite explicit where he notes, for example, that for people studying law - 'in the field of juridical concepts and verbal discourse their logic would be far superior to any form of logic they might use when faced with certain problems in the field of physics ...'.
material in a way more typical of formal operational thinking.  

(ii) The students' understandings of concepts, and a knowledge of the defining attributes and exemplars of those concepts, will be the basis for the further elaborations of knowledge. Those concepts may be interrelated with others, be more stable and possess a high degree of generality; such concepts could lead to an integrated knowledge of the curriculum. Alternatively, those concepts may be quite isolated, producing elaborated structures that lack stability and internal consistency and which are dependent upon continued external reinforcement for their permanency.

C. Since the growth of cognitive structures is an interactive process, there is a need for students to be active, and not merely passive recipients of information. However, being active does not mean that the student merely manipulates laboratory equipment and that the curriculum emphasises practical exercises. Active means cognitively active as the student 'operates' on his environment, co-ordinating, reorganising and integrating abstractions from that environment. At one point Piaget (1970: p.68) comments:  

... the most authentic ... activity may take place in the spheres of reflection, of the most advanced abstraction ...'

Yet it is this facet of Piagetian theory that has been most misinterpreted and abused by teachers and curriculum developers alike.

D. Basic to such action must be the generation of cognitive conflicts as the student tries to assimilate novel experiences. The learning environment must be sufficiently enriched and yet structured to be a source of conflict for the student. In the curriculum conflicts will arise at different levels: between particular experiences, and the structures to which they are to be assimilated, between subsystems of knowledge within a discipline

22 Lovell's (1971) review of formal operational thought supports such a notion and Sticht (1971) also raises the issue under the label of the ontogenetic recapitulation of learning.
and between general bodies of knowledge across disciplines. Consequently the curriculum must be conceived and taught more as an integrated totality, encompassing various subsystems of knowledge and often relatable in quite conflicting ways to other curricula and disciplines. But always the generation and resolution of conflict will be dependent upon pre-existing cognitive structure. Extreme discrepancy between the material presented by the teacher and the students' prior knowledge will fail to produce conflict that can be tolerated sufficiently long for meaningful integration. Either the new information will be rejected or else it will result in the formation of an isolated structure quite independent of the students' body of knowledge.

These then are the fundamental implications of cognitive theory described in this chapter, and ones that are recurrent themes in much of the literature. However, Piagetian theory is essentially normative and Flavell (1963) aptly comments:

[Piagetian theory] ... contains no obvious conceptual machinery for dealing with individual differences and development.

And it is this which presents the greatest limitation to the success of educational programs that utilise the Piagetian notions of the active child, etc. For students do vary in the degree to which they are predisposed to create, maintain and resolve cognitive conflicts, not only across disciplines but within disciplines. Since, as Beswick (1974) suggests, these differences will result from an interaction between prior experiences and the particular personality traits of openness and orderliness one would expect to find that older students would exhibit greater variability across specific subject areas. Consequently the implementation of programs that are based on Piagetian theory will only be relevant to particular individuals interacting with particular situations. And even if an equilibratory type process similar to that described above may be potentially the most effective source of motivation in school learning, the realities of the classroom and the human condition suggest that it will remain potential rather than actualised for many of the students. Ausubel (1971) sums up the situation:

Particularly in our utilitarian, competitive, and status-oriented culture, such extrinsic considerations as ego-enhancement, anxiety
reduction, and career advancement become with increasing age progressively more significant sources of motivation for school learning.

It will be the purpose of the following chapter to move outside the study of intrinsic motivational bases of school learning to those that pertain to the acquisition of knowledge as a means of gaining extrinsic reward.
Chapter 3

LEARNING AS AN ACHIEVEMENT-ORIENTATED ACTIVITY

Introduction

In contrast to the conceptualisation of the learning process as motivated from within by a need to resolve cognitive conflict in a meaningful manner, this chapter is more concerned with learning that is motivated by a desire for self-esteem, a striving for material rewards and a demonstration of one's excellence to fellow students. Therefore this chapter emphasises the social context in which the student is found, one characterised by the interactions of students and teacher, by consequent behavioural expectations and the arousal of various student needs, and more explicitly by a consideration of learning as a goal-directed activity defined by the teacher. The view of learning about to be elaborated is not sympathetic to the current widespread introduction of discovery-based courses of study that reflect, often incorrectly, the more intrinsic-motivated theory of learning previously described. Rather, it emphasises a learning process motivated by extrinsic reward but which nevertheless results in a meaningful acquisition of knowledge and knowledge that is not inferior to that attained by discovery learning. The following chapter proposes that both models of learning are relevant to classroom learning but vary in their applicability to individual students; in that chapter a theory of school-based learning, derived from these first chapters, is presented.

The earlier sections of this chapter further examine the concept of needs-press interaction introduced previously and consider its applicability to an understanding of academic achievement. This discussion also includes an analysis of the notion of 'congruence' between needs and related press, but finds that the theoretical understandings of congruence implicit in much of the contemporary research in this area are not sufficiently developed to be useful in this work. The following section then focuses upon those needs.

1 This position is quite similar to that which is evident throughout Ausubel's (1968) Educational Psychology: A Cognitive Viewpoint.
42

most relevant to the prediction of academic performance; in particular, the relationship between achievement motivation and school-based learning is considered. However, current relevant research is deficient in its specification of those goals to which the learning activity is directed. For unlike the problem-solving tasks that underlie much of the achievement motivation research, the goals of school-based learning are quite often unclear to students. For classroom learning goals presented to students are related to certain aspects of teaching behaviour, and hence vary in both type and clarity of definition between learning situations. The latter sections of this chapter suggest two learning goals that may be operative in the classroom, the first being an integrated knowledge of the curriculum and the second a knowledge of contents or details found in the curriculum. Finally, it is noted that these learning goals presented by teachers parallel closely the two types of accommodative activity that were seen to define the learning process in the previous chapter. Consequently this chapter is complementary to the previous one rather than in opposition to it. Whereas, traditionally, curricula have been based on a model of either intrinsic motivation which de-emphasises the role of the teacher or else one of extrinsic motivation that emphasises an expository-didactic approach, it is increasingly evident that an understanding of school-based learning necessitates a reconciliation between the two viewpoints.

I. Murray's Needs-Press Constructs

Basic to Murray's theory are the concepts of need and press: the concept of need appears foremost throughout his writings and will be discussed first.

a) The concept of need

Although the immediate impression one gets on reading Explorations in Personality (Murray, 1938) is that needs can be reduced to neuro-psychological processes, such is not the case. It becomes evident that for Murray a need is a hypothetical construct which appears to give an organisational coherence to a person's behaviour e.g. 'A behavioural trend may be attributed to a hypothetical force [a drive, force or propensity] within the organism' (Murray, 1938). Madsen (1961) clearly distinguishes two aspects of need that are evident throughout. Firstly, there
is a dynamic and transitory aspect that is the resultant of forces operating both within the person and the environment and which produces a certain type of behaviour - this could be referred to as its motivational aspect. Secondly, there is a need's dispositional aspect that accounts for a person's readiness to respond in a certain way only under particular conditions. And needs in general act so as to organise '... perception, apperception, intellection, conation and action in such a way as to transform in a certain direction an existing, unsatisfying situation' (Murray, 1938). The development of a person's needs and the consequent differing degrees of intensity is very much a function of the person's interaction with particular elements of the environment. Particular patterns of needs emerge as a result not only of the early abilities of the person but also as a result of the concomitant intensity and frequency of reinforcements that are associated with such interactions. In fact some needs remain quite latent and emerge at a later date because of 'gratuities or the chance attainment of end situations through random movement' (Murray, 1938).

This conceptual interdependence of needs and the environment leads to a consideration of the environment as composed of a set of psychological dimensions which have particular relevancies for particular behavioural tendencies. Murray (1938) argues that persons actively seek out situations that are characterised by those features which are most relevant to their own patterns of need. Generally, however, it is the environment which meets the person and which differentially excites or arouses the particular needs of that person. This effect of the stimulus-situation upon the person is referred to as the press of the situation, which Murray (1938) defines as:

... kind of effect an object or situation is exerting or could exert upon the S. It is a temporal gestalt of stimuli ...

b) The concept of press

Just as needs have both qualitative and quantitative aspects so too will the press of the environment. Press can vary as to the kind of effect it may have on the person, as well as the intensity of this effect. Thus a study of the psychological dimensions of the environment becomes for Murray a study of the press (pl.) of the environment. Yet not all aspects of the
stimulus-situation arouse or incite the person: those that do may be considered 'pressive' and those that have no such effect are described by Murray as being 'inert'. Further, a press may be either positive, being both enjoyable and beneficial, or negative, being distasteful and harmful. In either case it results in the person exhibiting a particular behavioural tendency and from which one can infer the arousal of an underlying need. And the practical implications of the concept of press is noted by Murray (1938):

One can profitably analyse an environment, a social group or an institution from the point of view of what press it applies or offers to the individuals that live within or belong to it. These would be its dynamically pertinent attributes.

These dynamically pertinent attributes will consist of those gesticulations, comments, facial expressions, behavioural expectations and role characteristics, etc. that constitute the social environment and which have particular relevance to the individuals. This has led Stern (1970), in his application of Murray's needs-press model to educational institutions, to define press in terms of behavioural typifications of institutional members as they interact with that institution. However, these do not constitute an objective world conceptually independent of the participants. No, they form part of a person's idiosyncratic knowledge of reality. Consequently press may be considered as a complex of meanings that the person ascribes to certain environmental stimuli with which he interacts and which are particularly salient to the arousal and satisfaction of internalised needs. It is this very subjective knowledge of one's environment that Murray refers to as beta press - 'the subjects' own interpretation of the phenomena which he perceives' (Murray, 1938). This can be contrasted to the alpha press of the situation which Murray describes as 'the press that actually exists, as far as scientific enquiry can determine it' and which is identifiable only through the use of disinterested trained observers. However, it is the beta press that Murray believes is the determinant of behaviour: in his description of childhood

2 Of course there are those physical attributes that pertain to the primary needs and which relate to food, shelter, etc. However, such needs are not relevant to this treatment of classroom interaction.
press he comments accordingly: 'if a child believes that a situation signifies a certain thing it will be this conception that will operate rather than what the psychologists believe the situation signifies' (Murray, 1938).

Two points should now be made with respect to this distinction: the first relates to a limitation inherent in the concept of beta press and the second emerges from the consideration of persons interacting with a social rather than a purely physical environment.

Firstly, Stern, Stein and Bloom (1956) note that the concept of alpha press takes into account those aspects of the environment that affect the behaviours of individuals regardless of their subjective awareness of them. For they argue that it is possible that certain environmental stimuli may unconsciously arouse the needs or behavioural tendencies of individuals. Consequently a person's explanation of those determinants of his behaviour (i.e. a description of his beta press) may, as Stern points out, reflect more of a rationalisation than reasoning.

Secondly, social interaction involves an intersubjective sharing of meanings. And following the symbolic interactionist and phenomenological viewpoint outlined earlier, these meanings possess a very real identity, one which will influence the behaviour of those individuals that are participating in social interaction. And so there is a further aspect of the environment which, by the very fact of it being shared, makes a unique contribution to the total press acting on the person. Stern and his associates approach this conceptualisation of a mutually shared aspect of press when they discuss the notion of consensual beta press:

When a particular way of perceiving the environment is shared by members of a functional group, it is called a common beta press and it usually reflects some of the means by which the group maintains its orientations to reality (Stern et al., 1956). However, in later writings (e.g. Stern, 1970) they tend to treat consensual beta press as a means of approximating the press to which, they argue, the individual is responding. In other words, they

3 More recently referred to as consensual beta press.
fail to give it a reality status of its own. A similar interpretation of the distinction between the sharing of a common experience and the individual's idiosyncratic view of his stimulus-situation is given by Gardner (1975) who considers it more of a methodological rather than theoretical distinction.

The concept of press that can be now elaborated appears to possess three unique aspects, each of which can contribute to the arousal and satisfaction of particular needs or behavioural tendencies within the person. There is that aspect of the environment to which the person is not cognisant but with which he interacts: this is an essential part of the alpha press of the environment. Then there is that aspect which places the person within a social situation that is shared with other people: this sharing of a common experience results in a consensual beta press similar to that originally proposed by Stern et al. (1956). Finally a person constructs a knowledge of those pressive aspects of his environment that are quite idiosyncratic: this corresponds to a person's private beta press.

Underlying the above discussions has been the recurrent theme that a person's behaviour may be considered as a function of both internalised needs and the pressive characteristics of the surrounding environment with which the person is interacting. The following section briefly considers the specific nature of the need-press interaction and the consequent notions of congruence and dissonance, before finally applying Murray's needs-press model of human behaviour to the study of school-based learning.

II Needs-Press Interaction

A need may manifest itself by leading a person to search for or to avoid certain kinds of press. Again, some features of the environment are more salient than others; these will be attended to whereas others may receive only peripheral attention. In a complementary manner a relevant press will encourage and support the expression of a need (Stern, 1970). Since both needs and press have quantitative aspects, a high degree of need aroused by a highly pressive situation will result in a heightened level of

---

4 'The collectively perceived significates of various press are an entirely adequate source from which to infer the environmental situation to which individuals are responding' (Stern, 1970).
activity compared to that of a person of low need. Such inter-
action will result in a feeling of satisfaction and accomplishment
for having achieved a particular end to which the need is directed;
alternatively, failure to achieve such an effect will result in
dissatisfaction and possible reaction of the person away from that
particular environment. It is important to note that the inter-
relationship between press and need should be considered from the
perspective of a complex of needs interacting with a complex of
press (pl.) that characterise the situation, rather than from one
that is merely a set of independent interactions. Consequently
Stern (1970) talks about combinations of needs-press, some of
which will be more satisfying than others. And those combinations
of needs-press that are satisfying display a quality of congruence.
In contrast, those combinations that are stressful and dissatisfy-
ing are dissonant. And it is this congruence-dissonance aspect
between personal needs and environmental press that Pace and Stern
(1958) believe will be more predictive of achievement, growth and
change than any single aspect of either the person or the environ-
ment.

The idea of congruence is an important one and yet it remains
quite difficult to interpret in a manner that makes it relevant to
the analysis of, for example, academic achievement. Typically,
congruence has been defined in terms of a symmetrical fit of the
person with his environment and thus a lack of congruence, i.e.
dissonance, is related to the difference between the level of need
of the person and the perceived relevant press of the environment
(e.g. Pulvino and Hansen, 1973; Genn, 1970). Yet the lack of
theoretical clarity of the concept is most evident in the
Australian study by Choo (1973) who designed various measures of
congruence including a pooling of student need and press scores to
give some indication of the congruence-dissonance dimension. The
conceptual meanings that could be attributed to each measure
illustrates the difficulty in interpreting Stern's (1970) descript-
don of congruence. The above-mentioned studies were all directed
towards prediction of academic performance; however, they were
markedly unsuccessful. This is not surprising as the concept-
ualisation of the relationship between congruence and academic
achievement and between congruence and Murray's needs-press model,
underlying these studies appears to be somewhat deficient in regard to the following:

a) Firstly, congruence that is operationally defined as the 'lack of difference' or 'fit' between a person's need and perceived press emphasises that meaning of congruence which relates to an internalised feeling of satisfaction and comfort as the person interacts with his environment. Consequently flourishing groups, in Stern's sense, are satisfied groups whose members are harmoniously interacting with each other. But flourishing groups, defined in this way, are not necessarily those groups whose academic performance will be superior. To argue that being in harmony with one's environment is an optimal condition for learning ignores the possibility that states of tension between the person and environment may in fact facilitate learning. The role of cognitive conflict and the maintenance of such conflict in the learning of new information has already been discussed. The effect of anxiety upon learning is another example where learning may be facilitated by moderate amounts of discomfort and stress (Ausubel, 1968; Branch, 1968). This possibility of an optimal yet assymmetrical relationship between the person and his environment leads to a further set of problems inherent in studies of this type.

b) Between individuals there may be variability as to the levels of dissonance that may be optimal or at least tolerated before academic performance is impaired due to anxiety, stress and feelings of alienation. The relationship between dissonance and anxiety itself may not be linear, as the study by Pulvino and Hansen (1973) suggests. And finally one must recall that the congruence-dissonance dimension refers to combinations of needs-press interactions rather than separate need-press interactions. From these,

5 One needs only to consider the intellectual productivity of such people as Galileo, Buffon and Priestley that occurred very much within a social environment that was anything but harmonious.

6 The Yerkes-Dodson type of effect is well known where students of moderate anxiety demonstrate higher academic performance than students of low or high anxiety (e.g. Cox, 1960). However, in this regard, Gaudry and Spielberger (1971) point out that there is sufficient contrary evidence to make for caution in accepting this law too readily. Yet the fact remains that one cannot assume the notion that there is an inverse linear relationship between anxiety and academic performance.
three important implications for studies of congruence follow. Firstly, those needs-press combinations that interact as a complex need to be theoretically identified as a complex and the notion of congruence applied to such a totality. Genn's (1970) attempt to reduce the thirty need-press measures to smaller aggregates may appear directed towards this end. Unfortunately, this was not the case: 'it was desirable in the interests of parsimony to reduce the dimensionality of the need and press measurement' (Genn, 1970). Secondly, there may be variability in the levels of optimal dissonance between such complexes of needs-press combinations; and from a different perspective, certain complexes may need to be satisfied before other complexes may affect the behaviour of the person. 

c) Finally, there has been a tendency in such studies both to define needs-press interaction solely in terms of a congruence dimension and then to propose that congruence itself would be the predominant predictor of academic achievement. Pulvino and Hansen's (1973) study is a case in point. But interaction means more than the degree of fit between the person and his environment. Murray's needs-press model itself indicates that students rated high on both need and press dimensions exhibit higher levels of activity than do students rated low on both dimensions. For at low levels of need a person may be harmoniously interacting with his environment and yet exhibit no tendency towards behaviour that satisfies that need. This is not meant to deny the importance of the concept of congruence. However, it does indicate the possible necessity of introducing a minimum level of need arousal below which congruence is not a determining factor of performance.

It is evident that those recent interpretations of interaction in terms of congruence have been far too restrictive and often oversimplified. They have failed to incorporate those aspects of need and press that determine the level of arousal of the person; 

7 Current research by Sheppard (1976) is approaching this question of satisfying prior complexes, in his case, social needs, before other complexes such as those related to achievement and cognitive mastery become effective.
instead they emphasised particular resultant effects of interaction such as anxiety and stress upon academic performance. Congruence, if it is to be a useful construct in the understanding of performance, must be seen as a separately identifiable source of effect. This would indicate that research into congruence should be directed towards its relationship to both the needs-press model and to internalised feelings of anxiety and dissatisfaction, and not to its use as a gross indicator of academic performance. Owing to this lack of conceptual clarity, congruence will not be a feature of this study into school-based learning, although its relevance to the problem will be noted. Rather attention will be given to the more fundamental understanding of interaction as can be derived from Murray's original formulation. The following section will now deal with the application of Murray's needs-press model to an educational context.

III. The Needs-Press Model and the Educational Context

The appropriateness of the needs-press model within an educational context is evidenced by a significant body of research that is currently emerging. This research has concentrated on establishing those needs most salient to the prediction of academic performance and the interaction of these needs with particular characteristics of the educational setting. Such characteristics include both teaching styles and peer-group influences.

The first substantial contribution was made by McKeachie (McKeachie, 1961; McKeachie, Isaacson and Milholland, 1964). Growing out of the work of McClelland, Atkinson and their associates (e.g. McClelland et al., 1953; Atkinson and Reitman, 1956) McKeachie presented an interactive model of motivation, teaching styles and learning; he subsequently argued that needs for affiliation, power and achievement are relevant to the prediction of academic achievement. At much the same time Auschuler (1968) isolated press for power, affiliation and achievement as the major dimensions of the classroom motivational climate, noting that press for power and achievement tended to predominate. From a different research perspective, and one based purely on the analysis of teaching behaviour Rosenshine (1971) presented evidence in support of an achievement-orientated teaching style that is associated with academic success. Similarly, Ryan's (1960) study suggested that a
teaching dimension characterised by 'affiliative nurturant' behaviour is important; however, such an effect was restricted to the lower school levels and was not evident in senior classes. That conclusion substantiates my own view that at senior levels of high schools the role of social needs and press is reduced and that the achievement-orientated dimension of teaching behaviour and school ethos tends to predominate. Consequently one aspect of the present study is an examination of the role of achievement motivation and achievement press as it applies to a learning situation that is characterised by an emphasis on task performance.

IV Need for Achievement and Academic Performance

Need for achievement is generally considered as the desire to compete with an internalised standard of excellence, either personally or externally defined, in some goal-directed activity. Murray (1938) describes it as the desire:

To accomplish something difficult. To master, manipulate or organise physical objects, human beings or ideas. To do this as rapidly and as independently as possible. To overcome obstacles and attain a high standard. To excel one's self. To rival and surpass others. To increase self-regard by the successful exercise of talent.

And the person when aroused by the relevant press will, Murray continues:

... be stimulated to excel by the presence of others ... enjoy competition ... overcome boredom and fatigue ... have the determination to win ... and be ambitious.

One would expect then that need for achievement would be related to academic performance, which after all is a measure of the student's ability 'to accomplish something difficult ... to master, manipulate or organise ... ideas' and which occurs in what is described as usually, particularly at the senior level, a highly competitive environment.

Yet the research findings in this area remain quite unclear. For example, Lavin (1965) found that the results of studies using projective measures of achievement motivation were quite inconsistent in their prediction of academic performance. On the other hand, questionnaire measures of achievement motivation provided consistent and positive relationships with academic performance, although such relationships were not strong. Lavin argues that,
apart from the low reliability of many of the projective test instruments, the inherent complexity of the achievement motive makes it not a suitable predictor of academic performance.  

Further, McClelland himself would tend to view the achievement motive, as measured by projective tests, to be a motivating force in business and commerce and not in scholarship (McClelland, 1969). But the fact still remains that one would expect need for achievement to affect academic performance since its effect on the learning process, by increasing attention and persistence and decreasing distractibility is clearly evident. Subjects who have a high need for achievement learn more efficiently (Kight and Sassenrath, 1966), tend to reach solutions in problem solving tasks more often (French and Thomas, 1958) and are generally more persistent (Feather, 1961). Heckhausen (1967) concludes that

... subjects with higher achievement motivation
... do better on all sorts of tasks; this is true particularly of tasks which permit learning, demand concentration, or contain levels of difficulty which by mastering, one's competence can be demonstrated.

Yet Heckhausen, too, notes the inconsistency of achievement motivation as a means of predicting academic performance.

To understand the inconsistent findings of the effect of achievement motivation upon learning and academic performance it is necessary to reconsider the basic properties of the achievement need-press complex. Firstly, there is that predispositional property of the person to act in a particular manner; secondly, there are varying states of arousal which will be dependent upon the press of the environment; and thirdly, there are the goals to which achievement-orientated activity is directed (Campbell, 1973). Typically achievement tasks or goals, particularly those involved in the learning studies mentioned above, are well defined,

---

8 See, for example, the paper by Mitchell (1954) on the factorial dimensions of the achievement motive. He isolated six constituent factors, including one which he labelled 'Academic motivation and efficiency' which was the only predictor of academic performance.
quite specific and may be attained within a short duration. In contrast, learning as it commonly occurs in the classroom cannot be viewed as a series of discrete, clearly definable learning tasks and academic performance to be some collective measurement of the student's attainment of such tasks. The goals of classroom learning are of a different sort, and academic performance must be interpreted with reference to these goals. It seems to me that the goals to which achievement-orientated activity are directed in the classroom are not sets of discrete problems, etc. but rather abstractions from those activities presented by the teacher and with which the student interacts. The remainder of this chapter suggests what two such learning goals may be. In this regard the discussion focusses on the meanings that may be attributed to those aspects of teacher behaviour which are important indicators of the types of goals that are legitimated by the educational process. Consequently this final section stresses the inherent interrelatedness of the classroom and argues that the nature of the knowledge which is disseminated in the classroom is very much a function of both student and teacher.

V On Specifying the Goals of Learning

Classroom interaction may be construed as social interaction where the participants share common goals, such as the understanding of a well-defined body of knowledge, a successful completion of the Higher School Certificate or perhaps the maintenance of particular classroom attitudes. Further, it may be characterised as the meeting place of particular patterns of ideation which, as Esland (1971) describes, may be interpreted, realised and justified by the participants in quite idiosyncratic ways. Yet to a certain extent these will be shared with the other members of the classroom. Consequently the classroom can be viewed as a set of implicit understandings between student and student and between student and teacher.

9 For example, the students may be involved in a ring-toss game, throwing rings on to a peg from varying distances (Atkinson, 1964) or arithmetic and verbal tasks lasting periods of only two minutes at a time (Lowell, 1952).
teacher which have been developed over varying periods of time. As was described in the first chapter these implicit understandings are the source of action, for persons in a situation tend to react according to those implicit understandings by which the situation is known; and in such action persons are constantly typifying and interpreting the actions of one another. In the classroom there will be an implicit understanding that the teacher is a mediator of learning and as such not only transmits a particular body of knowledge but also directs the learning process (Havighurst and Neugarten, 1975). And so the teacher's behaviour is interpreted within this set of meanings that typify what the students understand or expect of a teacher. As a result of this interaction students share with their teacher a definition of both the form of knowledge and the boundaries of that knowledge which constitute the curriculum and to which achievement-orientated activity will be directed. In the following paragraphs the variability of what constitutes knowledge as it is taught in the classroom will be considered.

The role of the teacher has become doubly important. Not only is he involved with arranging an environment that is optimally conducive to learning, but he also determines the form of knowledge that is to be constructed by the students - in effect he actively regulates what knowledge is to be transmitted. Rather than merely presenting a curriculum that has been prescribed by an educational authority, the teacher himself presents a very subjective body of knowledge that he has constructed over a period of time. Consequently an analysis of classroom learning cannot take for granted the uniformity in presentation of a prescribed curriculum. This will become very much in evidence in subsequent chapters and underlies the comment made by Esland (1971): 'It is therefore necessary not to consider subjects as given, but to firstly analyse what a teacher thinks a subject is'. Even this appraisal is too simple, for teaching and learning is an interactive process and teachers tend to alter what they classify as 'knowledge to be taught' depending upon their understandings of the pupils they are teaching. Keddie's (1971) analysis of what she regards as classroom knowledge is an important contribution in this regard.

Bernstein (1971) distinguishes three aspects of the educational
process which are now pertinent to the discussion: the curriculum which defines what constitutes valid knowledge; pedagogy which defines what constitutes valid transmission of knowledge and evaluation which defines what counts as a valid realisation of this knowledge on the part of the students. The former two aspects reflect respectively the content of the lessons and the manner by which such content is taught; while being conceptually separable in practice they are quite interdependent. According to Bernstein the curriculum that is presented by the teacher and which defines the knowledge to be learnt by the student can be regarded typically of two sorts:

a) if individual contents of the curriculum remain quite isolated and stand in a closed relation to each other it may be referred to as a collective type;
b) if the individual contents are not isolated but stand in an open relation to each other it may be regarded as an integrative curriculum.

Teachers then tend to differ in the degree to which they maintain boundaries both between disciplines and between topics and concepts which constitute specific subject areas. Keddie's (1971) analysis of the teacher-taught relationship illustrates this very distinction but goes further by demonstrating how the type of curriculum presented is often a function of the perceived abilities of the students. Pupils who are considered bright are presented material that reflects the demands of the subject, the teacher's presentation being guided by the underlying propositions and inherent structure of the discipline. In contrast, supposedly dull students are presented a curriculum that is reduced to elemental form as a 'series of stories'. Further, what the teacher accepts as valid educational knowledge can differ along another dimension. One can distinguish a boundary between a pure theoretical knowledge and commonsense everyday knowledge. Teachers will vary in the extent to which they will accept commonsense knowledge as valid classroom knowledge.

10 Bernstein's (1971) analysis is more concerned with those boundaries that exist between disciplines in the overall school curriculum. However, such an analysis is also relevant to subject areas and topics found within each discipline.
knowledge, just as pupils may vary in their acceptance of classroom experience defined in a purely theoretical way. Dissonance in this regard will lead to a breakdown in communication and a lack of sharing of a common reality.\textsuperscript{11}

Teachers will also vary in the manner in which this knowledge is transmitted. For example, Bernstein (1971) notes that the organisation and pacing of the knowledge transmitted varies between classrooms, and correspondingly so does the student's control over what, when and how he receives this knowledge. This is particularly relevant to the facilitation of intrinsic-motivated learning, examined in the preceding chapter. The studies of teaching behaviour commented upon in the initial chapter are most relevant here. These studies have focused on those aspects of teaching behaviour that attempt to guide intellectual processes and the subsequent acquisition of knowledge. They tend to differentiate a behaviour that calls for the retention of specific information from one that emphasises the understanding of conceptual material; between lower and higher cognitive demands upon students; and behaviour that can be categorised either as defining, describing, designating or comparing, contrasting and explaining (Dunkin and Biddle, 1974).\textsuperscript{12} These activities, rather than independent and isolated, are bound together within the classroom by the curriculum. Consequently underlying these studies is a tendency to differentiate a presentation of the curriculum as either a collection of specific facts or elements of information or a more integrated set of principles, concepts, etc. that may be applied to broader fields of knowledge. And is this not similar to Bernstein's categorisation of the curriculum? The interdependence of what constitutes the subject knowledge to be taught and the manner in which it is presented becomes evident. However, the above differentiations within the curriculum and within teaching behaviour are not absolute. Rather, curricula vary to the degree to which they

\textsuperscript{11} Holt (1964) in \textit{How Children Fail} discusses this lack of reality sharing: teachers and students often talk about different interpretations of concepts, etc. while assuming that they are talking about the same thing.

\textsuperscript{12} E.g. The Illinois Logic Instrument (Smith and Meux, 1962) and the Teacher Pupil Question Inventory (Davis and Tinsley, 1968).
display integration and collectiveness. Similarly, teaching
behaviour varies in both its emphasis on the retention of specific
information and its emphasis on the integration of that information —
and it is quite conceivable that a teacher may display a high
emphasis on both. The teacher's evaluation of academic performance
and the consequent legitimation of the knowledge that students
construct will be congruent with those aspects of teaching behaviour
that have just been described. The manner of testing, the actual
context of tests and even the types of answers accepted by the
teacher in the classroom all become an integral part of the learning
process.

It is proposed then that students interpret teaching behaviour
within a system of meanings that reflects an implicit understanding
of the teacher's role as one defining the boundaries and contents
of the discipline. Some teaching behaviours are more relevant
than others and one such set of behaviours is described above.
Arising out of such interactions the students build up a set of
expectations of the goals to which learning should be directed and
the form of knowledge most likely to be evaluated. Further, these
expectations are shared with other members of the class and the
notion of describing a class of students as an 'epistemic'
community appears appropriate. Yet an interactive perspective is
also a constructivist one: these expectations cannot be considered
within a stimulus-response paradigm but rather represent a re-
construction of past learning experiences in terms of the present
learning situation. For this reason studies relating teacher
behaviour and student learning that are carried out over short
periods of time cannot be expected to demonstrate large and signi-
ficant effects.

In this section two goals to which achievement-orientated
activity may be directed have been suggested. The first is an
integrated type of knowledge where the constituent topics and
concepts are meaningfully related to each other and to broader areas
of interest. The second is a non-integrative type of knowledge

13 Once again Berger and Kellner's (1964) comment is pertinent:
'Reconstructed present and reinterpreted past are perceived
as a continuum extending forwards into a projected future'.
where the constituent elements remain independent of each other and neither generalised nor related to other forms of knowledge. It should be noted that both these goals closely parallel the possible cognitive changes that result from the two forms of accommodative activity described in the previous chapter.

Briefly then, a consideration of the role of achievement motivation in school-based learning must analyse the goals to which such learning is being directed; these goals vary not only in type but also in the degree of clarity of definition. In this manner, by evaluating the goals of the learning activity as well as the press of the environment, one should be able to relate the effects of achievement motivation upon academic performance. It will be the purpose of the following chapter to interrelate this view of learning as a goal-directed activity with that of learning as accommodative activity generated by a desire to create, maintain and resolve cognitive conflicts.
The purpose of the present chapter is to summarise briefly and interrelate the underlying theoretical principles that are evident in the preceding chapters. In so doing, a theory of school-based learning is proposed.

Clearly the theoretical perspective that has been advanced is an interactive one and one which has focussed on both the cognitive and social aspects of knowledge construction. Both are seen as tightly interrelated and as such make a major contribution to the understanding of those processes involved in the learning of a particular body of knowledge. The interpretation of learning and development outlined in Chapter 2 is useful on two accounts:

a) by emphasising the central structuring capacity of the student which enters into every learning act, it points to an understanding of learning as a process of structural change;

b) by describing intrinsic motivation as a process involving the generation, maintenance and resolution of cognitive conflict, it identifies one important source of structural change that may be operative in the classroom.

Yet it was noted that often learning is not intrinsically motivated. Consequently Chapter 3 focused on the achievement need-press model as an alternative source of motivation that might bring about learning. In the following section of this chapter each of the above central ideas is used to define the theory of learning that has guided the present investigation into how learning typically occurs in the classroom.

I. Cognitive Readiness, Learning and Structural Change

Students interact with a curriculum that generally is sequenced in such a way that later contents presuppose the prior formation of concepts dealt with in earlier stages of the curriculum. For the purpose of this work, those concepts that are considered necessary for the acquisition of a particular body of
knowledge contained within the curriculum will be referred to as *prerequisite concepts*. Now students vary in their possession of those cognitive structures by which such prerequisite concepts are known, and hence in their readiness to assimilate novel aspects of the curriculum. In the following pages, that set of pre-existing cognitive structures to which the curriculum will be assimilated is defined as the *cognitive readiness*\(^1\) of the student.

A student who possesses a set of cognitive structures that are congruent with the prerequisite concepts of a particular curriculum may be referred to as possessing a high level of cognitive readiness. Since any totality of cognitive structures are in fact more than an aggregate of constituent elements it is argued that the interrelatedness of these structures will produce a stable or equilibrated configuration with respect to the student's knowledge of these prerequisite concepts. Alternatively, the student may possess a set of cognitive structures by which some of the prerequisite concepts are known and not others. This set of cognitive structures may be considered somewhat analogous to the intermediate stages in the equilibratory process described earlier where the subject's knowing structures are in a state of disequilibrium. Consequently it may be described as unstable and one likely to be inconsistent in those instances of experience that may be directly assimilated to it. Finally, the student may possess no such set of cognitive structures by which the prerequisite concepts are known and hence will be unable to assimilate instances of experience that are examples of these concepts.

Briefly then it is possible to differentiate three distinct levels of cognitive readiness that differ not only in the number of prerequisite concepts that may be directly assimilated to it but also in the organisational properties when the set of constituent cognitive structures are considered as a whole.

Learning was defined as the accommodative activity by which these pre-existing cognitive structures undergo integration and

---

1 This use of the term 'cognitive readiness' is similar to that of Ausubel (1968) who defines it as 'the adequacy of existing cognitive processing equipment or capacity for coping with the demands of a specified cognitive learning task'. 
reorganisation in the assimilation of novel aspects of the curriculum. Two such forms of accommodative activity were identified in Chapter 2:

(i) an accommodative activity that involves little integration and reorganisation of pre-existing cognitive structure; rather it simply involves the addition of new components which are arbitrarily related to pre-existing structure. This may be described as a non-integrative learning process.

(ii) an accommodative activity that involves a reorganisation of pre-existing cognitive structure and a resultant integration of assimilated material within the relevant and hence non-arbitrary structure - an integrative learning process.

Students will differ in the degree to which their learning activities can be characterised as either integrative or non-integrative, and correspondingly in the degree to which such learning activities lead to structural integration and reorganisation.

The following interdependence between level of cognitive readiness and the form of accommodative activity that characterises learning is proposed:

a) Students of low cognitive readiness are unable to construct a knowledge of the curriculum that is integrated with their general cognitive structures. Learning for these students would be largely non-integrative and would result in the production of isolated cognitive structures by which the curriculum was known.

b) Students of high or intermediate levels of cognitive readiness may use either an integrative or non-integrative learning process. Learning for these students would therefore result in the production of either isolated cognitive structures or else a set of cognitive structures integrated with their more general knowing structures.

These may be considered the two central guiding propositions of the study. However, the type of learning process used by the student will not only be dependent upon his level of cognitive readiness. It will also be dependent upon the student's level of motivation, its subsequent arousal and the implicit understandings between student and teacher of what constitutes the contents and
boundaries of the curriculum. It is this latter consideration which has led to the identification of two aspects of school-based learning, viz., intrinsic-motivated learning and achievement-orientated learning. Each of these models of learning have been used to generate a further set of propositions that have guided this research study. These will be outlined below.

II. Intrinsic-motivated Learning and the Curriculum

Central to the intrinsic-motivated model of learning are the concepts of cognitive structure, intrinsic motivation and the 'arousal' properties of the environment. The proposed interaction between each of these and the subsequent influence upon the learning activity of the student forms the basis for a major part of this present investigation. This will now be considered.

Intrinsic motivation has been defined as the tendency of an individual, in this case a student, to create, maintain and then resolve cognitive conflict. Resolution of such conflict is directed towards the production of an integrated rather than an isolated structure of knowing. However, since intrinsic motivated behaviour depends upon a dynamic predispositional property of the person (i.e. a motive), the student will not exhibit this cognitive style or strategy unless in an aroused state. Arousal will be facilitated by:

(i) the intellectual freedom of the student to seek out conflicting instances of experience and to resolve such conflicts in an integrative manner

(ii) the responsiveness of the classroom environment to the intellectual needs of the student which includes the teacher as a person capable of both resolving cognitive conflict when appropriate and supplying a diversity of information that is of interest.

The dimension of the learning environment that facilitates this generation of cognitive conflict and its subsequent resolution in an integrative manner will be referred to, throughout this work, as facilitation of intrinsic motivation.

The extent to which the student will in fact maintain and resolve the conflict, once created, in an integrative manner will also be dependent, in part, upon his level of cognitive readiness. As Chapter 2 indicates, when the information to be assimilated is
extremely discrepant with pre-existing cognitive structure then the student will seek early resolution. However, when the information is moderately discrepant with pre-existing cognitive structure, the maintenance of conflict may be tolerated until the information is integrated into the student's general knowing structures. Further, the effects of prior experience tend to modify the types of subject matter with which the student will interact in this manner.

These considerations lead to the following guiding propositions:

a) learning based upon intrinsic motivation results in the construction of an integrated understanding of the curriculum, provided that the environment is sufficiently arousing and that the student is interested in the particular subject area. However, this will be modified by the student's level of cognitive readiness such that:

b) for students of low and intermediate levels of cognitive readiness, the extreme discrepancy between the information to be processed and their pre-existing cognitive structures results in those students seeking early resolution of cognitive conflict and a failure to integrate that information into their more general knowing structures.

c) for students of high cognitive readiness, the moderate discrepancy between the information to be processed and their pre-existing cognitive structures is arousing; for these students conflict may be tolerated, depending upon the student's level of intrinsic motivation and the learning environment's facilitation of intrinsic-motivated behaviour, until such information becomes meaningfully integrated into their more general knowing structures.

This concludes a summary of those guiding propositions related to the intrinsic-motivated model of learning and upon which a major aspect of this study is based.

III Achievement-orientated Learning and the Curriculum

The interaction of achievement motivation, achievement press and goal specification in the conceptualisation of learning as a goal-directed activity represents the second aspect of the theory of school-based learning.

Two learning goals have been identified in Chapter 3. The first is a knowledge of the constituent elements of the curriculum
and the second an integration of these elements into the student's general body of knowledge. The teacher's specification of the former will be referred to in the ensuing chapters as emphasis on specific detail and the latter as emphasis on integration. The following guiding propositions summarise the proposed relationship between the teacher's specification of each of these learning goals and their students' learning activities:

a) The teacher's specification of the learning goal emphasis on specific detail will be positively related to a non-integrative learning activity and the students' construction of isolated cognitive structures by which the curriculum is known.

b) The teacher's specification of the learning goal emphasis on integration will be positively related to an integrative learning activity and the students' construction of an integrated knowledge of the curriculum.

These effects of goal specification upon student learning will be further modified by the students' level of achievement motivation and the achievement press of the school such that:

c) Students of high achievement motivation found in classes of high achievement press and high goal specification will perform better than students of low achievement motivation found under similar conditions, provided the criterion measure is congruent with the learning goal specified.

d) Students of high achievement motivation found in classes of high achievement press and low goal specification will perform worse than students of low achievement motivation found under similar conditions, provided the criterion measure is congruent with the learning goal specified.

However, just as the student's level of cognitive readiness was fundamental to the intrinsic-motivated model of learning, so too is it fundamental to the achievement-orientated model of learning.

Three levels of cognitive readiness have been described in section I of this chapter and it is proposed that the learning goals specified by the teacher will have differential effects upon the integrative learning activities of students at each level. These are summarised below.

Students of high cognitive readiness possess a stable set of
cognitive structures by which the prerequisite concepts of the curriculum are known. A positive relationship between the teacher's emphasis on integration and the construction of a well-integrated knowledge of the curriculum is suggested for these students; there should be no such relationship between the teacher's emphasis on specific detail and the students' participation in an integrative learning activity.

Students of intermediate cognitive readiness possess a set of cognitive structures which, when considered as a totality, are in a state of disequilibrium. And just as when an adolescent is faced with an unfamiliar body of knowledge such knowledge should be presented in a rather concrete form, it is argued that these students can construct a stable knowledge of novel aspects of the curriculum by first retaining specific details of the curriculum in the form of isolated structures and then subsequently integrating these structures with their more general structures of knowing. This suggests a positive relationship for students of intermediate cognitive readiness between an integrative learning activity and both the teacher's emphasis on specific detail and emphasis on integration.

Students of low cognitive readiness do not possess the necessary cognitive structures for the integration of novel aspects of the curriculum. Consequently one would not expect a positive relationship between the teacher's presentation of either of these learning goals and the construction of an integrated knowledge of the curriculum for these students.

With regard to the students' construction of isolated cognitive structures by which the specific contents of the curriculum are known, the theory does not postulate an interactive effect between cognitive readiness and the teacher's emphasis on specific detail.

The arousal properties of the learning activity itself will be considered briefly in this investigation. For students of high cognitive readiness it is argued that the integration of novel aspects of the curriculum will be of moderate difficulty and quite challenging; in contrast, the retention of specific course content would be relatively easy and of low incentive. For students of low cognitive readiness the situation would be quite different: the integration of information would be extremely difficult whereas
the construction of isolated cognitive structures by which specific course contents were known would be of sufficient difficulty to be challenging. This leads to the following guiding propositions:

a) for students of high cognitive readiness both achievement motivation and achievement press will be positively related to the students' construction of an integrated knowledge of the curriculum.

b) for students of low cognitive readiness both achievement motivation and achievement press will be positively related to the students' construction of a knowledge of specific course content.

This concludes a summary of the theoretical bases for this study. Certain guiding propositions have been formulated and these will be seen to influence the research design, the collection of data and the analyses that are reported in Chapters 6 and 7. The general research design suggested by the foregoing will conclude this chapter.

IV The Research Design — an Overview

The general research design that was derived from a consideration of the above propositions will now be briefly described. The type of study considered appropriate was a (short-term) longitudinal one, during which time students could construct a knowledge of a particular section of the curriculum. A non-experimental design was also required as it is not possible, and not in keeping with the underlying theoretical orientation of Chapter 1, to randomly assign students to differing treatment conditions, particularly over a fairly lengthy period of time.

The initial phase included the location of students likely to be exposed to one or more of the dimensions of the learning environment under consideration. During this period the development of techniques to be used in the assessment of both dependent and independent variables occurred. The dependent variable for the study was the student's knowledge of a particular section of the curriculum that had been taught during the main phase of the study. The independent variables were firstly the student's levels of cognitive readiness, achievement motivation, intrinsic motivation and interest in the curriculum; a second set were those related
to the learning environment, viz., achievement press, facilitation of intrinsic motivation, emphasis on specific detail and emphasis on integration. Once an appropriate sample of students had been located and various assessment techniques developed the main phase of the study commenced. This comprised of four stages and these are summarised in Table 5.3 (p.97), following the detailed description in Chapter 5 of the methods used to assess these variables.

Firstly, the assessment of the student's level of cognitive readiness was required at the onset of that portion of the curriculum that was to form the basis of the study. Throughout the period while the curriculum was being taught the learning goals presented by the teacher and the 'arousal' properties of the learning environment were assessed. This took the form of repeated observations, repeated interviews with the participants and the researcher's use of survey methods. The assessment of the student's knowledge of this curriculum followed immediately after the teacher had completed what he considered to be a satisfactory treatment of that section of the course. From the guiding propositions it is seen that two aspects of the student's knowledge of the curriculum were required to be assessed: the first dealt with the assessment of isolated structures of knowing and the second with an integrated set of structures by which the curriculum was known. To this end two measures need to be constructed. Finally, both intrinsic motivation and achievement motivation are relatively stable predispositional properties of the individual, in this instance the student; measurement of both these characteristics therefore occurred at the conclusion of this phase of the study, being less disruptive to the normal function of the classes.

This concludes a brief overview of the research design. In the following chapter details of the development of appropriate methods of measuring the variables described above will be presented, together with the rationale and procedure used to select both a student sample and a segment of a curriculum on which to test the proposed theory of school-based learning.
Chapter 5

METHODS AND MEASURES

Introduction

The previous four chapters have been theoretical: those chapters have emphasised an interactive perspective, have generalised from purely psychological processes to educational, and have reached an understanding of learning that is applicable to the real world of the classroom. This understanding constitutes a 'middle-range' theory, lacking both the formalisation of a general theory and the exclusive dependence upon the practical situation for its construction which characterises the emergence of a 'grounded' theory (see, for example, Pelto (1970) and Glaser and Strauss (1968)). The purpose of this methodological chapter is to examine the manner in which one is able to transform information that describes the classroom situation into elements that constitute a middle-range theory of learning. Phillipson (1972) has described this purpose accordingly '[it] denotes the logic-in-use involved in selecting particular observational techniques, assessing their yield of data, and relating the data to theoretical propositions'.

As a result there are three central issues within the organisation of this chapter. The first relates to the measurement of those student characteristics identified in Chapters 2 and 3 as determinants of academic performance. The second is perhaps the most crucial of the chapter for it deals with the assessment of particular dimensions of the learning environment, dimensions related to the arousal of student motivation and the specification of goals to which learning activities are directed. Finally, the selection of that aspect of a curriculum within which the study was to take place is seen to be a function of both these issues. This stage of the study comprised three distinct phases. The first resulted in the delineation of both a student sample and a curriculum in which to situate the investigation; the second was directed towards the construction of measures whereby those aspects of the classroom situation which were central to the propositions of Chapter 4 could be assessed; and the third measured these
theoretical constructs within the context of a defined section of curriculum.

I. Towards Defining a Sample

(a) Phase One

This phase of the investigation comprised two related research activities throughout the latter part of 1974 - the first occurred while the researcher assumed the role of relief-teacher with the Commonwealth Teaching Service, the second while the researcher observed in considerable detail four senior science classes in the Australian Capital Territory (A.C.T.).

Both these experiences were important in the development of an appropriate methodology, one that was congruent with both the theoretical perspective described earlier and the educational system in which the study was to be situated. Implicit in the interactive perspective is the notion of a sharing of reality with the participants; consequently, participant observation as a means of understanding the learning environment seemed consistent with this perspective. Yet as will become evident in the discussion of participant observation in section V of this chapter, the relationship between researcher and participant is of a special kind and one that needs to be developed over time. This phase was important in establishing the bases for such a relationship for it introduced the researcher into the school system, not solely as a researcher, but also as a person with considerable expertise in science teaching and one who could share with the teacher at both a theoretical and a practical level the ongoing experiences of the science classroom. In this manner a dialogue between the researcher and a core of science teachers was established. Such dialogue provided the added benefit of serving as a constant source of input to the actual generation of the theory of school-based learning and to the overall design of the study itself, and foreshadowed many of the technical problems that were likely to be encountered throughout the duration of the study.

The use of participant observation as a predominant method of understanding the learning environment requires that the researcher be fully conversant with the curriculum being examined. Because of this basic constraint, the researcher decided to place the study within the context of the Biological Science: Web of Life curriculum
at the Form 5 level of the A.C.T. school system.  

(b) The Web of Life: an overview

The 'Web of Life' course was adapted by the Australian Academy of Science, with the co-operation of the Victorian and South Australian education departments, from the work of the American Biological Sciences Curriculum Study foundation. The Australian adaptation commenced in 1964 in both Victorian and South Australian educational systems, and its entry into the A.C.T. school system did not appear until 1970. It is a student-centred, enquiry-based course whereby the student is expected to understand both a substantive body of biological knowledge and the underlying syntactical structure inherent in that knowledge. Schwab (1962) notes the importance of the syntactical structure of the discipline and describes it as comprising 'the pattern of its procedures, its method, how it goes about using its conceptions to attain its goals'. In contrast, the traditional biology courses have focused heavily upon the substantive body of knowledge that comprises the discipline. For example, Klopfer (1971) contrasts the traditional science curricula with the emergent enquiry-based courses:

... the traditional science courses concentrate on the knowledge of scientific facts, laws, theories, and technological applications, while the newer courses put emphasis on the nature, structure, and unity of science, and on the process of scientific enquiry ... The traditional courses are taught largely by the lecture and recitation method and see confirmation in laboratory exercises which are not essential to the course, whereas the modern programs employ discovery investigations as the basis of course development.

Such a quotation represents the common belief that the modern curricula, such as the 'Web of Life' will be taught in a particular

---

1 The researcher had considerable experience in the development, teaching and examination of the 'Web of Life' course in Victorian high schools.

2 A thorough discussion of this point is to be found in Ford and Pugno, *The Structure of Knowledge and the Curriculum*, 1964.
manner by the teacher as a process of discovery. Yet it will become evident throughout this work that the knowledge transmitted and the manner in which it is transmitted, will be dependent upon the teacher's quite idiosyncratic interpretation of that body of biological knowledge by which the 'Web of Life' curriculum is known. This is not meant to indicate that there are not certain basic characteristics of the curriculum by which it is known by all teachers. Indeed there are, and these are described below. Rather, the variability of presentation in the curriculum is a function of firstly, the relative importance placed upon these characteristics, secondly, what constitutes legitimate instances of them, and finally, differing methods of organising or relating such characteristics. The most basic characteristics by which the course is known by both teachers and students are the three core student-teacher activities which utilise the materials provided. These are described below and will be referred to throughout the ensuing chapters.

(a) the study of a textbook which includes a set of guide questions and problems at the end of each chapter. The guide questions summarise the basic content of each chapter whereas the problems utilise concepts discussed in the chapter and are principally aimed at further developing the general principles inherent in the course. The purpose of each is quite clear:

... guide questions, which are intended to indicate the material ... that the student should remember.

... problems ... opportunity to use the ideas they [the students] are developing (Biological Science: Web of Life Teachers Guide, 1973).

(b) the participation in laboratory and field exercises which are contained within a laboratory manual. These exercises include both a set of detailed instructions that enable the student to proceed on his own, as well as questions interspersed throughout which help summarise and direct the student's progress. At the end of some exercises there is a section labelled 'For Further Investigation', the purpose of which is to further develop the theme of the exercise, often drawing attention to the open-ended nature of scientific enquiry.

(c) the further development of ideas and the understanding of scientific methodology by a set of invitations to enquiry contained
in an appendix to the laboratory manual. These generally describe
pieces of research and are organised in a programmed manner for
either individual or class discussion.

Each of these student-teacher activities is related in a
Teachers Guide. This integrates the basic propositions, concepts,
etc. that underlie each section of the curriculum with the relevant
exercises, guide questions and problems. Appendix 5.1 presents
a summary of the basic student-teacher activities for a particular
section of the course, viz., the concept of diffusion.

(c) Living in Water and Living on Land

The selection of a specific content area of the 'Web of
Life' curriculum in which to situate the main study was guided by
the following three factors:

(i) the time required to develop the researcher role as one
of participant observation. Participant observation, as already
indicated, is a process whereby a researcher shares certain
experiences with other participants, in this instance the sharing
of a curriculum with students and teachers. Such common under­
standings of the learning environment grow out of the researcher's
interaction with those individuals. Consequently assuming the
research role of a participant observer is a developmental process
that occurs over a lengthy period of time. 3

(ii) the time required to develop psychometric measures of
student characteristics as well as additional assessment procedures
for the learning environment.

(iii) arising from the methodology being adopted, a section
of sufficient length to allow both a meaningful interpretation of
the learning environment and the implementation of the learning
model being proposed.

As a result of each of these considerations it was decided to
implement a study of those sections of the curriculum dealing with
'Living in Water' and 'Living on Land', and which correspond to
Chapter 6 and Chapter 7 of the text respectively. While the
suggested time allocation for this section of the curriculum was
only four weeks, it was thought by the researcher and based on

3 See, for example, Olesan and Whittaker (1967) for the differing
phases of this role-making process.
previous experience that it could well occupy from six to eight weeks. Teachers tend also to commence this section at the beginning of the second term of the school year, thus allowing sufficient time for the development of the participant-observer relationship with the teachers and students as well as the development of necessary psychometric measures.

(d) The Student-Teacher Sample

The sample of students and teachers that were the focus of the study comprised those 5th form classes that were due to commence Chapters 6 and 7 at or shortly after the beginning of second term of the 1975 school year. Further, it was the intention that only those classes were to be included in the sample where the researcher had developed a satisfactory rapport with both students and teachers by the end of the first term of that year.

Twenty-nine 5th form biology teachers were initially contacted at the end of 1974 and the beginning of 1975 as to the possibility of implementing the research program within their classes. Of these, twenty-five tentatively accepted the proposal and four totally rejected the idea. It should be emphasised that many of the teachers were already aware of the researcher's interests as a result of the initial research activity and this certainly contributed to the high initial acceptance rate. Since six of these twenty-five teachers proposed to finish the relevant section of the curriculum before the end of first term, they were considered a potential pilot group. In the ensuing period of role clarification a further two teachers were removed from the sample. As a result the final sample comprised seventeen classes numbering 363 students with which the researcher had established an appropriate rapport with the teacher. The development of the desired participant-observer role vis-a-vis the student was less successful during this stage, a factor which was to have considerable bearing on the assessment of the learning environment. Since this remains a defining characteristic of the sample it is commented upon here; however, it will be elaborated further in section V of this chapter.

4 At that time the total number of biology teachers actually teaching the 'Web of Life' course in the A.C.T. was approximately thirty-five.
II. The Measurement of Student Characteristics

This section is concerned with the identification and measurement of those student characteristics that are essential to the theory of learning described earlier. Initially the measurement of the students' cognitive readiness is considered. This section then focuses on the development of an achievement test to assess those cognitive structures that were constructed as a result of the students' interaction with the curriculum presented by the teacher. The measurement of the students' motivational predispositions either to create, maintain and resolve cognitive conflicts or strive for a particular standard of academic excellence occupies the latter part of the section.

(a) Cognitive Readiness

(i) Identification of necessary prerequisite structures

The identification and measurement of prerequisite cognitive structures for the 'Web of Life' curriculum was undertaken by Gardner (1969) who employed a two-category classification of prerequisites:

(a) essential prerequisites that must be mastered prior to the commencement of the course;
(b) valuable but not essential prerequisites of which the student should have some preliminary knowledge.

Gardner interprets the prerequisites within the Gagné model of concepts, principles and intellectual skill (e.g. Gagné, 1965), and lists 116 such prerequisites which he considers fundamental to an understanding of the 'Web of Life' curriculum. However, these prerequisites are those that are developed throughout the student's interactions with general science curricula; they do not include those prerequisites for a particular section of the 'Web of Life' curriculum that are developed in earlier sections of it. Consequently the usefulness of Gardner's list of prerequisites for this study was quite limited. For the purpose of this work it was necessary to identify those prerequisite structures that are necessary for the development of the concepts inherent in 'Living in Water' and 'Living on Land' and which are developed throughout earlier sections of the 'Web of Life' curriculum as well as in earlier science curricula. To this end a list of sixty-eight concepts that this researcher felt were necessary for the
student to have developed prior to the commencement of the relevant section of the curriculum was constructed.

Before a test of cognitive readiness could be constructed a validation of these concepts as a representative sample of the universe of potential prerequisites was necessary. This is a question of content validation and is basically judgemental (Brown, 1970). The method adopted was to ask two independent judges, both of whom were co-authors of the curriculum, to examine the initial list of sixty-eight prerequisite concepts defined above and ascertain their content validity. Both judges agreed on the validity of most of the sixty-eight prerequisite concepts. However, they differed on the depth of understanding of those concepts related to atomic structure and physical chemistry that was required for the understanding of this section of the curriculum. A final list of thirty-two prerequisite concepts was agreed upon and these are included in Appendix 5.2(a). Of these, eighteen related to biological concepts and fourteen to chemical, physical and mathematical concepts; further, twenty were associated with earlier sections of the 'Web of Life' course and twelve with previous science curricula.

(ii) The construction of the Cognitive Readiness Test

A Cognitive Readiness Test was constructed to ascertain the students' prior acquisition of the prerequisite cognitive structures identified and validated by the previous procedure. Items selected to assess the presence of these prerequisites reflected both characteristics of a concept described earlier, viz., the internal organisational properties of that structure and the exemplars which may be the source of assimilations to the structure. Items were derived from the Biology Readiness Test Materials (1969) and the Victorian Universities and Schools Examinations Board examination papers (1969-1973); a further group of items was designed by the author. In all thirty-eight items comprised the test, and these items are to be found in Appendix 5.2(b). Approximately six teachers in the study were shown the items in an attempt to:

a) ensure the 'face' validity of the test items
b) ensure that the difficulty level of the items was sufficient to differentiate those students who had developed the prerequisite structures from those who had not.
Phi coefficient and degrees of difficulty were utilised in a manner similar to that used in the Biology Diagnostic Tests (1971). Students were grouped into upper and lower tertiles on the basis of their total score for the test; each constituent item was then tested for its ability to discriminate into which of these groups students who passed the item belonged. An item score of .2 was considered the lower limit for both the phi coefficient and degree of difficulty. Computational details for the calculation of phi coefficients are to be found in Ferguson (1966).

The S.P.S.S. program (1975) RELIABILITY, which determines Cronbach's alpha as a reliability coefficient, was used to examine the overall reliability of the scale.
(iii) Administration of the Cognitive Readiness Test

Cognitive readiness has been interpreted in Chapter 4 as comprising the student's set of cognitive structures that are prerequisite to the meaningful integration of novel stimuli, in this instance a section of the curriculum. Since it is being argued that learning in part results from the teacher-student interactions of everyday classroom life, the measurement of cognitive readiness needed to reflect the general level of cognitive functioning that typifies the student's interaction with the curriculum. Consequently students were not warned in advance as to the occurrence of the Cognitive Readiness Test. During the initial lesson of the relevant section of the curriculum the researcher administered the test; nearly all students were able to complete the test within the suggested time of 40 minutes.5

As a result of an examination of both the phi-coefficient and the degree of difficulty of each item, eight items were removed from the final assessment of the students' cognitive readiness. This resulted in an alpha reliability coefficient = .82 for the thirty item test. Appendix 5.2(c) contains details of these analyses, together with the prerequisite concept(s) that each item is testing. Although the validity of the test had been examined by teachers within the study it was decided to determine a further aspect of its validity and one based upon its relationship with a designated criterion. The criterion selected was the Form 4 School Certificate examination, for it can be argued that many of the concepts underlying the Cognitive Readiness Test are developed within the Form 4 science curriculum; further, many of those prerequisite concepts developed in earlier sections of the 'Web of Life' curriculum are themselves dependent upon concepts contained within it. The concurrent validity coefficient for this relationship was .67.

5 The time did vary slightly due to unforeseeable circumstances. For example, in one school a senior master entered the classroom, bluntly interrupted the test proceedings, and publicly criticised a pupil for leaving her school bag on top of her locker. Such 'organisational' problems were to be encountered continually throughout the study.
(b) Academic Performance as Structural Change

Learning has been described as an accommodative activity that results in the production of either isolated or integrated cognitive structures as a means of knowing the content of the curriculum. This section considers the measurement of both these aspects of structural change.

(i) The measurement of isolated structures

The ability of students to recall accurately specific aspects of the curriculum denotes the presence of isolated cognitive structures, by which the curriculum is known (Piaget, 1964). A test to ascertain the presence of these structures was designed. This test required the student to recall specific guide questions that had been set by the teacher and which were considered basic to the section of curriculum being studied. A scale of fifteen items was constructed, representing a sample of seven guide questions of a total number of thirteen that were basic to the chapters involved. An example of two items from this scale follows:

1. Of what importance is plankton within the pond community of a freshwater pond?
2. What does a biologist mean by the word: adaptation?

The entire scale, together with scoring procedures is included in Appendix 5.3(a),(b).

This scale constituted one part of an achievement test; the second measured the construction of a knowledge of the curriculum that was well integrated into the student's greater body of knowledge.

(ii) The measurement of integrated structures

A meaningful integration of novel aspects of the curriculum results in a generalisable and quite dynamic structure and one that is highly interrelated with the total set of concepts by which the student knows reality. Consequently a measure of the development of integrated structures was one that required the student to apply underlying concepts inherent in the curriculum to novel situations, to relate such concepts to one another in a meaningful manner and to display an understanding of the internal organisational properties of those concepts. A scale of twenty-three items was

---

6 Section section I of this chapter, where guide questions are defined as 'the material ... that the student should remember!'
initially constructed, the source of these items being from both the Victorian Universities and Schools Examination Board (V.U.S.E.B.) 5th form biology examination papers and the Australian Council for Educational Research (A.C.E.R.) Biology Diagnostic Tests (1971). A typical item follows, and the entire scale is included in Appendix 5.4(a):

Which one of the following features is most likely to be present in an angiosperm which lives submerged in water?

A. a thick stem  
B. thin leaves  
C. an extensive root system  
D. conspicuous flowers  

Reason: ..................... (5 lines)  

Appendices 5.4(b), (c) contain the scoring procedure used as well as a list of those underlying propositions most related to each item.

In this manner an achievement test was constructed comprising one set of items assessing the presence of isolated structures and a second set assessing the presence of integrated structures. The former will be referred to as the Guide Questions scale and the latter as the Problems scale and together they will be referred to as the Achievement Test.

(iii) Administration of the Achievement Test

The Achievement Test was administered following the conclusion of 'Living in Water' and 'Living on Land'. Since one essential aspect of the theory of school-based learning being examined deals with achievement motivation and its arousal, it was necessary for the students to approach the Achievement Test as they would typically approach a school assessment task. This 'aroused' condition was accomplished by:

a) encouraging the teachers to consider the Achievement Test as a valuable means of assessing their students' progress, particularly vis-a-vis other students  
b) encouraging the teachers to inform their students that the Achievement Test was an integral part of their school assessment  
c) ensuring the teachers administered the test themselves  
d) giving the students at least one week's warning as to

7 With regard to this latter point, the researcher usually remained unobtrusively in the preparation room adjoining the laboratory.
a forthcoming test, or whatever was the typical classroom procedure. 8

The test duration was approximately one hour and most students finished well within the time limit. As in the case of the Cognitive Readiness Test both phi-coefficients and the degree of difficulty were calculated for each item, and summary statistics are to be found in Appendices 5.3(c) and 5.4(d). The reliability coefficient (alpha) for the Guide Questions scale was .82 and for the Problems scale (20 items) .79.

(c) Need for Achievement

Need for achievement has been measured typically in two ways: by either projective techniques or by use of questionnaires. In the case of the projective techniques those of McClelland are the most notable, where stories constructed by the person are scored for underlying themes related, in this instance, to achievement motivation. Alternatively, achievement motivation has been measured by questionnaires such as the Edwards Personality Preference Schedule (Edwards, 1959), the Stern Activitites Index (Stern, 1970) and the Californian Psychological Inventory (Gough, 1969). Two points made in Chapter 3 are now relevant:

i) that the achievement motive measured by a projective technique is of a different nature than that measured by questionnaire and is more relevant to business and commerce than to scholarship (McClelland, 1969)

ii) that questionnaire measurement of need for achievement has found consistent positive, yet low, correlations with academic performance (Lavin, 1965).

For these reasons a questionnaire measurement of need for achievement appeared preferable, and one that was appropriate to the underlying interactive perspective of the study. The achievement scale contained within the Activities Index (Stern, 1970) best satisfied these requirements. Further, its use by Gardner (1972), Genn (1970), Choo (1973) and more recently by Sheppard (1976) has demonstrated its suitability within the context of the Australian secondary school system. Skager's (1972) review of

8 Somewhat surprisingly, one teacher commented that by forewarning students this would ensure a greater class attendance on the day of the test.
the Activities Index criticises the two-choice fixed-format of the questionnaire and recommends an increase in the number of categories available for the respondent to answer each item. As a result, a 5-point Likert-type procedure was used in this study for both the achievement motivation measure as well as that of achievement press, to be discussed shortly. Stern's achievement motivation measure is found in Appendix 5.5 together with summary statistics. The reliability coefficient ($\alpha$) of the 10-item scale estimated from a trial run ($N = 110$) was .73 and for the main study .76.

(d) Intrinsic Motivation and Student Interest in Biology

As in the case of achievement motivation both projective and questionnaire techniques have been employed for determining the students' level of intrinsic motivation. For example, the Ontario Test of Intrinsic Motivation (OTIM) (Day, 1971) is a 110-item questionnaire which has been used quite extensively; in contrast, there is the curiosity TAT developed by Beswick (1964) that is a projective measure of intrinsic motivation. However, this study required a short general measure of intrinsic motivation that could be administered at the same time as the measures of achievement motivation, achievement press and the students' perceptions of their classroom environments. Consequently the short Intrinsic Motivation (Curiosity) Scale consisting of sixteen items and constructed by Beswick (1974) was used. These items are typically autobiographical statements to which the student responds 'true and typical of me', 'sometimes true', or 'not true', an example being: 'If I read something that puzzles me, I keep reading until I understand it'. This short intrinsic motivation scale has been used at both the tertiary and secondary levels of education in Australia and has reported reliabilities ($\alpha$) of .71 and .68 respectively (Beswick, 1974, 1975). In the present study its reliability coefficient ($\alpha$) in the pilot group ($N = 110$) was .72 and for the main sample .65.

The students' interest in biology was measured using a modified form of item no. 24 contained within the Matriculation Students'
Questionnaire 1973 Form A2 of the Regional Colleges Project (Anderson, Batt, Beswick, Harman and Selby Smith, 1975). This item is reproduced in Appendix 5.6, together with the short Intrinsic Motivation (Curiosity) Scale.

III Assessing the Learning Environment

(a) A General Introduction

Two aspects of the learning environment have been identified in Chapters 2 and 3 that will influence the form of accommodative activity adopted by the student as he interacts with a particular curriculum. The first deals with that aspect associated with the arousal of both achievement and intrinsic motivation; the second deals with the specification of particular learning goals, viz., the emphasis on specific detail and the emphasis on integration. Further, in Chapter 3, three conceptualisations of classroom reality have emerged. Firstly, there is a purely objective reality, described by some detached observer, and corresponding to Murray's alpha press. Secondly, there is a sense in which reality is shared by the participants in any interaction, and it is this sharing of reality which is close to Stern's conception of consensual beta press. Thirdly, there is the individual's quite idiosyncratic construction of reality by which the private beta press is known. It is the purpose of this section to discuss the means of assessing each of these aspects of classroom experience and thereby derive the research strategy that was the basis of this study's assessment of the learning environment.

The assessment of the learning environment by use of observational schedules has been the typical method of focussing on the alpha press of the classroom. For example, the many observational schedules described in Mirrors of Behaviour (Simon and Boyer, 1967, 1970a, 1970b) are such attempts to measure 'objective' classroom experience. On the other hand, student questionnaires have been used in an attempt to discover the students' perceptions of the classroom environment. The Class Activities Questionnaire (Steele, House and Kerins, 1971) is one such example that has been used in Australia to monitor the students' perceptions of the Australian Science Education Project (A.S.E.P.) curriculum (e.g. Power and Tisher, 1975). However, what is being measured by the student
questionnaire method remains in question. Certainly it is assessing an aspect of the learning environment that is quite distinct from the 'objective' reality described by the typical observation schedules. Power and Tisher's (1975) finding of only a weak relationship between the equivalent categories of the Classroom Activities Index and their own observation instrument would attest to this. However, the claim that by use of questionnaires one is measuring the students' idiosyncratic perceptions of the learning environment has been challenged by Circourel and Kitsure (1963) and more recently by Silverman (1973) who notes that:

... one cannot be sure whether quantitative data derived from multiple choice questionnaires ... does in any sense reflect the manner in which people in everyday life generally conceive of objects and events.

Silverman, for example, argues that the students' perceptions of the classroom measured by questionnaires is an assessment which is shared with the researcher but within an interpretative framework prescribed by the researcher - the structured nature of the questionnaire tends to limit the expression of experience into pre-designed categories. How close such categories correspond to the experiences of the students depends very much upon the derivation of the questionnaires involved. A questionnaire assessing the learning environment that is constructed independently of the situation in which it is to be used will reflect very much the researcher's understanding of that situation, an understanding that may be quite incongruent with that of the participants. Alternatively a questionnaire that results from the researcher's interaction with that situation can make quite a different claim about the aspect of the learning environment it is measuring. For now the questionnaire is assessing a more consensual understanding of the learning environment; and the degree to which such a consensual interpretative framework resulted from an interactive relationship between the researcher and the students determines its concordance with the students' own reality construction.

10 See, for example, Armistead's (1974) *Reconstructing Social Psychology*, and particularly Chapter 6, on the use of questionnaires to assess experience.
Yet the point remains that the questionnaire method does at best, describe a consensual or shared interpretation of the classroom experience. Attempts to analyse the private or idiosyncratic world of the student have not been common in classroom research, since they involve a complete submersion by the researcher in the situation as he tries to understand the very meaning by which the student knows his learning environment. One such attempt has been made by Smith and Geoffrey (1968) who employed *participant observation* in their analysis of the psychological dimensions of the classroom.

Participant observation has been described by Schwartz and Schwartz (1955) as follows:

For our purpose we define participant observation as a process in which the observer's presence in a social situation is maintained for the purpose of scientific investigation. The observer is in a face-to-face relationship with the observed, and by participating with them in their natural life setting, he gathers data. Thus, the observer is part of the context being observed, and he both modifies and is influenced by this context. The role of participant-observer may be either formal or informal, concealed or revealed; the observer may spend a good deal or very little time in the research situation; the participant-observer may be an integral part of the social situation or largely peripheral to it.

However, Gold (1958) clearly differentiates between two roles that the researcher may occupy that are inherent in the above description.

(i) observer-as-participant: Gold restricts the role of observer-as-participant to those situations where the researcher is generally involved in one-visit interviews and more formalised observational techniques. He notes the dangers of this technique: 'brief relationships with numerous informants expose an observer-as-participant to many inadequately understood universes of discourse that he cannot take time to master'.

(ii) participant-as-observer: In this role the field relationship between the participants and the researcher is far more intense and enduring. The researcher may sometimes be involved in formal observations using, for example, scheduled interview formats; at other times his relationship with the participants may be far less formal. Above all, the researcher
is primarily a participant, and out of such participation he constructs a knowledge of the individual's environment. Again Gold notes inherent dangers: 'the informant may become too identified with the field worker to continue functioning as merely an informant. In this event the informant becomes too much of an observer. Second, the field worker may over-identify with the informant and start to lose his research perspective'.

It is this latter researcher role of participant-as-observer that most closely describes the common interpretation of participant observation. By use of this procedure researchers have claimed to enter the constructed world of the individual, but again one must be careful. Participant observation does not necessarily produce a knowledge of the learning environment that is in accord with the student's private view; it may be no more or less congruent with that view than that obtained by a questionnaire derived out of the researcher's interaction with that situation.

Bullivant (1976) recently criticised the Smith and Geoffrey study (1968) as an example of participant observation on these grounds since Smith used a predetermined set of psychological dimensions with which to analyse the classroom. For participant observation to penetrate the private world of the student Bullivant sees the source of such dimensions and guiding hypotheses to be the situation itself, a position not dissimilar to Armistead (1974) and Silverman (1973) mentioned earlier.

Perhaps this general introduction to the assessment of learning environments can best be concluded by a quotation contained within On Paradigms and Problems of Palliatives: Rethinking Teacher Education (Smith, 1976) which illustrates well an emergent direction of research in this area:

... Since the interpretation is being made by the acting unit in terms of objects designated and appraised, meanings acquired, and decisions made, the process has to be seen from the standpoint of the acting unit ... To try to catch the interpretative process by remaining aloof as a so-called 'objective' observer and refusing to take the role of the acting unit is to risk the worst kind of subjectivism - the objective observer is likely to fill in the process of interpretation with his own surmises in place of catching the process as it occurs in the experience of the acting unit which uses it ...
Since this manuscript has been prepared, it has been suggested that the common usage of 'participant observation' has restricted its meaning solely to Gold's conception of 'participant-as-observer'. This being the case, it would now appear preferable to refer to this aspect of the research procedure as 'co-operative observation'. This descriptive term would still emphasise the relationship established between the researcher and both students and teachers.
(b) A Consensual Knowledge of the Classroom

The theory of school-based learning that has been proposed and the underlying conceptualisation of the teacher-taught relationship as an 'intersubjective sharing of reality' suggested that the most appropriate methodology was one that involved the researcher in sharing the classroom experience with both teachers and students. Yet at the same time the methodology needed to be appropriate to the context in which it was situated. For these reasons, the consensual aspect of the learning environment was assessed and no claim could be made that this assessment was representative of the private world of any student. Rather, its claim was to a knowledge of the classroom constructed by the researcher and shared with the participants, but within an interpretative framework that resulted in part from the theoretical formulations described earlier and in part from the researcher's interactions with those participants.

With regard to Gold's (1958) dichotomy of the types of participant observation the role assumed by this researcher was closer to Gold's description of observer-as-participant. However, as the following paragraphs indicate, the researcher employed both formal and informal assessment procedures and built up an enduring relationship with both students and teachers. Yet it must be stressed that the research strategy adopted should not be construed as typifying Gold's 'participant-as-observer' researcher role or Bullivant's (1976) conception of participant observation.

The participant observation procedure was directed towards the assessment of a consensual knowledge of both the learning goals specified by the teacher and the properties of the learning environment likely to facilitate the arousal of intrinsic motivation. By use of interview techniques and participating within 'the lived-in-experience' of the classroom, the researcher was able to make relative judgements of learning goals and 'arousal' conditions presented by the teachers and shared by the students. The means of assessing consensual achievement press will be described separately as it is considered by this researcher to be more relevant to the total school environment than to the particular classroom.
(1) Participant observation, interviews and the lived-in-experience

A 'lived-in-experience' necessitated the researcher's presence at many of the class lessons during which 'Living in Water' and 'Living on Land' were taught: eight were considered a minimum number, although due to administrative problems, two classes were visited only six times during this period. This enabled the researcher to 'observe' at least two-thirds of those lessons during which this section of the curriculum was being taught.11

During these lessons the researcher adopted a non-intervening role while the teacher was actively involved in teaching (e.g. lecturing); quite often, however, the teacher did make reference to the researcher, seeking perhaps advice or an alternative explanation. At those times during which the teacher assumed an expository role, detailed notes were taken of the content and nature of the lesson - a sample of these is to be found in Appendix 5.7. However, the curriculum under study is enquiry-based with an emphasis on group laboratory work which lent itself well to an informal sharing of the classroom experience with the students. The researcher was able to move freely around the classroom at all times and enter and leave it at will; when the teacher was absent from the room the researcher generally remained so long as students were present. Quickly the researcher became a source of information and ideas in many of the classes and found it easy to participate in the student activities that characterise the 'Web of Life' curriculum. Yet the reticence of some classes indicated that the role of researcher still remained quite formalised, and hence participant.observation as a characteristic of this study could not claim to be penetrating the private experiences of those students.

There is an obvious danger with participant observation of attempting to record and take notice of all aspects of the classroom situation; such was not the case in this study. Once an interpretative framework had been established,12 the classroom experience

11 The researcher had, in fact, visited the classes on a number of occasions during the earlier phases of the study.
12 As mentioned on p.85, a framework constructed in part out of the (continued on next page)
was analysed within the defining categories of this framework and appropriate records taken. Samples of the teacher-student activities that were the focus of the analysis are presented in Appendices 5.7 and 5.8 and these activities are commented upon only briefly here.

It has already been argued that teachers construct and present a quite idiosyncratic body of knowledge by which the curriculum is to be known. As a result an assessment of the learning goals defined by the teacher was based upon the various emphases the teacher placed upon each of the student-teacher activities that characterise the course, as well as the teacher's own interpretation of the inherent meaning of those activities; further, the degree to which these goals were shared with the students was considered an important aspect of this assessment. The number of guide questions set and marked by the teacher and the students' conscientiousness in their attention to detail in answering these questions were considered, for example, to be evidence for the specification of the learning goal emphasis on specific detail. Other features of teaching behaviour that were considered indicators of this learning goal included the teacher's presentation of factual material in the form of 'notes', the asking of questions that required the recall of information already dealt with in the curriculum, and the use of guide questions in classroom testing procedures. The teacher's tendency to relate the curricular materials to both earlier and later sections of the 'Web of Life' course and to outside bodies of knowledge, to clearly explain the meaning of concepts and describe the evidence on which they are based, and to emphasise the importance of the problems and invitations to inquiry were considered evidence of the learning goal emphasis on integration.

Those characteristics that are pertinent to the arousal of intrinsic motivation have been described by Suchman (1964) and Beswick and Tallmadge (1971). In the context of this study the students' freedom, both physical and intellectual, to create,

(Footnote 12 from previous page) researcher's interaction with the participants, particularly in phase one of the study, and in part from the earlier theoretical formulations of Chapters 2 and 3.
maintain and resolve cognitive conflict was evidenced by, amongst other things, the use of reference materials by the students, the teacher encouraging the students to attempt the 'for further investigations' and the setting of assignments that allowed the students to explore new ideas and reach their own tentative conclusions.

However, together with participant observation, more formalised interviews with students were an important feature in the assessment of the learning environment. The use of the interview in psychological research has been described in Kerlinger (1973) and Macobby and Macobby (1954) and it is not the intention to elaborate upon it here as a research technique; further, a comparison of both participant observation and interviewing is to be found in Becker and Geer (1970).

The interviews purposely followed the period of participant observation. Apart from this being less disruptive to the ongoing presentation of the curriculum, it allowed the researcher to focus on specific issues that became evident throughout this period. These interviews tended to be semi-structured and concentrated on such issues as a) the perceived aims of the teacher and the course, and the congruence of these with the students' own educational aspirations, b) the amount of 'intellectual' freedom in the class, and c) a comparison (where appropriate) of the teacher's presentation of the curriculum with that of a teacher in a parallel class. These interviews helped to substantiate, in a more formalised manner, that the knowledge of the learning environment constructed by the researcher was, in fact, a knowledge shared both with the participants and between the participants. This latter aspect could be evidenced since the interviews were held with small groups of students and so were directed at establishing a consensual knowledge of the learning environment.

Approximately half the student sample was interviewed in this manner and excerpts from these interviews appear in Chapter 8 and

---

13 During the initial phases of the study interviews were also used but in a far less formal and highly exploratory manner, as a means of establishing those classroom characteristics that were most pertinent to the specification of learning goals.
Appendix 5.7. No formalised interviews occurred with teachers.

(ii) The rating of learning environments

At the conclusion of each lesson, or shortly after, the researcher filled in a rating scale, the items of which were consistent with the interpretative framework guiding the participant observation procedure. The purpose of this rating scale was to help focus the researcher's attention on those characteristics of the classroom experience that were fundamental to goal specification and the arousal of intrinsic motivation. Appendix 5.8 contains these rating scales and three items are reproduced below:

Teacher sets guide questions to be done during classtime.
Teacher emphasises the forthcoming Higher School Certificate examination.
Integration of course material with material dealt with in earlier sections of the course, or with future sections.

The ratings made by the researcher were based upon experiential data derived from participant observation, and hence the rating scale does in fact reflect a shared view of the classroom. However, there was one aspect of this rating procedure that could not be shared with the participants of a particular classroom. This was the researcher's knowledge of other teacher-taught relationships that comprised the sample and which necessarily influenced the ratings assigned to each of the items. However, such an influence remained consistent with the overall purpose to make relative judgement about classrooms along specified dimensions.

On approximately eight occasions ratings were made for each class; however, the scores on each were not summated to give a final assessment of the learning environments. There was one important reason for this. Just as the student was constructing his knowledge of the classroom so too was the researcher actively constructing his shared view of that experience. Being an interactive process, the researcher's view of the classroom was constantly changing in a manner aptly described by Garfinkel (1969): 'By waiting to see what will have happened, he learns what it was he previously saw'. Instead, these rating scales served simply to act as a focusing procedure, the importance of which should not be ignored.

The overall assessment of the learning environment was made following this period of participant observation. It consisted
of the researcher taking into account the total set of observations, interviews and informal discussions that resulted from participant observation and making a relative judgement on the basis of this experiential data. In the case of the specification of learning goals this procedure resulted in the teachers being rated on a 1-7 scale; with the facilitation of intrinsic motivation a 1-6 scale was appropriate. This degree of discrimination was the maximum justified by the procedure described above.

The final assessments for each of these aspects of the learning environment for each class is found in Appendix 5.8.

(iii) The validity of rating the learning environments

The reliability, and validity, of data derived from participant observation procedures is a general source of controversy. In this regard Armistead (1974) describes procedures to ensure the reliability of data collected by participant observation techniques. Included in these procedures is an emphasis on several quite independent people to be involved in the process; this is analogous to the notion of inter-judge reliability. Yet such a procedure was impractical for this study since the role adopted by a colleague would need to develop over a lengthy period of time; added to this would be the necessity of the person being fully conversant with the 'Web of Life' curriculum.

In an attempt to overcome these problems the researcher used a questionnaire technique as a validation check of the ratings made. The issues raised with respect to the assessment of learning environments became immediately relevant, and one needed to ask: 'What sort of questionnaire will assess the same aspect of the learning environment that has been assessed during the period of participant observation?'. Now the claim has been made that the ratings represented a consensual knowledge of the classroom. Consequently a validation study using a questionnaire method must also assess a similar aspect of the learning environment.

---

14 See, for example, Broadbent (1973) 'In Defense of Empirical Psychology' and Armistead's (1974) rejoinder. Proponents of participant observation contend that, in fact, the validity of such data is indisputable and the only issue is that of reliability (e.g. Bullivant, 1976).

* Appendices 5.7(a), (b), (c) contain excerpts from the researcher's records and provide another source of evidence to substantiate the ratings made.
As already indicated, a questionnaire derived out of the context of the situation, containing items that possess inherent meanings shared by the participants, will assess a consensual perception of the learning environment.

Best (1974) has developed a Biology Classroom Activities Checklist (BCAC) which has been used in South Australian Biology classes. The items contained in it are relevant to the 'Web of Life' course and have resulted from discussions with both students and teachers participating in the course. Further, it contains subscales that have particular relevance to those dimensions of the learning environment that are of interest in this work. For example, the items constituting the scale 'Demand of Memorization' possess 'face' validity for a measure of the learning goal emphasis on specific detail; 'Demand for Interpretation' has some similarity to the learning goal emphasis on integration; and finally, the subscales number 6, 4 and 2 in Table 5.1 appear to underlie certain aspects of the classroom dimension facilitation of intrinsic motivation.

Table 5.1

The Seven Classroom Activities Scales contained within the Biology Activities Checklist (Best, 1974)

<table>
<thead>
<tr>
<th>Scale No.</th>
<th>Scale</th>
<th>No. of Items</th>
<th>Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Demand for Interpretation</td>
<td>13</td>
<td>.72</td>
</tr>
<tr>
<td>2</td>
<td>Student Initiative</td>
<td>7</td>
<td>.57</td>
</tr>
<tr>
<td>3</td>
<td>Demand for Memorization</td>
<td>5</td>
<td>.43</td>
</tr>
<tr>
<td>4</td>
<td>'Don't ask what it means, just get on with it'</td>
<td>10</td>
<td>.68</td>
</tr>
<tr>
<td>5</td>
<td>Teacher knows best</td>
<td>4</td>
<td>.41</td>
</tr>
<tr>
<td>6</td>
<td>Freedom in discussion</td>
<td>3</td>
<td>.43</td>
</tr>
<tr>
<td>7</td>
<td>Questioning (laboratory)</td>
<td>5</td>
<td>.43</td>
</tr>
</tbody>
</table>

However, while the Checklist could be used as a basis for the construction of a suitable questionnaire, it was not sufficiently congruent with those dimensions of the learning environment that were to be assessed; further, the reliability of many of the relevant scales was quite low.

The procedure for the construction of a suitable questionnaire
can be briefly described as follows. Those relevant items from the BCAC, together with items designed by this researcher, were included in a 50-item Biology Classroom Perceptions Questionnaire. These items then were assessed for their relevance to the learning situation in the early stages of the participant observation period. A trial form of the questionnaire produced a set of three scales relating to the specification of learning goals and to the arousal of intrinsic motivation. These scales will be referred to as the 'classroom perception scales'. It should be noted that the 'emphasis on specific detail' classroom perception scale is the same as Best's (1974) 'Demand for Memorization' subscale, having a reliability coefficient (alpha) of .68 in the trial form (N = 110) and .62 in the main study. The 'emphasis on integration' classroom perception scale had a reliability of .74 (12 items) in the trial form and .76 (10 items) in the main study; the classroom perception scale 'facilitation of intrinsic motivation' had corresponding reliability coefficients of .80 and .76 (10 items). A list of items contained in each scale, as well as details of the relevant statistical analyses, is found in Appendix 5.8.

Two further aspects of scale construction need to be considered:

a) scale sensitivity: the ability of the scales to discriminate between the classes under study was investigated using an analysis of variance procedure. Significant F-ratios indicated that the scales were in fact sensitive to differences between the learning environments along the dimensions being assessed.

b) validation of items: a factor analysis of the 25 items, using a varimax rotation, verified the assignment of items to particular scales.

Statistical details of both of these latter analyses are found in Appendix 5.8. In Appendix 5.8 are the ratings of each classroom as assessed by participant observation, together with the class means of the relevant classroom perception scales, which reflect a consensual knowledge of the classroom as measured by the questionnaire. The correlation between each is an indication of the validities of the ratings derived from participant observation. These were .51 (emphasis on specific
In contrast, the researcher's ratings were constructed with a knowledge of each of the learning environments to be assessed.
detail), .75 (emphasis on integration) and .74 (facilitation of intrinsic motivation). Such correlations are quite satisfactory since the students' questionnaire assessments were made without the students possessing a knowledge of other classroom experiences that comprised the sample.

It was also noted that students within classes differed in their perceptions of the learning environment as measured by the classroom perception scales. The question arose of whether the students' perceptions of their learning environment, measured in this manner, were influenced by their levels of intrinsic motivation, interest in biology, achievement motivation and cognitive readiness. This question is treated in considerable detail in Appendix 5.9 and only the more theoretically important findings for this study are summarised here.

Firstly, the students' scores on the classroom perception scale 'emphasis on specific detail' were negatively related to their scores on the Cognitive Readiness Test: students of low cognitive readiness tended to perceive their teacher's presentation of the curriculum as placing greater emphasis on the retention of specific details than did their peers of higher cognitive readiness. Two further important relationships were observed. Firstly, for students found in classes rated by the researcher as possessing a high level of facilitation of intrinsic motivation, those students of higher intrinsic motivation rated their classes higher on the corresponding classroom perception scale than did students of lower intrinsic motivation; no such relationship existed for those students found in classes characterised by the researcher as weak in the facilitation of intrinsic motivation.

A similar relationship existed for the students' perception of the achievement press of the school. Students of higher achievement motivation rated their learning environments stronger on the dimension achievement press than students of lower achievement motivation, but only in those classes where the consensus was that the achievement press was in fact strong. Each of these relationships has important implications for an understanding of the interactive perspective adopted in this study; these will be discussed in Chapters 8 and 9.

This concludes an examination of the research procedures used to assess both the learning goals specified by the teacher and the

15 The procedure used to assess the achievement press of the school is presented in the following section.
classroom properties associated with the facilitation of intrinsic motivation.

(c) Measuring the Arousal of Achievement Motivation

The measurement of the arousal of achievement motivation presented a somewhat different problem. For while the specification of learning goals and the arrangement and presentation of the curriculum as it affects the arousal of intrinsic motivation is predominantly classroom centred, the source of arousal of achievement motivation is more widespread. The source of arousal may be in the home (Marjoribanks, 1975), in the school (Stern, 1970) or within the specific classroom (Gardner, 1972). This researcher was of the opinion that the overall school environment as a source of achievement motivation arousal was more important than that pertaining to any specific classroom; the source of arousal as derived from the home environment remained outside the scope of this study. Since the role of the researcher was one of participant observation within the classroom and not the school, the assessment of the consensual achievement press was based upon Stern's Achievement Press scale (Stern, 1970). The final reliability coefficient (alpha) for this scale was .62 using six items; summary statistics are found in Appendix 5.10.

IV The Biology Students and Classroom Perceptions Questionnaire

The scales measuring the student characteristics of intrinsic motivation, achievement motivation and interest in biology were contained in a questionnaire which was referred to as the Biology Students and Classroom Perceptions Questionnaire. This questionnaire also contained the classroom perception scales described above, as well as Stern's achievement press scale. This questionnaire included a small group of items related to the students' perception of the learning environment which were of interest to the researcher; these remained unscaled. The questionnaire was administered following the students' completion of the Achievement Test; the students generally completed the questionnaire within

16 The complete Stern Achievement Press scale contains 10 items; however, the reliability coefficients (K-R 20) for the 10-item scale were only .52 in the pilot sample and .47 in the main sample.
a time of twenty minutes. The questionnaire is reproduced in Appendix 5.11, and Table 5.2 provides a summary of the scales contained within it.

Table 5.2

The Measures Contained within the Biology Students and Classroom Perceptions Questionnaire

<table>
<thead>
<tr>
<th>Scale</th>
<th>No. of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Need for achievement (Stern, 1970)</td>
<td>10</td>
</tr>
<tr>
<td>2. Intrinsic Motivation (Curiosity)</td>
<td>16</td>
</tr>
<tr>
<td>(Beswick, 1974)</td>
<td></td>
</tr>
<tr>
<td>3. Interest in Biology (Anderson et al., 1975)</td>
<td>1</td>
</tr>
<tr>
<td>4. Achievement press (Stern, 1970)</td>
<td>10</td>
</tr>
<tr>
<td>5. 'Emphasis on specific detail'</td>
<td>5</td>
</tr>
<tr>
<td>6. 'Emphasis on integration'</td>
<td>10</td>
</tr>
<tr>
<td>7. 'Facilitation of intrinsic motivation'</td>
<td>10</td>
</tr>
</tbody>
</table>

V Summary of the Methods and Measures

This concludes a consideration of the methods used to assess the various attributes of the student and the learning environment identified in Chapter 4 as relevant to the theory of school-based learning. Both the research strategy adopted in this study, as well as the measures used, are summarised in Table 5.3.

In the following two chapters the analyses of the data obtained from applying the measures described in this chapter within the overall research design of the study will be presented.
Table 5.3
A Summary of the Research Design

<table>
<thead>
<tr>
<th>Date</th>
<th>Research Activities</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>May - December 1974</td>
<td>(i) Relief teaching in A.C.T. secondary schools</td>
<td>(i) generation of theory</td>
</tr>
<tr>
<td></td>
<td>(ii) Preliminary study of four senior science classes</td>
<td>(ii) initial contact with biology teachers as an introductory stage in developing researcher role</td>
</tr>
<tr>
<td>February - May 1975</td>
<td>(i) School visits</td>
<td>(iii) assessment of possible technical and administrative problems</td>
</tr>
<tr>
<td></td>
<td>(ii) Test construction</td>
<td></td>
</tr>
<tr>
<td>May - June 1975</td>
<td>Administration of Cognitive Readiness Test</td>
<td></td>
</tr>
<tr>
<td>June - August 1975</td>
<td>Classroom participant observation procedures</td>
<td>(i) the assessment of the students' levels of cognitive readiness</td>
</tr>
<tr>
<td>August 1975</td>
<td>Administration of Achievement Test</td>
<td></td>
</tr>
<tr>
<td>August 1975</td>
<td>Administration of the Biology Students and Classroom Perceptions Questionnaire</td>
<td>(i) the assessment of the students' knowledge of the curriculum in terms of both isolated and integrated structures of knowing</td>
</tr>
<tr>
<td>September - Oct. 1975</td>
<td>Student interviews</td>
<td>(i) the assessment of the students' levels of intrinsic motivation, achievement motivation and interest in biology</td>
</tr>
<tr>
<td>November - June 1976</td>
<td>Analysis of quantitative and interview data</td>
<td>(ii) the assessment of the students' perceptions of both the learning goals presented by the teacher and the facilitation of intrinsic motivation by the learning environment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(iii) the assessment of the consensual achievement press of the school</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(i) clarify issues raised during the research period</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(i) relate the data obtained in earlier stages with the guiding propositions</td>
</tr>
</tbody>
</table>
Chapter 6

RESULTS - PART A: THE LEARNING OF SPECIFIC DETAIL

This work, as already outlined, is concerned with the student's construction of both isolated structures of knowing and highly integrated structures by which concepts are known in relation to other bodies of knowledge. The student's performance on the Guide Questions scale is indicative of the former and is the principal concern of this chapter; the student's performance on the Problems scale as a means of assessing a well-integrated understanding of particular concepts is the concern of Chapter 7.

Each of the subsequent two chapters is divided into two major sections that correspond to the two models of school-based learning that underlie the guiding propositions of Chapter 4, viz., the achievement-orientated model of learning and the intrinsic-motivated model of learning. Within each of these major sections two theoretical issues have guided the analysis and presentation of results. In the case of the achievement-orientated model the possible interaction between motivation, press and goal specification which is inherent in the model is fundamental to the initial analysis. However, each of these variables may interact with the level of cognitive readiness of the student and it is this proposition that guides the second aspect of the analysis. Similarly with the intrinsic-motivated model, the initial analysis is concerned with investigating the possible interaction between intrinsic motivation, its arousal and the student's interest in biology; the latter aspect of this analysis is concerned again with the interaction of cognitive readiness and each of these variables. In the above analyses student performance was measured by the student's overall score on either the Guide Questions or Problems scales.

Chapter 6 concludes with an alternate form of analysis of the student responses to particular questions that constituted the Guide Questions scale. In particular, the final section focuses on 'novel' examples used by students, examples not contained in the prescribed curriculum. The tendency of each class of students to generate 'novel' answers to guide questions is then related to the
dimensions of the learning environment that characterise each classroom.

I. The Achievement-Orientated Model of Learning and Student Performance on the Guide Questions Scale

The analysis of data employed both analysis of variance and multiple regression procedures. Because of the difficulties created for multiple regression by missing cases, an initial decision was made to limit the analysis to those student cases upon which complete data sets had been collected. This resulted in a final sample size of 274 students, drawn from a total of 363 students who were officially enrolled in those classes under study.

For analysis of variance the learning environment dimensions that had been rated by the researcher were divided into two categories at the median. Those classes which had been rated 1, 2 or 3 along a particular dimension were regarded as being 'high' on that dimension; classes rated 4, 5, 6 or 7 comprised a 'low' group. As is discussed in Chapter 5, in the case of achievement press class mean scores were used rather than observer ratings and the classes were divided into two groups based upon these consensual scores. Similarly, the students were divided into high and low groups with respect to the student characteristics of achievement motivation and intrinsic motivation. For theoretical reasons the student characteristic of cognitive readiness was considered quite separately. For basic to the development of structural growth is the inherent notion of three distinct forms that may characterise cognitive structures throughout the process of learning. Consequently a three-category split was made on the cognitive readiness variable: students being regarded as either 'high', 'intermediate' or 'low' in the knowledge of those concepts considered prerequisite to the understanding of the unit of curriculum under study. The cutting points for each of the categories were decided both on the researcher's prior experience of teaching the curriculum and the necessity to employ roughly equal numbers of students in each category. While such a procedure may not be completely satisfactory, it can be argued that students who are found in the high group are, in all probability, those students most likely to possess a fairly well-integrated totality of cognitive structures by which the designated prerequisite concepts
* Here interaction refers to the relationship between the student and his learning environment in either of the two senses described on p. 17. When interaction is used in the statistical sense it refers to the multiplicative function of each of two independent variables. Hence both regression analysis and ANOVA may be viewed as one means of providing evidence for the presence of each of these two types of student-learning environment relationships, and is not to be construed as an end in itself. A further source of evidence is provided by the qualitative data which will be discussed in Chapter 8.
are known; students described as intermediate in their level of cognitive readiness are likely to be those students who possess a set of cognitive structures that are in a state of disequilibrium, and hence these students will be inconsistent in their knowledge of those instances of experience by which a particular concept is known; finally, those students categorised as low are most likely to be those students who do not possess a set of cognitive structures by which the prerequisite concepts may be known.

In the analyses that follow, as has been indicated, both regression and ANOVA procedures were used to investigate the possible interactions that may be operative in the classroom. For while regression analysis provides a more powerful procedure for this purpose, the regression program available in SPSS (1975) imposed severe limitations on its applicability. Because the violation of such limitations as those related to multicollinearity makes the interpretation of the analysis difficult or ambiguous, the analysis of variance procedure, using a fixed-effects model, was also employed in the study of interactive effects.

(a) The achievement-orientated model - a three-way interaction model of learning

The theory of learning that has been proposed in Chapter 3 may be described as a 3-way interactive model of learning. Basic to its conceptualisation is the interaction between goal specification, achievement press and achievement motivation and it is the investigation of this interaction which occupies the present section of results. Although two learning goals have been proposed in Chapter 3, reference to the guiding propositions of Chapter 4 suggests that it is the teacher's emphasis on the retention of specific detail that is more relevant to the explanation of student performance on the Guide Questions scale. Consequently it is the interaction of this learning goal with achievement press and achievement motivation which will be examined in this chapter.

An ANOVA procedure was used to examine this interaction and details of this analysis are to be found in Appendix 6.1.  

Reference

1 Due to the high correlation between the interactive terms and the independent variable emphasis on specific detail the multiple regression procedure was inappropriate.
Figure 6.1

The 3-way interaction of the Student's Level of Achievement Motivation, the Achievement Press of the School and the Teacher's Specification of the Learning Goal Emphasis on Specific Detail, upon Student Performance on the Guide Questions Scale
to this appendix indicates that there was a significant interactive effect of achievement press, achievement motivation and emphasis on specific detail upon student performance on the Guide Questions scale ($4.35 > 3.86 = F_{1,273},.05$).

The mean performance scores for each group of students that results from this 3-way consideration of the three independent variables, achievement press, achievement motivation and emphasis on specific detail are graphically represented in Fig. 6.1.

Two important conclusions can be drawn from a consideration of Fig. 6.1 which are directly relevant to the major guiding propositions of the study. Firstly, students of low achievement motivation when found in an environment characterised by a high achievement press and low goal specification performed significantly better on this criterion than students of high achievement motivation ($t = 1.69$, df = 39, $p = < .05$). There appeared no difference between these two groups of students when found in environments characterised by a low achievement press and low goal specification. Secondly, students of high achievement motivation performed significantly better under conditions of high achievement press and high goal specification than did students of low achievement motivation ($t = 2.54$, df = 50, $p < .01$). There was no difference between these two groups when experiencing low achievement press and high goal specification conditions. The implications of these results will be basic to the discussion in Chapter 8 of the effect of achievement press upon students of high achievement motivation, when the goals to which achievement-orientated activity is to be directed are not clearly specified by the teacher.

To describe more fully the effects found by the ANOVA reported above, a regression procedure was used involving dummy variables for each of the independent variables, achievement press, achievement motivation and emphasis on specific detail. The full or 7-term model may be considered that model incorporating all terms found in the ANOVA, including all main effects terms, all 2-way interaction terms and the 3-way interactive term. However, the

---

2 The interaction of variables will be denoted by a '. ' e.g. achievement press.achievement motivation.emphasis on specific detail.
following 3-term reduced model was proposed to account for the major portion of the explained variance:

\[
\text{Performance} = \beta_1 \text{achievement motivation} + \beta_2 \text{achievement press} + \beta_3 \text{emphasis on specific detail}
\]

In this stepwise regression analysis the 3-way interactive term was entered first. This was consistent with both the guiding propositions of the achievement-orientated model of learning outlined in Chapter 4 and the significant effect of the 3-way interaction upon the criterion already found. The results of this 3-term regression model obtained from a stepwise multiple regression analysis are summarised in Table 6.1. Details are to be found in Appendix 6.1(b).

<table>
<thead>
<tr>
<th>Variable Entered</th>
<th>Simple Correlation</th>
<th>Final Beta</th>
<th>F when Entered</th>
<th>Overall F-ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achievement Press.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Achievement Motivation.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emphasis on Specific Detail</td>
<td>.27</td>
<td>.13</td>
<td>20.84***</td>
<td></td>
</tr>
<tr>
<td>Achievement Press</td>
<td>.23</td>
<td>.17</td>
<td>5.32*</td>
<td></td>
</tr>
<tr>
<td>Emphasis on Specific Detail</td>
<td>.22</td>
<td>.16</td>
<td>6.27*</td>
<td>11.09***</td>
</tr>
</tbody>
</table>

* p < .05, *** p < .001

Reference to Appendix 6.1(b) indicates that the overall improvement in explained variance obtained by using the 7-term model over and above that explained by the 3-term model was non-significant \((1.21 < 2.40 = F_{4,266,.05})\). It is apparent from this analysis that apart from the significant 3-way interactive
effect already discussed, both the achievement press perceived by the student and the teacher's emphasis on the retention of specific detail make a unique contribution to the explanation of student performance over and above that made by the interactive effect itself.

This concludes the analysis of the data relating to the identification of a possible 3-way interaction between achievement press and emphasis on specific detail. In the following section the interaction of the student's level of cognitive readiness and each of these variables will be considered.

(b) Cognitive readiness and the achievement-orientated model of learning

The interaction of cognitive readiness with those variables that constitute the achievement-orientated model of learning is examined in this section. The correlations between student performance on the Guide Questions scale and the interactive effect of cognitive readiness and each of achievement motivation, achievement press and emphasis on specific detail are summarised in Table 6.2

Table 6.2
Correlations of Student Performance on the Guide Questions Scale with the Independent Variables and Interactive Terms\(^1\) of the Achievement-Orientated Model of Learning (N = 274)

<table>
<thead>
<tr>
<th></th>
<th>Student Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive Readiness</td>
<td>.47</td>
</tr>
<tr>
<td>Emphasis on Specific Detail</td>
<td>.29</td>
</tr>
<tr>
<td>Cognitive Readiness.Emphasis on Specific Detail</td>
<td>.13</td>
</tr>
<tr>
<td>Achievement Press</td>
<td>.26</td>
</tr>
<tr>
<td>Cognitive Readiness.Achievement Press</td>
<td>.39</td>
</tr>
<tr>
<td>Achievement Motivation</td>
<td>.10</td>
</tr>
<tr>
<td>Cognitive Readiness.Achievement Motivation</td>
<td>.46</td>
</tr>
</tbody>
</table>

\(^1\) e.g. Cognitive Readiness.Achievement Motivation

A stepwise multiple regression analysis was used to investigate the interaction between cognitive readiness and the two variables achievement press and emphasis on specific detail. Once again the appropriateness of the regression program (SPSS, 1975)
had to be considered in the selection of those interactive effects that could be examined using this form of analysis. There was a high correlation between cognitive readiness and the interactive term 'cognitive readiness.achievement motivation'; it was considered therefore that the consequent extreme multicollinearity would make the multiple regression procedure unsuitable for the study of this particular interactive effect.

The procedure used in the examination of the two interactive effects, cognitive readiness.achievement press and cognitive readiness.emphasis on specific detail, was similar to that used by Anderson (1970) and Marjoribanks (1975). The analysis was done in five steps. Firstly, cognitive readiness was correlated with the criterion; secondly, a two-term regression model incorporating both cognitive readiness and the second independent variable was tested for its being significantly better than the one-term model; thirdly, an interaction term was added to produce a three-term regression model and again this was tested to establish a significant improvement over the previous two-term model. Finally, the curvilinear relationship, in the form of a squared term, for both cognitive readiness and the independent variable was tested in a full 5-term regression model. This final model can be stated:

\[
\text{Performance on} = \beta_1 C.R. + \beta_2 \text{Ind.V.} + \beta_3 C.R. \times \text{Ind.V.} + \beta_4 (C.R.)^2 + \beta_5 (\text{Ind.V.})^2
\]

where C.R. = Cognitive Readiness
Ind.V. = Independent Variable

Details of these analyses are to be found in Appendix 6.2(a),(b). It is evident from these appendices that the 5-term and 4-term regression models do not significantly improve the amount of explained variance from that derived from the three-term models. The results of the 3-term regression models involving achievement press and emphasis on specific detail are summarised in Table 6.3.

The interaction between cognitive readiness and achievement press and between cognitive readiness and emphasis on specific detail is seen to be significant at the .05 level.
Table 6.3

Multiple Regression Analyses for the Prediction of Student Performance on the Guide Questions Scale from Emphasis on Specific Detail, Achievement Press and Cognitive Readiness

<table>
<thead>
<tr>
<th>Variable Entered</th>
<th>Simple Correlation</th>
<th>Final Beta</th>
<th>F when Entered</th>
<th>Overall F-ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive Readiness</td>
<td>0.47</td>
<td>-0.22</td>
<td>75.61***</td>
<td></td>
</tr>
<tr>
<td>Achievement Press</td>
<td>0.26</td>
<td>-0.40</td>
<td>1.07</td>
<td></td>
</tr>
<tr>
<td>Cognitive Readiness.</td>
<td>0.39</td>
<td>0.60</td>
<td>4.1*</td>
<td>27.22***</td>
</tr>
<tr>
<td>Achievement Press</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cognitive Readiness</td>
<td>0.47</td>
<td>0.18</td>
<td>75.61***</td>
<td></td>
</tr>
<tr>
<td>Emphasis on Specific Detail</td>
<td>0.29</td>
<td>-0.51</td>
<td>18.15***</td>
<td></td>
</tr>
<tr>
<td>Cognitive Readiness.</td>
<td>0.13</td>
<td>0.37</td>
<td>4.5*</td>
<td>34.77***</td>
</tr>
<tr>
<td>Emphasis on Specific Detail</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* p < .05, *** p < .001

The two regression equations incorporating the two significant interactions, cognitive readiness.achievement press and cognitive readiness.emphasis on specific detail, were used to sketch the regression surfaces that appear in Figs. 6.2(a) and 6.2(b). Raw regression weights were used in the construction of these surfaces and hence each regression equation includes a constant. The use of this procedure was considered more meaningful for the discussion of relative interaction effects.

In both graphical representations the conclusions that may be drawn are quite similar. In Fig. 6.2(a) the greater effect of cognitive readiness upon performance at low levels of achievement press compared to its effect at high levels of press is evident by comparing the gradients of a and b. Conversely the greater effect of achievement press upon performance at lower levels of cognitive readiness is evidenced by a comparison of slopes c and d. The positive gradient of c indicates that students low in cognitive readiness placed under conditions of high achievement press perform
Figure 6.2a
The Regression Surface Representing the Interaction of the Student's Level of Cognitive Readiness and the Achievement Press of the School, upon Student Performance on the Guide Questions Scale
better than if placed in a low press environment. In contrast, the negative gradient of slope \( d \) indicates that at a high level of cognitive readiness the effect of high achievement press is to reduce the level of performance below that obtained when a similar group of students are placed in a low achievement press situation. The gradient of slope \( e \), which approximates to zero, indicates a region on the regression surface where the effect of achievement press on performance is negligible: this corresponds to a cognitive readiness score of approximately 20 items correct on the Cognitive Readiness Test.

The interaction of cognitive readiness and the teacher's emphasis on specific detail is not as pronounced and this is indicated in Fig. 6.2(b). At levels of low cognitive readiness the effect of emphasis on specific detail shows a strongly positive relationship with student performance. However, at high levels of cognitive readiness the negative relationship between the emphasis on specific detail and performance is much weaker than in the case of the previous interaction. A more accurate conclusion would be that at this level of cognitive readiness the effect of emphasis on specific detail is negligible.

The ANOVA procedure was used to test the significance of the interactive effect of cognitive readiness with achievement motivation because the regression program was unsuitable for the analysis of this interaction due to the effects of multicollinearity. There was no support for a significant interaction between these two variables \((.697 < 3.03 = F_{2,272,.05})\). Details of this analysis are found in Appendix 6.2(c).

This concludes a consideration of the 2-way interactions between cognitive readiness and each of the three variables, achievement motivation, achievement press and emphasis on specific detail. The above analyses tend to support a significant relationship between student performance and the interactive effect of cognitive readiness with each of achievement press and emphasis on specific detail. There was no such evidence to support a significant relationship between student performance and the interactive effect between cognitive readiness and achievement motivation.
Emphasis on Specific Detail  Cognitive Readiness

Figure 6.2b
The Regression Surface Representing the Interaction of the Student's Level of Cognitive Readiness and the Teacher's Emphasis on Specific Detail, upon Student Performance on the Guide Questions Scale
II The Intrinsic-Motivated Model of Learning and Student Performance on the Guide Questions Scale

This aspect of the theory of school-based learning is concerned with the constructs of cognitive readiness, intrinsic motivation, the facilitation of intrinsic motivation and interest in biology. The present major section will draw together the results that were obtained by examining the relationships between these variables and student performance on the Guide Questions scale. However, this model of learning is principally concerned with the explanation of student performance on those tests designed to assess the development of well-integrated structures of knowing. It does not attempt to explain directly student performance on tests on this nature which are assessing the students' retention of specific details dealt with in the syllabus. Yet it does suggest that students who possess well integrated structures of knowing should be able to apply these structures to the questions that comprise the Guide Questions scale. As a result this section will be comparatively brief for in a sense it will be far more exploratory, lacking the specific guiding propositions of the previous sections.

Initially the results that relate to the interaction of cognitive readiness, intrinsic motivation and the facilitation of intrinsic-motivated behaviour will be considered. This analysis will be followed by an examination of the data for any evidence of an interaction of intrinsic motivation and those properties of the learning environment likely to facilitate its arousal. Finally, an analysis of possible main effects due to the students' levels of intrinsic motivation and interest in biology is presented.

(a) Cognitive readiness and the intrinsic-motivated model of learning with respect to the learning of specific detail

The relationship between the student's cognitive readiness and both intrinsic motivation and its arousal was considered at two levels. Firstly, the interaction of cognitive readiness with both intrinsic motivation and the facilitation of intrinsic motivation taken together was investigated; this was then followed by an analysis of the interaction between cognitive readiness and intrinsic motivation, and between cognitive readiness and the facilitation of intrinsic motivation.

The 3-way interaction between cognitive readiness, intrinsic
motivation and the facilitation of intrinsic motivation was examined using a multiple stepwise regression analysis and a 4-term regression model:

\[
\text{performance} = \beta_1 \text{cognitive} + \beta_2 \text{intrinsic} + \beta_3 \text{facilitation of intrinsic motivation} \\
+ \beta_4 \text{cognitive readiness, intrinsic motivation, facilitation of intrinsic motivation}
\]

Both the second and third terms were entered together in the same step and the actual point of entry of each was decided by their partial correlation with the criterion. Details of this analysis are to be found in Appendix 6.3(a).

The analysis demonstrated that the relationship between student performance and this interaction was not significant (2.04 < 3.86 = F_{1,273,.05}).

A multiple regression procedure was then used to analyse the possible interactive effect between the student's level of cognitive readiness and the teacher's presentation of the curriculum in a manner that may lead to the arousal of intrinsic motivation. Such a procedure was considered not suitable for an analysis of the interaction between cognitive readiness and the student's level of intrinsic motivation, because of the high correlation between cognitive readiness and the interactive term.

Applying a 3-term regression model, entering cognitive readiness in first, the facilitation of intrinsic motivation second and the interaction term last, the interaction term failed to significantly improve the amount of explain variance above that explained by the previous step (3.34 < 3.86 = F_{1,273,.05}). However, two relevant points emerge from an examination of this analysis, the details of which are found in Appendix 6.3(b).

a) the improvement in explained variance obtained by the use of the 2-term model involving cognitive readiness and facilitation of intrinsic motivation over that explained by the 1-term model involving cognitive readiness only was not significant (2.01 < 3.86 = F_{1,273,.05}).
b) while the interaction term does not significantly improve the amount of explained variance above that explained by the 2-term model, when entered second in the equation and hence prior to the facilitation of intrinsic motivation it does have a significant effect upon the amount of explained variance ($3.92 > 3.86 = F_{1,273,.05}$).

There is some evidence then to support a 2-term regression model including both cognitive readiness and the interaction term of 'cognitive readiness.facilitation of intrinsic motivation' to explain student performance on the Guide Questions scale. A regression surface was constructed using raw regression coefficients to represent the interaction and this is included in Appendix 6.3(c). Reference to this appendix indicates that the interactive effect, while being significant, is quite weak. There is a small to moderate positive relationship between the facilitation of intrinsic motivation dimension of the classroom and student performance for students of high cognitive readiness. For students of low cognitive readiness this relationship is negligible. However, such a conclusion needs to be interpreted with extreme caution due to the analyses' lack of theoretical guidance and subsequent exploratory nature.

An ANOVA procedure was used to examine the relationship between student performance and the interaction of cognitive readiness and the student's level of intrinsic motivation. There was no support for such an interactive effect ($1.38 < 3.86 = F_{1,273,.05}$). Details of this analysis are contained in Appendix 6.4.

A third variable involved in this aspect of the school-based theory of learning was interest in biology. A stepwise regression procedure failed to support a significant relationship between student performance and an interactive effect of cognitive readiness with this variable ($.01 < 3.86 = F_{1,273,.05}$).

This concludes the analysis and presentation of those results relating to possible interactive effects between cognitive readiness and those variables that constitute the intrinsic-motivated model of learning. In the following section a further possible inter-
action is considered, viz., the interaction between intrinsic motivation and the presentation of the curriculum in a manner likely to arouse intrinsic motivation.

(b) The interaction between intrinsic motivation and the facilitation of its arousal

The relationships between student performance and intrinsic motivation, the facilitation of intrinsic motivation and the interactive effect between each of these two variables is summarised in Table 6.4

Table 6.4

<table>
<thead>
<tr>
<th>Correlation of Student Performance on the Guide Question Scale with those Variables Involved in the Interaction of Intrinsic Motivation with its Arousal (N = 274)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student Performance</td>
</tr>
<tr>
<td>Intrinsic Motivation</td>
</tr>
<tr>
<td>Facilitation of Intrinsic Motivation</td>
</tr>
<tr>
<td>Intrinsic Motivation,Facilitation of Intrinsic Motivation</td>
</tr>
</tbody>
</table>

* p < .05

From Table 6.4 it would appear that there is no significant relationship between student performance and the interactive effect of intrinsic motivation and the environmental variable facilitation of intrinsic motivation. This apparent lack of significance of an interactive effect was confirmed by use of the ANOVA procedure, details of which are to be found in Appendix 6.4. The weak, yet significant, relationship between intrinsic motivation and student performance will be examined in the third section of these results relating to an intrinsic-motivated model of learning.

(c) Intrinsic motivation, interest in biology and student performance on the Guide Questions scale

In the previous analyses of section II(a) the results indicate a weak, yet significant, relationship between student performance on the Guide Questions scale and the interaction of cognitive readiness and the teacher's presentation of the curriculum
in a manner likely to arouse intrinsic motivation. However, it was found that there was no interactive effect upon performance on this criterion between either intrinsic motivation and cognitive readiness or intrinsic motivation and the environmental variable facilitation of intrinsic motivation. This final section of those results relating to the intrinsic-motivated model of learning and student performance on the Guide Questions scale deals with an examination of a possible main effect of intrinsic motivation upon performance. Also included in this analysis will be a consideration of the effect of a student's interest in biology upon this criterion.

Table 6.5

Correlation Matrix between Variables Comprising the Intrinsic-Motivated Model of Learning and Student Performance on the Guide Questions Scale (N=274)

<table>
<thead>
<tr>
<th></th>
<th>Performance</th>
<th>Cognitive Readiness</th>
<th>Intrinsic Motivation</th>
<th>Facilitation of Intrinsic Motivation</th>
<th>Interest in Biology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cognitive Readiness</td>
<td>.47***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intrinsic Motivation</td>
<td>.13*</td>
<td>.23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Facilitation of Intrinsic Motivation</td>
<td>.06</td>
<td>.04</td>
<td>.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interest in Biology</td>
<td>.17*</td>
<td>.07</td>
<td>.26**</td>
<td>.06</td>
<td></td>
</tr>
</tbody>
</table>

* p < .05, ** p < .01, *** p < .001

As the above correlation matrix indicates the relationships between intrinsic motivation and performance and between interest in biology and performance are significant, although not strong. Two further relevant relationships should also be noted. Firstly, cognitive readiness is significantly related to intrinsic motivation (r = .23, p < .01); secondly, intrinsic motivation is significantly related to the student's interest in biology (r = .26, p < .01).

To estimate the contribution made by intrinsic motivation, while controlling for the influence of cognitive readiness and
the interest in biology, a regression analysis was performed involving cognitive readiness and both these variables. The 3-term regression model that results is as follows:

Performance = β₁ cognitive readiness + β₂ interest in biology + β₃ intrinsic motivation

The partial correlation of intrinsic motivation with performance following the entry of cognitive readiness was reduced to .03; following the entry of interest in biology this partial correlation was further reduced to .003. This indicates that the significant relationship between intrinsic motivation and student performance (r = .13) was largely due to the significant relationship between intrinsic motivation and cognitive readiness. Consequently it was found that there was no significant improvement by the addition of intrinsic motivation to the 2-term regression model involving only cognitive readiness and interest in biology. The overall F-value for the 2-term regression model was 41.86 (p < .001) and the regression coefficient for interest in biology was found to be significant (6.00 > 3.86 = 0.05). Appendix 6.5 contains details of this analysis.

This concludes the presentation of those results that relate the intrinsic-motivated model of learning with student performance on the Guide Questions scale. It was found that there was some evidence to support a significant relationship between student performance on this criterion and the interaction of cognitive readiness and facilitation of intrinsic motivation. There was also a significant main effect due to the students' interest in biology; however, the effect of intrinsic motivation upon performance was found not to be significant, after controlling for the effect of cognitive readiness and interest in biology. It would appear that the effect of intrinsic motivation upon student performance on the Guide Questions scale is an indirect one, and represented or 'transmitted' in both the students' cognitive readiness scores and their interest levels in biology.

The analyses reported so far in this chapter have been concerned with the student's overall performance on the Guide Questions scale. Consequently the unit of analysis has been the student himself. In the following section an alternative analysis is considered where the unit of analysis is the class and the dependent variable is the
novelty of class response to individual questions on the scale.

III. The Classroom Environment and Novelty of Response

The effect upon the novelty of class response by the teacher's emphasis on specific detail and on the integration of information with more general bodies of knowledge is examined in this section; also included in this analysis is the effect of both the teacher's presentation of the curriculum in a manner likely to arouse intrinsic motivation and the achievement press of the school. A novel response was considered, one which, when answering an item on the Guide Questions scale, did not utilise the examples, definitions, etc. that are provided within the relevant section of the text. Responses to questions 3 and 15 were particularly suitable for this analysis since each presented the student with the opportunity to generalise beyond the textbook presentation of certain concepts and to construct novel exemplars by which such concepts could be known.

Question 3 was scored in two parts and it is the second which is of interest in this analysis. An assessment as to the derivation of the example used by the student to substantiate the biological concept of diffusion was made by the researcher. Many of these examples were derived from the basic course materials, others could be recognised as novel answers and not found within Chapter 6 of the textbook or the related laboratory exercises.

Table 6.6

<table>
<thead>
<tr>
<th>Example</th>
<th>Absolute Frequency</th>
<th>Relative Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>'Release of gas in a room'</td>
<td>126</td>
<td>55%</td>
</tr>
<tr>
<td>Other text examples</td>
<td>81</td>
<td>35%</td>
</tr>
<tr>
<td>Novel responses</td>
<td>24</td>
<td>10%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>231</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

* Novelty of response is inversely proportional to the retention of specific details contained within the prescribed curriculum. Consequently it may be considered an indirect measure of the dependent variable under consideration, viz., the students' construction of isolated structures of knowing.
From Table 6.6 it is evident that 90 per cent of the examples used as sources of evidence for diffusion were to be found within the basic course materials related to Chapter 6, 'Living in Water' - 55 per cent of the responses used the major example described in the text and only 10 per cent of student answers used sources of evidence that were not found in the prescribed curriculum. The proportion of novel responses for each class was calculated; this proportion was found not to be significantly related to the dimensions of the learning environment under consideration. Details of the frequency of each type of response for individual classes is to be found in Appendix 6.6(a).

A similar analysis with question 15 is presented in Appendix 6.6(b) where the answers have been scored according to the example used by the student as illustrating either a plant or animal adaptation. Table 6.7 summarises the details of this appendix.

Table 6.7

<table>
<thead>
<tr>
<th>Types of Examples used to Illustrate either Plant or Animal Adaptation</th>
<th>Absolute Frequency</th>
<th>Relative Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Plant Adaptations</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Examples derived from the basic course materials</td>
<td>386</td>
<td>90.6%</td>
</tr>
<tr>
<td>Examples not contained within the basic course materials</td>
<td>40</td>
<td>9.4%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>426</td>
<td>100.0%</td>
</tr>
<tr>
<td><strong>Animal Adaptations</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Examples derived from the basic course materials</td>
<td>380</td>
<td>79.4%</td>
</tr>
<tr>
<td>Examples not contained within the basic course materials</td>
<td>100</td>
<td>20.6%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>480</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

The percentage of novel responses made by each class was correlated with the rating of that class made by the researcher on the dimensions of the learning environment under consideration.
These are summarised in Table 6.8 and are detailed in Appendices 6.6(c), (d).

Table 6.8

Correlation between Percentage of Novel Responses in a Class and Ratings of Learning Environment (N=17)

<table>
<thead>
<tr>
<th>Dimension of Classroom Environment</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emphasis on Specific Detail learning goal</td>
<td>-.55**</td>
</tr>
<tr>
<td>Integrative Learning Goal</td>
<td>.41*</td>
</tr>
<tr>
<td>Facilitation of Intrinsic Motivation</td>
<td>.69**</td>
</tr>
<tr>
<td>Arousal of Achievement Motivation</td>
<td>.07</td>
</tr>
</tbody>
</table>

* p < .05, ** p < .01

As Table 6.8 indicates, each of the learning goals specified by the teacher, as well as the facilitation of intrinsic motivation within the classroom, was significantly related to the percentage of novel responses made by each class. Classes with a high rating on the facilitation of intrinsic motivation as well as those with a high rating on the integration of information into more general bodies of knowledge produced a greater number of novel examples than did those low on these dimensions; classes that were characterised by a high emphasis on specific detail produced fewer novel responses than did classes where there was no such emphasis. The arousal of achievement motivation was found not to be significantly related to this criterion.

This concludes an examination of student performance on two items of the Guide Questions scale which provided the student with the opportunity to demonstrate a knowledge of both the concepts of adaptation and diffusion, which was quite independent of the course materials from which such knowledge was derived. In both cases the results indicate that few students did, in fact, produce answers that were not taken directly from the text. The results relating to the effect of the learning environment upon the production of novel responses were ambiguous. With regard to question 3 there was no significant effect; however, in the case of question 15 three dimensions of the learning environment were seen to be significantly related to the proportion of novel responses for
each class. In Chapter 8 it is suggested that such differing results may have been due to the different nature of the concepts themselves, diffusion being more specific and adaptation possibly being more readily generalisable.

The explanation of student performance on the Guide Questions scale in terms of either an achievement-orientated model of learning or one dependent upon the arousal of intrinsic motivation has directed the analyses reported in this chapter. These results will form the basis for the discussion in Chapter 8, together with those results obtained in the following analyses related to the explanation of student performance on the Problems scale.
RESULTS - PART B: AN INTEGRATED KNOWLEDGE OF THE CURRICULUM

Student performance on the Problems scale, used as a measure of the students' understanding of the concept dealt with in the unit of curriculum under study, is the principal concern of this chapter. The method of presentation of results dealing with this criterion is quite similar to that of the previous chapter. However, due to the nature of the questions comprising the scale there will not be a final treatment of student answers to individual questions but solely a consideration of the students' overall performance. Again the first major section will deal with an analysis of the relationships between student performance and those variables that constitute the achievement-orientated model of learning, and the second with those variables that constitute the intrinsic-motivated model of learning.

I. Student Performance on the Problems Scale and the Achievement-Orientated Model of Learning

Basic to the achievement-orientated model of learning are the concepts of cognitive readiness, achievement motivation, achievement press and goal specification. Two goals specified by the teacher are seen as important in the acquisition of a well integrated set of cognitive structures by which the curriculum is known. The first relates to the teacher's emphasis upon the retention of the information contained in the curriculum, the second to the teacher's emphasis upon an integration of that information into broader areas of both biological and general knowledge. However, the effect of each of these learning goals will be modified by both the students' levels of cognitive readiness and achievement motivation and the achievement press of the school. This section will initially examine the relationships between student performance on the Problems scale and both emphasis on specific detail and emphasis on integration, as well as the achievement press of the school, and the achievement motivation of the student. These analyses will be followed by an examination of the relationships between student performance on this criterion and the interactive effects of cognitive readiness and each of the
remaining independent variables that constitute the achievement-orientated model of learning.

(a) The interaction between press, motivation and goal specification

The interaction between achievement press, achievement motivation and the specification of both learning goals, emphasis on integration and emphasis on specific detail, will be initially considered in this section. This in turn will be followed by the analyses of the interactive effects of press, motivation and the specification of each of the learning goals when taken separately. The final analysis of the section will propose an overall model that best explains student performance on the Problems scale when these four variables are considered.

i) The 4-way interaction and student performance

An ANOVA procedure was considered more appropriate to test the significance of the 4-way interaction of achievement press, achievement motivation and the specification of both learning goals. Reference to Appendix 7.1(a) indicates that the relationship between student performance on the Problems scale and this interaction was not significant ($3.45 < 3.86 = F_{1,273,05}$).

ii) The interaction of press, motivation, emphasis on specific detail

The mean performance scores for each category of variable that comprises this interaction are to be found in Appendix 7.1(b), together with the relevant statistical details of this section. Figure 7.1 provides a summary of these results.

To test the significance of this 3-way interaction the ANOVA procedure was used, details of which are reported also in Appendix 7.1(b). This analysis supports a significant relationship between student performance on the criterion and the interactive effect of achievement motivation, achievement press and emphasis on specific detail ($9.04 > 6.73 = F_{1,273,01}$).

Reference to Appendix 7.1(c) indicates that for classes that were rated high on both achievement press and goal specification,

1 Due to the high correlation between the interactive term and the independent variables a regression analysis was not an appropriate means of testing the significance of the interactive effect in this and the following two analyses.
Figure 7.1

The 3-way Interaction of the Student's Level of Achievement Motivation, the Achievement Press of the School and the Teacher's Emphasis on Specific Detail, upon Student Performance on the Problems Scale
students of high achievement motivation performed significantly better than students of low achievement motivation (3.59 > 3.46 = \( t_{67,.001} \)). However, when placed under conditions of high goal specification and low achievement press there was no significant difference between performance on the Problems scale of these two groups of students (.69 < 2.1 = t_{62,.05} ). There were also no significant differences in performance between students of differing levels of achievement motivation when found in classes of low goal specification and experiencing either high or low levels of achievement press. In the above analyses two-tailed tests of significance were applied (the guiding proposition of Chapter 4 had not suggested this 3-way interactive effect); further, a conservative approximation, \( p = \frac{\alpha}{n} \), to Scheffe's technique to control for the effects of multiple comparisons between means was used.\(^2\)

(iii) The interaction of press.motivation.emphasis on integration

The relationship between student performance on the Problems scale and the interactive effect between achievement press, achievement motivation and the teacher's emphasis upon the integration of material dealt with in the curriculum will now be considered.

In contrast to the above analysis there appeared no significant interactive effect between press, motivation and goal specification, when the goal specification was emphasis on integration (3.09 < 3.86 = \( F_{1,273,.05} \)). Details of this analysis are to be found in Appendix 7.1(d).

This concludes the analysis of those possible interactive effects between student performance and motivation.press.goal specification that are suggested by the achievement-orientated model of learning. However, an examination of the ANOVA procedure reported in Appendix 7.1(a) suggests the possibility of a significant interactive effect between both learning goals upon student performance on the criterion. This will be investigated in the following section.

---

2 Where \( \alpha = \) overall level of significance, \( p = \) final level of significance for any one comparison, \( n = \) number of comparisons.
(iv) The interaction between the specification of particular learning goals

The interactive effect of a teacher emphasising both the integration of specific information into the students' more generalised knowing structures and the retention of details of that information will be examined in this section. Fig. 7.2 summarises the mean performance scores for students found in each of the four possible types of learning environment that may be characterised by the specification of two learning goals. An ANOVA procedure was used to test the significance of this 2-way interaction, and the results of this analysis together with the mean performance scores for students found in each of the four possible types of learning environments are summarised in Appendices 7.2(a), (b). Reference to Appendix 7.2(a) indicates a significant interactive effect between the teacher's emphasis upon an integrative learning goal and the emphasis placed upon the retention of information dealt with in the curriculum (6.99 > 6.76 = F_{1,273,.01}).

Table 7.1
Stepwise Multiple Regression to Test the Significance of the Interaction between the Specification of both Learning Goals in the Explanation of Student Performance on the Problems Scale

<table>
<thead>
<tr>
<th>Variable Entered</th>
<th>Simple Correlation</th>
<th>Final Beta coeff.</th>
<th>F-value of Beta coeff. on entry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emphasis on Integration</td>
<td>.31</td>
<td>-.62</td>
<td>26.95***</td>
</tr>
<tr>
<td>Emphasis on Specific Detail</td>
<td>.17</td>
<td>-.37</td>
<td>3.89*</td>
</tr>
<tr>
<td>Emphasis on Integration.</td>
<td>.24</td>
<td>.49</td>
<td>8.56**</td>
</tr>
<tr>
<td>Emphasis on Specific Detail</td>
<td>.24</td>
<td>.49</td>
<td>8.56**</td>
</tr>
</tbody>
</table>

R = .36, R^2 = .13, 13.66 > 3.88, F_{3,271,.01}

* p < .05, ** p < .01, *** p < .001

A stepwise multiple regression analysis was also used to test the significance of this interactive effect. The two independent variables were entered first in the regression equation and these were followed up by the entry of the interactive term. The results
Figure 7.2

The 2-way Interaction of the Teacher's Specification of both the Learning Goals, Emphasis on Integration and Emphasis on Specific Detail, upon Student Performance on the Problems Scale
are summarised in Table 7.1 and support the interactive effect upon performance found in the above analysis.

A schematic representation of this regression equation using raw regression weights is shown in the following Fig. 7.3. This presents a more useful and accurate summary of the interactive effect upon performance over the entire range of the two dimensions of learning environment being considered, than that obtained by use of the analysis of variance procedure.

Slope $d$ represents the situation where the teacher's emphasis upon the retention of information is minimal and where the emphasis upon an integrative learning goal varies from very high to very low (i.e. varies across the ratings from 1 to 7). The actual gradient of this slope approximates to zero and indicates that at very low levels of emphasis on specific detail changes in the level of the teacher's emphasis on integration result in negligible changes in student performance. Contrast this situation with that represented by slope $a$. For low levels of teacher emphasis upon the integration of information into more general knowing structures, the effect of increasing the level of emphasis on specific detail actually decreases the students' performance on the Problems scale. This is indicated by the negative gradient of slope $a$. The next slope to consider is $e$. This slope represents the level of emphasis upon the integration of information where the effect of changes in emphasis on specific detail is minimal: as is seen from the diagram, these classes are equivalent to a rating of 5 on the classroom dimension emphasis on integration. It should also be noted that the performance of these classes remains quite low. Slope $c$ represents the positive effect of increasing the level of emphasis on specific detail for classes rated very high on the specification of an integrative learning goal: this amounts to an overall change in performance of 5.4 marks (1.05 standard deviations) on the Problems scale. Finally, slope $b$ summarises the situation of those classes high on the teacher's emphasis on the retention of information dealt with in the curriculum where the teacher varies the amount of emphasis placed upon the integration of this information into the students' general knowledge. The overall effect of changing the level of emphasis on integration while maintaining
The Regression Surface Representing the Interaction of the Teacher's Specification of both the Learning Goals, Emphasis on Integration and Emphasis on Specific Detail, upon Student Performance on the Problems Scale
a very high level of emphasis on specific detail was 7.9 marks (1.54 standard deviations) in performance on the Problems scale.

This concludes the presentation of those results relating student performance on the Problems scale to a 2-way interactive effect between the teacher's emphasis on both the retention of specific detail dealt with in the course and the integration of that information into broader structures of knowing. The final analysis of this section will be directed towards establishing an overall model that best explains student performance on the criterion and one that can be derived from a more detailed consideration of the ANOVA reported in Appendix 7.1.

(v) The derivation of an overall model

The full 15-term model, comprising four main effects and eleven possible interactions, is summarised by the ANOVA procedure referred to in section 1a(i). The following reduced 4-term model was proposed to account for the major portion of variance explained by the full model:

\[
\text{Performance} = \beta_1 \text{emphasis on } + \beta_2 \text{ achievement } + \beta_3 \text{ emphasis on integration press } + \beta_4 \text{ emphasis on specific detail.}
\]

A stepwise multiple regression procedure involving dummy variables was used to analyse the above 4-term regression model. Details of this analysis are summarised in Table 7.2.

These results supported a 4-term model comprising two main effects, a 2-way interaction and a 3-way interaction, with each contributing a significant amount of variance in the explanation of student performance on the criterion. The amount of variance explained by this reduced model was then compared to that explained by the full model as a means of assessing whether the reduced model was accounting for the major portion of this variance. Reference to Appendix 7.3 indicates that the amount of variance explained by the full model over and above that explained by the reduced model was of borderline significance \(1.77 < 1.82 = F_{11,261,.05}\).

Further analyses indicated that no single term of the remaining
Table 7.2
Stepwise Multiple Regression using Dummy Variables in a 4-term Regression Model to Explain Student Performance on the Problems Scale

<table>
<thead>
<tr>
<th>Variable Entered</th>
<th>Simple Correlation</th>
<th>Final Beta</th>
<th>F-Ratio when Entered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emphasis on Integration</td>
<td>.14</td>
<td>.09</td>
<td>8.04**</td>
</tr>
<tr>
<td>Achievement Press</td>
<td>.23</td>
<td>.20</td>
<td>15.31**</td>
</tr>
<tr>
<td>Emphasis on integration.</td>
<td>.16</td>
<td>.11</td>
<td>5.72*</td>
</tr>
<tr>
<td>Emphasis on specific detail</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Achievement press.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Achievement motivation</td>
<td>.26</td>
<td>.16</td>
<td>5.53*</td>
</tr>
</tbody>
</table>

\[ R = .34, R^2 = .12, F = 8.98 > 3.41 = F_{4,269,.01} \]

* p < .05, ** p < .01

Terms in this full model contributed a significant amount of variance over that contributed by the 4-term model. Therefore it may be concluded that this 4-term model does, in fact, appear to best explain student performance on the Problems scale when the variables of achievement press, achievement motivation, emphasis on integration and emphasis on specific detail are being considered.

It is useful to summarise the results of this section. The guiding propositions of Chapter 4 suggested a significant effect upon student performance on the Problems scale due to the interaction of achievement motivation, achievement press and the specification of the learning goal emphasis on integration. This 3-way interaction was not substantiated in the analyses. Rather, a 4-term model was proposed to best explain student performance on this scale. The model included both the variables achievement press and emphasis on integration as main effects. Two higher order interactions were also included in the model. Firstly, there was a second-order interactive term representing the interaction of both the teacher's emphasis on specific detail and the teacher's emphasis on integration. Optimal performance occurred for those students found in classes with a high rating on both...
these dimensions of the learning environment. Secondly, a third-order interactive term suggested that students of high achievement motivation performed significantly better than students of low achievement motivation when experiencing a learning environment rated high on the dimensions of achievement press and emphasis on specific detail; there was no significant difference between each of these groups of students under conditions of high achievement press and low emphasis on specific detail.

This concludes the analysis of those results that relate to the interactions between achievement press, achievement motivation and the specification of both learning goals. In the following section the relationships between student performance and the possible interactive effects of cognitive readiness and each of these variables will be considered.

(b) Cognitive readiness and its interaction with press, motivation and goal specification

The guiding propositions of Chapter 4 suggest an interactive effect upon student performance between cognitive readiness and each of the variables analysed in the previous section. It was argued that achievement motivation, achievement press and the teacher's emphasis on the integration of information would be positively related to performance for those students of higher cognitive readiness; in contrast, the teacher's emphasis on specific detail was thought to assist those students of intermediate cognitive readiness in the development of a well-integrated knowledge of the curriculum, provided these students also experienced a strong emphasis on integration. The strategy used to investigate these possible interactive effects was three-fold. Firstly an ANOVA procedure was used to investigate the possible interaction of cognitive readiness and the teacher's emphases on both specific detail and integration upon student performance on the Problems scale. A multiple regression analysis was inappropriate for this purpose. Secondly, a stepwise multiple regression analysis was used to examine the interaction of cognitive readiness and achievement press on this criterion; again, this procedure was inappropriate in the case of the interaction 'cognitive readiness.achievement motivation' and an ANOVA procedure was used.

(i) The 3-way interaction of cognitive readiness, emphasis on specific detail and emphasis on integration

The interactive effect of the students' level of cognitive
readiness and both emphasis on specific detail and emphasis on integration upon student performance on the Problems scale will be examined in this section. Fig. 7.4 summarises the mean performance scores for students of each level of cognitive readiness found in each of the four possible types of learning environment that may be characterised by the specification of both these learning goals.

An ANOVA procedure was used to test the significance of this 3-way interaction, and the results of this analysis are to be found in Appendix 7.4(a). Reference to this appendix indicates a significant interactive effect between the student's level of cognitive readiness and the teacher's specification of both learning goals upon the criterion \( (4.42 > 3.03 = t_{2,271,.05}) \).

An examination of Appendix 7.4(b) indicates three significant relationships that are represented in Fig. 7.4 and which are suggested by the theory outlined in Chapter 4. Firstly, for students of intermediate cognitive readiness found in classes with a high rating on emphasis on integration, those students found also in classes where their teacher emphasised the retention of specific detail performed significantly better than in those classes where there was no such emphasis \( (1.78 > 1.68 = t_{40,.05}) \). Of the three relationships observed, this is theoretically the most important for it substantiates, as the discussion of Chapter 8 will point out, the qualitative aspects of the concept cognitive readiness. Secondly, for students of both intermediate and low cognitive readiness found in classes of weak emphasis on integration, those students found also in classes which were characterised by a strong emphasis on specific detail performed significantly worse on the Problems scale than their peers in classes where there was no such emphasis \( (1.79 > 1.68 = t_{42,.05}; 2.88 > 2.72 = t_{42,.01}, \text{ respectively}) \).

Again, each of these relationships have particular implications for the conceptualisation of cognitive readiness; these will be discussed also in Chapter 8. In the following section the 2-way interaction of cognitive readiness and achievement press upon student performance on the Problems scale will be considered.
Figure 7.4
The 3-way Interaction of the Student's Level of Cognitive Readiness and the Teacher's Specification of both the Learning Goals, Emphasis on Integration and Emphasis on Specific Detail, upon Student Performance on the Problems Scale
The interaction of cognitive readiness and achievement press

A stepwise multiple regression analysis was used to investigate the interaction of cognitive readiness and achievement press upon student performance on the Problems scale. The method used was the same as that described in section 1(b) of Chapter 6, and details of this analysis are to be found in Appendix 7.5. As was found in the previous analysis of Chapter 6, the 5-term and 4-term regression models did not significantly improve the amount of explained variance over and beyond that explained by the three-term model. Hence the results concerning the 3-term model are of principal interest and it is these that are summarised in Table 7.3.

Table 7.3
The Interaction of Achievement Press and Cognitive Readiness upon Student Performance on the Problems Scale

<table>
<thead>
<tr>
<th>Variable Entered</th>
<th>Simple Correlation</th>
<th>Final Beta</th>
<th>F when Entered</th>
<th>Overall F-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive Readiness</td>
<td>.62</td>
<td>.79</td>
<td>170.16***</td>
<td></td>
</tr>
<tr>
<td>Achievement Press</td>
<td>.36</td>
<td>.01</td>
<td>3.22</td>
<td></td>
</tr>
<tr>
<td>Cognitive Readiness. Achievement Press</td>
<td>.48</td>
<td>-.20</td>
<td>.57</td>
<td>58.35***</td>
</tr>
</tbody>
</table>

*** p < .001

Note: The overall F-ratio applies to the reduced 3-term model

An examination of Table 7.3 shows that the interaction of cognitive readiness and achievement press was not significantly related to student performance on the Problems scale. Using the 3-term model and entering the interactive term last this result is quite clear. Yet a consideration of the partial correlations of achievement press and the interactive term with performance following the entry of cognitive readiness, together with the resultant beta coefficients if each were entered next, is interesting. The significance of the interactive term is very much
dependent upon the point at which it is entered in the regression equation. If the point of entry was dependent upon the partial correlation of the remaining terms with the criterion, then the interactive term 'cognitive readiness.achievement press' would be entered after cognitive readiness but before the second independent variable. This would result in a significant interaction of cognitive readiness and achievement press \( (3.88 > 3.86 = F_{1,273,.05}) \). It should now be noted that the amount of variance explained by the 2-term regression model of cognitive readiness and the interactive term is significant over and above that explained by cognitive readiness alone; such was not the case for the 2-term model of both cognitive readiness and achievement press. Since the guiding propositions suggest an interactive effect to be operative rather than purely a main effect of achievement press then these results lend support to this proposal. This relationship will be discussed in Chapter 8. However, of immediate concern is the relationship between student performance and the interaction of cognitive readiness and achievement motivation. 

(iii) The interaction of cognitive readiness and achievement motivation

To test the significance of the interactive effect of cognitive readiness and achievement motivation upon student performance on the Problems scale the ANOVA procedure was used. The mean performance scores on the Problems scale for those students of differing levels of achievement motivation and at each level of cognitive readiness are summarised in Fig. 7.5.

The ANOVA analysis indicated that the relationship between student performance and the interactive effect of cognitive readiness and achievement motivation was significant \( (3.66 > 3.03 = F_{2,273,.05}) \). Reference to Appendix 7.6 also shows that of those students comprising the high cognitive readiness group, students of high achievement motivation performed significantly better than those of low achievement motivation \( (3.02 > 2.38 = t_{95,.01}) \).

The results that are relevant to the possible interactive effects of cognitive readiness and the four variables under consideration can now be summarised. A significant interactive effect upon performance of cognitive readiness and achievement motivation has been demonstrated by use of the ANOVA procedure.
Figure 7.5

The 2-way Interaction of the Student's Levels of Achievement Motivation and Cognitive Readiness upon Student Performance on the Problems Scale
However, in the case of achievement press the evidence to support an interactive effect of cognitive readiness and achievement press is quite limited. Finally, there was a significant interaction of cognitive readiness and the teacher's specification of each of the learning goals upon the student's construction of an integrated knowledge of the curriculum. This latter finding is particularly important in understanding the construct 'cognitive readiness'.

This concludes the presentation of those results that relate to the achievement-orientated model of learning as a means of explaining student performance on the Problems scale. In the following major section, the guiding propositions that underlie an intrinsic-motivated conceptualisation of learning will form the basis of further analyses.

II. The Intrinsic-Motivated Model of Learning and Student Performance on the Problems Scale

The method of presentation of results relating to the intrinsic-motivated model of learning to student performance on the Problems scale is quite similar to that found in section II of Chapter 6. Initially the relationship between student performance and the interactive effect of cognitive readiness and both intrinsic motivation and the properties of the learning environment likely to facilitate its arousal will be considered. This in turn will be followed by an examination of the interactive effects of cognitive readiness and these two variables taken separately; the interaction of cognitive readiness and the students' interest in biology will also be included in this analysis. The subsequent analyses of this section will focus on firstly, the possible interaction between intrinsic motivation and the facilitation of intrinsic motivation and, finally, the main effects of each of the variables under consideration.

(a) The interactions of cognitive readiness and intrinsic motivation, facilitation of intrinsic motivation and student interest in biology

Central to the intrinsic-motivated model of learning was the proposition that the maintenance and resolution of cognitive conflict will be dependent upon the set of cognitive structures into which the novel information is to be assimilated. It was argued that resolution of cognitive conflict leading to the integration of this
information into the students' general knowing structures can only occur for those students possessing a stable set of prerequisite structures. To investigate this proposition the relationship between student performance on the Problems scale and the interactive effect of cognitive readiness and both intrinsic motivation and the 'arousal' properties of the learning environment will be examined.

This 3-way interaction was analysed using a multiple stepwise regression procedure and a 4-term regression model:

\[ \text{Student} = \beta_1 \text{cognitive readiness} + \beta_2 \text{intrinsic motivation} + \beta_3 \text{facilitation of intrinsic motivation} + \beta_4 \text{cognitive readiness}. \]

The results of this and subsequent related analyses are to be found in Appendices 7.7(a), (b), (c). Reference to Appendix 7.7(a) indicates that the relationship between the interactive term and the criterion was not significant \((1.20 < 3.86 = F_{1,273, 05})\).

Using regression analysis the interaction between cognitive readiness and facilitation of intrinsic motivation was considered next; such a procedure was inappropriate for analysing the interaction of cognitive readiness and intrinsic motivation. A 3-term regression model was used and the form of analysis was similar to that described in section II of Chapter 6. The relationship between student performance on the Problems scale and the interaction of cognitive readiness and the teacher's presentation of the curriculum in a manner likely to arouse intrinsic motivation was found not to be significant \((2.46 < 3.86 = F_{1,273, 05})\).

An ANOVA procedure was used to test the significance of the amount of variance explained by the interactive effect of cognitive readiness and intrinsic motivation over and above that explained by the main effects. The improvement in the amount of explained variance was found not to be significant \((1.80 < 3.03 = F_{2,273, 05})\).

A third variable involved in the intrinsic-motivated model of learning is the students' interest in biology. A multiple
regression analysis failed to support a significant relationship between student performance and the interaction of cognitive readiness and the students' interest in biology \( (0.64 < 3.86 = F_{1,273},.05) \).

An alternative procedure for the analysis of these interactive effects is a test of heterogeneity of regression slopes for each of these variables at each level of cognitive readiness. The rationale for this second form of analysis is as follows. In Chapter 4 it was suggested that the students' construction of a well-integrated knowledge of the curriculum is dependent upon both quantitative and qualitative properties of that set of cognitive structures that characterise each level of cognitive readiness. Students of 'high' cognitive readiness were considered to possess a stable set of cognitive structures by which prerequisite concepts are known; in contrast, students of 'intermediate' cognitive readiness possessed an unstable set of cognitive structures. And it is an examination of the regression slopes of each of these variables for each level of cognitive readiness which focuses upon this qualitative difference between each of the levels of cognitive readiness. The regression slopes for each of these variables are presented in Table 7.4.

Table 7.4

The Regression Slopes upon Student Performance on the Problems Scale for Intrinsic Motivation, Facilitation of Intrinsic Motivation and Interest in Biology at each Level of Cognitive Readiness

<table>
<thead>
<tr>
<th>Variable</th>
<th>Cognitive Readiness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Intrinsic Motivation</td>
<td>-.04</td>
</tr>
<tr>
<td>Facilitation of Intrinsic Motivation</td>
<td>.03</td>
</tr>
<tr>
<td>Interest in Biology</td>
<td>.10</td>
</tr>
</tbody>
</table>

* \( p < .05 \), ** \( p < .01 \)
In the case of the facilitation of intrinsic motivation and the students' interest in biology, the analysis provided no support for significant differences between the regression slopes for each of these variables at each level of cognitive readiness (0.58 < 3.03 = F_{2,273,.05}, 2.20 < 3.03 = F_{2,266,.05}, respectively). However, it should be noted that there was a significant correlation between interest in biology and performance on the Problems scale for students of high cognitive readiness; no such relationship was evident for students of low or intermediate levels of cognitive readiness.

With regard to intrinsic motivation the results demonstrated a significant improvement in the amount of variance explained by the full model, incorporating both additive and interactive terms, over and above that explained by the reduced additive model\(^3\) (3.66 > 3.03 = F_{2,273,.05}). For students of high cognitive readiness there was a positive relationship between the students' level of intrinsic motivation and their construction of an integrated knowledge of the curriculum, as indicated by their performance on the Problems scale. And this relationship was significantly greater than that characterising students of low and intermediate levels of cognitive readiness. Details of these analyses are to be found in Appendix 7.7(d).

This concludes the analyses related to the interaction of cognitive readiness and each of the three remaining variables of the intrinsic-motivated model of learning. Evidence was presented to support the relationship between a well-integrated understanding of the curriculum on the part of the student and the interaction of his level of cognitive readiness and intrinsic motivation. The evidence for an interactive effect between interest in biology and the students' level of cognitive readiness was quite limited; no evidence was found for a significant interaction between cognitive readiness and the facilitation of intrinsic motivation. In the following analysis the interaction of the student's level of intrinsic motivation and the 'arousal' properties of the learning environment will be considered.

An ANOVA procedure was used to test the significance of the 2-way interaction of intrinsic motivation and its arousal upon the criterion, multiple regression analysis being inappropriate.

\(^3\) The procedure used to test the heterogeneity of regression slopes is outlined in Appendix 5.9.
Reference to Appendix 7.7(e) shows that the results obtained by the ANOVA procedure failed to support a significant interactive effect \((0.88 < 3.86 = F_{1,273,05})\).

(b) **The main effects of facilitation of intrinsic motivation and interest in biology upon student performance**

The previous analyses suggest an interactive effect between cognitive readiness and intrinsic motivation upon student performance. The final analysis to be reported in this section considers possible main effects of the remaining two variables, interest in biology and facilitation of intrinsic motivation. Stepwise multiple regression analysis was suitable for this purpose. To test the significance of each of these two variables acting as main effects the following 2-term regression equation was proposed:

\[
\text{Student performance} = \beta_1 \text{cognitive readiness} + \beta_2 \text{Ind. variable}
\]

where 'Ind. variable' was either facilitation of intrinsic motivation or interest in biology

The results of this analysis are summarised in Table 7.5. These results demonstrate that there was no significant relationship between student performance on the criterion and either the teacher's presentation of the curriculum in a manner likely to arouse intrinsic motivation or the students' level of interest in the course.

**Table 7.5**

<table>
<thead>
<tr>
<th>Variable Entered</th>
<th>Simple Correlation</th>
<th>Final Beta</th>
<th>F when Entered</th>
<th>Overall F-ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive Readiness</td>
<td>.62</td>
<td>.62</td>
<td>168.27 ***</td>
<td></td>
</tr>
<tr>
<td>Interest in Biology</td>
<td>.09</td>
<td>.04</td>
<td>.69</td>
<td>84.39 ***</td>
</tr>
<tr>
<td>Cognitive Readiness</td>
<td>.62</td>
<td>.62</td>
<td>170.16 ***</td>
<td></td>
</tr>
<tr>
<td>Facilitation of Intrinsic Motivation</td>
<td>.03</td>
<td>-.06</td>
<td>1.44</td>
<td>85.94 ***</td>
</tr>
</tbody>
</table>

*** p < .001
It is now useful to summarise the results of this section. The guiding proposition of Chapter 4 suggested a 3-way interaction of cognitive readiness, intrinsic motivation and facilitation of intrinsic motivation upon student performance on the Problems scale. The analyses failed to provide evidence for such an interaction. However, the analyses demonstrated that for students of high cognitive readiness, those students of higher intrinsic motivation performed significantly better than students of lower intrinsic motivation; no such relationship was present for students of intermediate or low cognitive readiness. Limited evidence was presented of a similar relationship between the students' interest in biology and their level of cognitive readiness. Overall, the results relating to those properties of the learning environment likely to facilitate the arousal of intrinsic motivation were extremely disappointing, and failed to show any significant effect of this variable upon the students' construction of an integrated knowledge of the curriculum.

This concludes the presentation of those results relating both the achievement-orientated and the intrinsic-motivated models of learning to the students' performance on a scale designed to measure the students' development on an integrated knowledge of the curriculum. These results, together with those found in Chapter 6, will form the basis of the discussion in Chapter 8 concerning the validity of the proposed theory of school-based learning.
Chapter 8
DISCUSSION OF RESULTS

The presentation of the quantitative results concerned with the guiding propositions of both the achievement-orientated and intrinsic-motivated models of school-based learning has been completed. In the discussion that follows these results are related to the qualitative data that was obtained throughout the research period. The qualitative data, which consist of the records of student interviews and the researcher's observations of teacher-student interactions, have been used in two ways in this work. Firstly, the qualitative data helped establish the ranking of each classroom on three of the dimensions under consideration, viz., emphasis on specific detail, emphasis on integration and facilitation of intrinsic motivation. Secondly, this data generated insights into the dynamics of the classroom situation which enabled the researcher to better explain particular aspects of the analyses that have been presented in the previous two chapters.

Initially both the quantitative results and the qualitative data are related to the achievement-orientated model of learning; this is followed by a consideration of those results and data relevant to the intrinsic-motivated model of learning. However, there are certain underlying concepts such as cognitive readiness, the assimilation-accommodation model and the person's interaction with the environment, that are common to both models of learning. Hence following this initial discussion, attention in Chapter 9 is directed towards summarising the overall pattern of results in terms of the more basic theoretical orientations that have been adopted in the study.

I. The Achievement-Orientated Model of Learning

Central to the achievement-orientated model of learning is the idea that the student interprets teacher behaviour within a 'system of meanings that reflect an implicit understanding that the teacher's role is one of defining the contents and boundaries of the curriculum' (Chapter 3). Arising out of such interactions the student builds up a set of expectations of what will be evaluated,
and hence what will constitute the goals to which his learning activities will be directed. This led to the proposition that a student's learning activities will be directed towards the learning goals specified by the teacher. In the initial section of the discussion that follows the results and qualitative data are related to this proposition. However, the theory outlined in Chapter 4 suggests that this is a general proposition and the extent to which students direct their learning activities towards the goals specified by the teacher is modified by both student characteristics and other aspects of the learning environment. Firstly, it was proposed that both the achievement press of the school and the achievement motivation of the student influences the degree to which the student approaches those learning goals specified by the teacher. This is the concern of the second section of this discussion. Secondly, it was proposed that the student's level of cognitive readiness influences his interaction with these learning goals and the subsequent form of accommodative activity that characterises his learning. This is considered in the final section of the present discussion.

(a) The learning goals specified by the teacher and the students' learning activities

Two main effects found in the analyses of Chapters 6 and 7 support the general proposition that students' learning activities are directed towards those learning goals specified by their teachers. Firstly, students experiencing a learning environment where there was a strong emphasis on specific detail performed significantly better on the Guide Questions scale, assessing recall of information, than did students in classes rated low on this dimension. Secondly, students found in classes with a high rating on the dimension emphasis on integration performed significantly better on the Problems scale, assessing mainly the application of concepts to novel situations, than did students in classes where there was little emphasis on integration.

Yet it is interview data that most clearly identifies the psychological processes underlying these results. The qualitative data indeed showed that students both develop expectations of what constitutes the knowledge most likely to be evaluated and then direct their learning activities towards the attainment of this knowledge. For example, students were asked whether they
were free to develop their own ideas and solutions to the problems found in the textbook, or whether they felt restricted in the types of answers they could give.¹ The majority of students felt that they were very restricted in the type of answers that would be accepted by the teacher. This is illustrated in the replies of the following two students:

i) I've done it occasionally but usually when they are handed back, he's got down the answer you know it was meant to be but you decided to look at it from a different angle. You don't do it very much because it seems you get marked on the right answers. I don't know how his marking works but if you hand in answers from the angle you have looked at it from, he usually has written "this could be true but the answer is meant to be ..." and you don't get the marks ... this is true of all class questioning ... (class no. 24).

or more simply:

ii) You know what the teacher will accept as the right answer so that is what you write (class no. 28).

Only in the cases of classes 20 and 27 (both rated highest on the dimension facilitation of intrinsic motivation) did most students agree that they were given the opportunity to write down their own ideas and solutions to these problems.

Evidently most students built up a set of expectations of the types of answers, and at a deeper level the forms of knowledge, that would be accepted by their teacher as legitimate biological knowledge. And these expectations arose out of the everyday teacher-student interactions that characterise learning experiences. This relationship between teacher behaviour and goal specification was clear in the following student's comment: 'We have to do all the guide questions ... and the teacher expects us to know most of what is there [in the textbook]' (class no. 16).

Not all students, however, directed their learning activities

¹ As noted in Chapter 5, 'the problems at the end of each chapter are designed to give students the opportunity to use the ideas they are developing and extend their understanding beyond that developed elsewhere in the course' (Teachers Guide, 1973).

² The number at the end of each student quotation refers to the class in which the student was found. This can be referred back to Appendix 5 where the ratings for each class on each of the relevant dimensions of the learning environment can be found.
with the same intensity towards these specified goals. Firstly, the quantitative results indicated that the students' level of cognitive readiness interacted with the learning goals to influence their learning activities. These results will be seen in section 8.1(c) to substantiate the proposition that there are qualitative differences between each of the levels of cognitive readiness. Secondly, the results also demonstrated that the students' level of achievement motivation as well as the achievement press of the school influenced the intensity of the students' approach to these learning goals. These results will now be discussed for they are directly concerned with validating the achievement-orientated model of learning.

(b) Achievement press, achievement motivation, goal specification and student performance

This section is concerned with the interaction of achievement motivation, achievement press and goal specification upon student learning. The guiding propositions that underlie this aspect of the theory of school-based learning have been described in Chapter 4, p.64 and the relevant analyses are found in sections 1(a) of the previous two chapters. Firstly, a summary of the results of these analyses is presented; then a qualitative data is used to assist in the interpretation of these findings.

The quantitative results suggested a 3-term regression equation to explain student performance on the Guide Questions scale. In addition to two main effects of achievement press and emphasis on specific detail, this equation included a three-way interactive term of achievement press, achievement motivation and teacher emphasis on specific detail. Further, those students of low achievement motivation responded more to achievement press than those of high achievement motivation under conditions of low goal specification; but the reverse was true under conditions of high goal specification. These results support the relevant guiding propositions outlined in Chapter 4. However, the results relating to student performance on the Problems scale did not support these guiding propositions. The analyses suggested a 4-term regression equation to explain student performance on this criterion. In addition to two main effects, achievement press and emphasis on integration, this equation included two high-order interactions,
vz., a second-order interaction of emphasis on integration and emphasis on specific detail and a third-order interaction of achievement press, achievement motivation and emphasis on specific detail. There was no evidence of an interaction of achievement press, achievement motivation and teacher emphasis on integration.

The interview data are most relevant to an interpretation of these results. Not only do the data demonstrate the effect of achievement press upon student learning but the data also indicate that students have different perceptions of the relevance of each of the learning goals to the Higher School Certificate examination. As a result it will be suggested that due to the perceived lack of relevance of the teacher's emphasis on integration to the Higher School Certificate examination there was no significant interaction of achievement press, achievement motivation and emphasis on integration on the Problems scale. The interview data will be used now to help explain each of these findings.

i) The effect of achievement press upon student learning

The effect of achievement press within the learning environment was evident throughout the research period. For example, those classes of low achievement press were characterised by low attendance rates, late coming to class, little homework being done and general apathy. In the interviews these classes were most often described as 'slack' and lacking teacher directiveness. The following comment was typical:

... it is really slack, you can take advantage of it, that's what everyone has been doing. We are supposed to do homework but we don't do it ... they [the teachers] don't care whether you are doing it or not and they say to us: "it's you who are losing out and not us" ... a teacher should be a bit persistent at you to do it (class no. 22).

Why did many students feel that teachers should be more persistent and more directive? Nearly all students interviewed from these classes indicated a concern that this lack of achievement press would be detrimental to their chances of success at the NSW Higher School Certificate examination (HSC). Students from classes of high achievement press agreed that such a prevailing classroom climate would most likely lead to increased academic performance at this examination. High achievement press, by increasing persistence and attention to academic work, was seen by most students
to be a precondition for successful performance on tasks such as the Achievement Test administered in this research program, and more importantly the HSC examination. The interview data then support the findings of the effect of achievement press upon student performance in the above analyses.

ii) The relevance of the learning goals to the Higher School Certificate examination

Academic performance at the HSC examination was also thought by many students to be related to the teacher's emphasis on specific detail. Students in classes rated low on the dimension teacher emphasis on specific detail often commented that their teacher should spend more time marking guide questions, test their knowledge of the textbook regularly, and only deal with material and activities directly concerned with the prescribed curriculum and especially the textbook. By so doing these students felt that their chances of success at the HSC examination would be increased. Further, it was found that those students in classes with a great emphasis on specific detail who expressed boredom with their teacher's presentation of the curriculum, nevertheless, justified their teacher's presentation on the grounds that it was orientated towards the final examination. These students had defined the form of biological knowledge to be evaluated at the HSC examination as requiring the retention of those specific details dealt with in the 'Web of Life' curriculum.

If indeed the teacher's emphasis on specific detail was perceived as being associated with academic performance on the HSC examination, how did the students regard the teacher's emphasis upon integration? Of those students found in classes rated high on

3 It was only in classes 2 and 20 that this was not the case, and it should be pointed out that both these classes were also rated high on the dimension teacher emphasis upon integration.

4 How might such a perception of the learning goals of the course have been developed? Recalling the comment made earlier that a student's expectations 'represent a reconstruction of past learning experiences in terms of the present learning situation', it is suggested that the Messel text upon which the School Certificate course of the previous year was largely based itself presented such a learning goal. One student contrasted both these courses: 'The "Web of Life" is a story book of relationships rather than old Messel's fact after fact after fact after fact' (no. 20).
this dimension, most said that the main aim of their teachers was
to create interest in biology and a knowledge of biology that would
be useful after they had left school.

This difference in the students' perception of each learning
goal is best seen in the following student's appraisal of the aims
of her teacher, a teacher who strongly emphasised the retention of
specific information but gave little emphasis on its integration
into the broader areas of knowledge:

She does everything so that we can pass the exam ...
all she is trying to do is to get you through the
Higher School Certificate, not trying to get you
interested in the subject or get you to learn
something from it that you will remember for life
(class no. 16).

It is this distinction in the students' perception of both
types of teaching behaviour which is most relevant to the inter­
pretation of the interactive effects observed in the analyses.

iii) An interpretation of the interactions of achievement
press, achievement motivation and goal specification
operative in the classroom

For students of high achievement motivation a strong
emphasis on specific detail would be congruent with their expecta­
tions of the form of teaching behaviour most likely to result in
academic success. Consequently they would be likely to have a
higher performance on the Guide Questions scale than students of
low achievement motivation, provided the achievement press of the
school was high. If, however, these same students were experiencing
a weak teacher emphasis on specific detail, then this lack of
congruence between their expectations of the form of teaching most
likely to lead to academic success and their actual classroom
experiences is likely to be frustrating and anxiety provoking.
Such an effect would result in a reduced performance, and one
possibly below that of students of low achievement motivation experi­
iencing similar conditions. Both these interactive effects were
supported by the results of Chapter 6.

With regard to student performance on the Problems scale the
lack of a significant interaction between achievement motivation,
achievement press and emphasis upon integration can be explained
by considering also the differences in student perceptions of
teaching behaviour noted above. As teacher emphasis on integration
was not associated with future academic success, the goal specified by such behaviour may be considered of low incentive value for those students of high achievement motivation. This would result in there being no significant difference between the performance levels of students at each level of achievement motivation when found in classes rated high on both teacher emphasis on integration and achievement press.

However, the significant interactive effect upon student performance on the Problems scale between achievement motivation, achievement press and teacher emphasis on specific detail is more difficult to interpret. Two explanations appear possible. Firstly, it could be considered that the retention of information found in the curriculum was necessary for the development of an integrated understanding of the curriculum. This is certainly suggested in the Teachers Guide (1973). However, because there was no main effect for teacher emphasis on specific detail, one would have to argue further that the retention of specific details was a necessary part of the accommodative activity that characterised the learning process of only those students with high achievement motivation. Secondly, it may be that this interactive effect is not directly related to the form of accommodative activity adopted by the student. Rather, it could be related to the affective state of the student prior to that accommodative activity. For it has been suggested that classes with little emphasis on specific detail may be anxiety provoking for students of higher achievement motivation. Alternatively, classes with a high rating on this dimension would be perceived by these students as more likely to lead to successful academic performance. Hence once students of high achievement motivation experienced an environment they thought likely to lead to academic success then the main effect of teacher emphasis on integration on their learning could become operative. Of these two possible explanations, I would suggest the latter is more probable, and that the former is inconsistent with the proposition, implicit in Chapter 4, that achievement-motivated behaviour is goal-directed rather than (cognitive) process orientated.

The most important consequence of these analyses has been the demonstration that achievement motivation can be meaningfully related
to academic performance provided that firstly, the achievement press of the school is seen as necessary for its arousal and secondly, that achievement-motivated behaviour is seen to be directed towards a complex of learning goals. For achievement-orientated behaviour as it commonly occurs in the classroom cannot be viewed simply as the acquisition of discrete, clearly definable learning tasks. The learning goals are better considered as an abstraction from those activities presented by the teacher and with which the student interacts: this the results demonstrate quite clearly. Yet the goals to which such achievement-orientated behaviour is directed represent a reconstruction of previous learning in the light of present learning experiences. This was most clearly shown in the interview data where a distinction was evident between the students' perceptions of the primary purposes of each of the learning goals under consideration. These issues will be returned to in the concluding chapter. For the moment it is necessary to consider those results that are directly relevant to a justification of the notions of cognitive readiness and 'learning as accommodative activity' that have been adopted in this study.

(c) **Cognitive readiness and the accommodation-assimilation model**

Central to the accommodation-assimilation model of learning has been the notion of cognitive readiness, which represents that set of pre-existing cognitive structures to which the curriculum is to be assimilated. Three distinct levels of cognitive readiness were proposed. These levels differ not only in the number of prerequisite concepts that have been directly assimilated to it but also in the organisational properties of the set of constituent cognitive structures considered as a whole. That is, the levels of cognitive readiness differ not only quantitatively but also qualitatively.

As already noted not all students directed their learning activities towards the goals specified by the teacher. The results of Chapter 6 indicated that for students of higher cognitive readiness the teacher's emphasis upon specific detail had a negligible effect upon their performance on the Guide Questions scale; on the other hand the specification of this learning goal had a positive effect upon students of low cognitive readiness. Evidence
was reported in Chapter 7 to suggest that the teacher's emphasis upon integration had a positive effect on student performance on the Problems scale for those students of high and intermediate cognitive readiness, and a negligible effect for those students of low cognitive readiness; this interactive effect itself was further modified by the prevailing teacher emphasis on specific detail. Each of these findings, together with related interview and observational data, will be considered in the following sections.

Students found in classes with a strong emphasis on the retention of specific detail often expressed boredom with the curriculum as it was presented. This appeared particularly so for students of higher cognitive readiness, although in the case of class no. 16 every student of that class was interviewed and volunteered an expression of boredom without being questioned specifically - the extent of this boredom is apparent in the following student's description of her learning experience:

... writing out all the questions and answers, and all that again, going into all the detail, you might know it but you have to write it out again to be handed in and that takes up all the time ... it's the dull routine ... it's knowing what we are to be doing day after day after day ... (class no. 16).

Generally, however, those students of low cognitive readiness expressed satisfaction with this learning goal specified by the teacher. This tendency was further supported when students found in classes with a weak teacher emphasis upon specific detail were interviewed. When these students were asked whether they were satisfied with their teacher's presentation of the curriculum, two types of responses were obtained. Firstly, most students of low cognitive readiness commented that there was insufficient direction given by the teacher, that insufficient notes were dictated to them; that there was too little emphasis placed upon the marking of guide questions and a general inability to understand the purposes of the course. No student of high cognitive readiness suggested that the teacher should dictate notes, that they would prefer to work through more guide questions in class, or more generally that they were dissatisfied with the teacher's lack of emphasis on the retention of specific detail. Both these types of responses were true of all except two classes, where all
students expressed dissatisfaction with their teacher's lack of emphasis on specific detail. These two classes were rated lowest on this dimension, which itself suggests that even for students of higher cognitive readiness there may well be some minimum level at which the teacher needs to emphasise the retention of specific detail.

The interactive effect\(^5\) between the student's level of cognitive readiness and the teacher's emphasis upon specific detail, supported by both the quantitative results and interview data, can be directly related to the accommodation-assimilation model used to explain student learning. It has been proposed in Chapter 4 that for students of low cognitive readiness learning would be largely non-integrative, resulting in the production of isolated elements of structure by which the curriculum was known. Consequently a learning environment characterised by a high emphasis on the retention of specific detail was an environment in which these students could intellectually cope, and the attainment of such a goal specified by the teacher could be considered satisfying to these students. Hence one would expect students of low cognitive readiness to perform significantly better on a test assessing knowledge of the constituent elements of the curriculum, such as the Guide Questions scale, when experiencing a learning environment characterised by a high emphasis on specific detail rather than one rated low on this dimension. On the other hand, students of higher cognitive readiness are capable of either a non-integrative or an integrative learning process, the latter resulting in a knowledge of the curriculum that is related to their more general knowing structures. The former learning process may be considered relatively easy for these students, and less satisfying. Hence the effect of teachers specifying a learning goal that requires students of high cognitive readiness to process information in a non-integrative way would not be

---

\(^5\) It would appear that this and the following interactive effect are relevant to the literature on education set (Siegel and Siegel, 1965) and cognitive preference (Heath, 1964; Tamir, 1976) and that the proposed accommodation-assimilation model of learning would be helpful in the explanation as to why students employ differing 'sets' or 'cognitive preferences'.
arousing, and hence would have little effect upon these students' performance on the Guide Questions scale.

The interview data revealed a different pattern of results when students commented upon the level of teacher emphasis on integration that prevailed in their classroom. For those classes where there was a high level of teacher emphasis upon integration two types of responses were represented. Again these were generally dependent upon the students' level of cognitive readiness. Most students of lower cognitive readiness stated that they could not see the relevance of much of the material dealt with in the class, and generally felt unable to cope with the learning goal specified by the teacher. Rather, they tended to see this learning goal more suited to the 'better' students. Indeed the student of higher cognitive readiness did tend to find this environment stimulating, often commenting that it was better than the 'traditional' methods. This difference in attitude, by students of differing cognitive readiness, towards the teacher's presentation of each of these learning goals under consideration is best expressed by the following student of low cognitive readiness:

... the practs ... you have to be hypothetical and I suppose if you've got brains this is pretty challenging and pretty good fun but if you're not really top of the class, a struggler, it's a bit hard trying to think out how things could happen ...

and on the course itself, this same student:

... it is just like general knowledge ... they may as well call biology English because you come to class and just have to do comprehension ... you don't learn any facts that would help you in an exam (class no. 15).

The interactive effect between the student's level of cognitive readiness and the teacher's emphasis upon integration can also be interpreted within the accommodation-assimilation model of learning. As pointed out in Chapter 4 students of low cognitive readiness are unable to construct a knowledge of the curriculum that is integrated with their general knowing structures; consequently the specification of an integrative learning goal would not be arousing for these students. However, students of higher cognitive readiness are able to direct their learning activities towards the attainment of an integrated understanding of the curriculum
which, as the interview data indicates, is highly satisfying to them.

Briefly, then, the interview data suggested a two-way interactive effect upon student performance on the Problems scale of both the students' level of cognitive readiness and the teacher's emphasis on integration. However, as the quantitative results indicate, this interactive effect was further modified by the degree to which the teacher emphasised the retention of specific details contained in the curriculum. This latter finding of a three-way interaction of cognitive readiness and both learning goals is important for it justifies the understanding of cognitive readiness that has been proposed; in particular, it supports the notion that each of the levels of cognitive readiness differ in their degree of structural stability. These findings will now be discussed.

Students of low cognitive readiness experiencing a weak emphasis on integration and a strong emphasis on specific detail scored significantly less on the Problems scale than when found in either of the remaining three types of learning environment rated on these dimensions. As argued above, these students were presented a learning goal which was congruent with their preferred mode of accommodative activity; however, that accommodative activity was incongruent with the development of a knowledge of the curriculum necessary to answer those questions comprising the Problems scale. Such a distractor produced a depressed level of performance. However, when also experiencing a strong emphasis on integration these same students were not so distracted but their performance level, while being somewhat higher, still remained generally low due to their lack of pre-existing structure with which to assimilate novel aspects of the curriculum.

The situation for students of intermediate cognitive readiness was quite different, and this was to be expected. For it was proposed that these students possess a set of pre-existing cognitive structures which, when considered as a totality, are in a state of disequilibrium. The results indicated that optimal performance for these students occurred when they experienced a learning environment characterised by a high rating on both emphasis on specific detail and emphasis on integration. Such a finding
suggests that these students could construct an integrated knowledge of the curriculum by first retaining specific details of the curriculum in the form of isolated structures, and then subsequently integrating these structures with their more general structures of knowing. This process is similar to that found in the transitional period of concrete to formal operational thought where the adolescent's set of formal operations is in a state of disequilibrium, and the adolescent is still dependent upon 'concrete' experience for the continued existence of these mental operations (e.g. Inhelder and Piaget, 1958).

Students of high cognitive readiness were described in Chapter 4 as possessing a stable set of cognitive structures by which the prerequisite concepts of the curriculum were known. For these students changes in the levels of teacher emphasis upon specific detail failed to produce significant changes in their development of a well-integrated knowledge of the curriculum. Such a knowledge of the curriculum was found, however, to be positively related to the teacher's emphasis on integration for those students found in conditions of low teacher emphasis on specific detail; however, this relationship was not evident for students of high cognitive readiness found in classes of high teacher emphasis on specific detail. This latter result is more difficult to interpret but it has been suggested already that the teacher's emphasis on the retention of details is itself a source of arousal for academic achievement. It may well be that this arousal compensates for the lack of goal specification at the low levels of teacher emphasis upon integration and encourages the student to higher academic performance. Because his preferred mode of accommodative activity is towards the development of an integrated knowledge of the curriculum this could result in the slightly increased performance on the Problems scale under these conditions.

It is the pattern of results that emerge from these analyses, rather than the results taken separately, that supports the proposition that the three levels of cognitive readiness differ not only quantitatively in their number of constituent elements but also qualitatively in their organisational properties. These results also support the proposition that students of both high and low
cognitive readiness possess a preferred form of accommodative activity. This latter proposition is further supported by those results examining the relationships between student performance and the interactions of cognitive readiness and both achievement press and achievement motivation. These will now be considered briefly.

The quantitative results support an interactive effect upon student performance on the Problems scale of cognitive readiness and achievement motivation; these results also provided some evidence of a significant interaction of cognitive readiness and achievement press upon student performance on this criterion. Students with high cognitive readiness scores performed better when they were of high achievement motivation or found in classes of high achievement press, compared to those who were of low achievement motivation or found in classes of low achievement press. There were no such differences evident for students of low cognitive readiness. Other things being equal, it would appear that for students of high cognitive readiness the effect of high achievement motivation would be to intensify that form of accommodative activity which is most satisfying to them, viz., an integrative learning process. As the results indicate this led to an increased performance on the Problems scale. A similar effect occurred when students of high cognitive readiness experienced a learning environment characterised by a strong achievement press.

This interactive effect just described contrasts markedly with that found when student performance on the Guide Questions scale is considered. In contrast to their performance on the Problems scale, students of low cognitive readiness found in classes with a strong achievement press performed better on this scale than did those found in classes of low achievement press; there appeared no significant differences for students of high cognitive readiness. Again the effect of achievement press upon the student's learning activities is evident: those students of low cognitive readiness would be more likely to be persistent and attentive in that form of accommodative activity to which they are better suited. This would result in an increased performance on the Guide Questions scale. However, the lack of a significant
interactive effect between cognitive readiness and achievement motivation on this task is more difficult to interpret. It may well be that students of low cognitive readiness feel that academic work is beyond their capabilities, particularly if they are of high achievement motivation. This would result in them diverting their attention to those activities in which they were able to excel and away from academic tasks in which they may have a history of failure.

Two sets of interactive effects have been examined in this section. The first considered the interactions between cognitive readiness and the learning goals specified by the teacher; the second considered the interactions of cognitive readiness and both achievement press and achievement motivation. The overall pattern of results that emerges from an examination of these possible interactive effects upon student performance strongly supports the cognitive theory on which this study is based. A further aspect of this theory was the concept of intrinsic motivation and its subsequent arousal. Results associated with the intrinsic-motivated model of learning will now be discussed.

II The Intrinsic-Motivated Model of Learning

Underlying the intrinsic-motivated model of learning were two central ideas. The first, and one derived from the interactive perspective implicit in Piagetian literature, was the notion that intrinsic motivation is a consequence of cognitive conflict arising from the interaction of the individual with novel aspects of his environment. The second, and one this time derived from the equilibratory model of cognitive development, was the idea that the student's level of cognitive readiness was an essential element in the generation of cognitive conflict and the continued maintenance of such conflict until a meaningful resolution could occur. The results of Chapters 6 and 7, as well as pertinent interview and observational data, will now be discussed in relation to both these aspects of the proposed intrinsic-motivated model of learning.

(a) Intrinsic Motivation and its Arousal

In Chapter 4 it was proposed that learning based upon intrinsic motivation leads to the construction of an integrated understanding of the curriculum, provided that the environment is
sufficiently arousing and that the student is interested in the particular subject area. The results of Chapter 7 are relevant to this proposed 3-way interaction. These analyses failed to support an interactive effect upon student performance on the Problems scale between intrinsic motivation, facilitation of intrinsic motivation and interest in biology. Rather, only a main effect due to intrinsic motivation was apparent, and this was subsequently seen to be modified by the student's level of cognitive readiness. An equivalent set of analyses were also reported in Chapter 6, using student performance on the Guide Questions scale as the criterion. Again there was no significant 3-way interaction; however, there was a main effect upon performance due to the student's level of interest in the subject. Since this latter scale was not assessing an integrated understanding of the curriculum but rather a knowledge of its constituent elements, this finding was not unexpected. For the moment the differing effects of intrinsic motivation and interest in biology should be noted as these will be discussed shortly. Of immediate concern, however, is the question of why the environmental variable, facilitation of intrinsic motivation, failed to have an effect upon the student's construction of an integrated knowledge of biology. An examination of both the observational and interview data will be useful in this regard.

Already it has been concluded that most students built up a set of expectations of those contents and boundaries of biological knowledge that they thought would be acceptable to their teachers; only in the case of classes 20 and 27, which both received the highest rating on facilitation of intrinsic motivation, did the majority of students feel that they were given intellectual freedom to develop their own ideas and solutions to problems. Yet it was argued in Chapter 4 that the arousal of intrinsic motivation was facilitated by the intellectual freedom of the student to 'seek out conflicting instances of experience and to resolve such conflicts in an integrative manner'. When students were asked whether there was the opportunity in their class to explore topics, etc. which they found particularly interesting, the consensus of all classes in the sample was negative. No such opportunity existed. Evidently, while classes 20 and 27 were allowed a great
degree of intellectual freedom in their development of ideas, they too felt restricted in the areas to which such freedom might be applied. This restriction was particularly evident when students in each class were asked whether all class members did the same problems, guide questions and practical exercises. While students of class 20 were not required to do guide questions, students of both classes agreed that all class members were required to do the same activities and generally at the same time. The observational data further indicated that almost all students in the total sample did the same prescribed exercises and that it was only in classes 20 and 27 that variations to these prescribed activities occurred. The following comment, from a student of class 20, was quite rare:

...[the teacher] wants us to develop our own ideas, to become good scientists, she likes us to construct hypotheses and see how they can be tested ... keen on scientific method ... with some experiments she wants to know how it could be changed, how the results would be different ... and often we try it... (no. 20).

Rather, the majority of students perceived their course in the following way:

It's not a sort of inspiring course ... a lot of work to get done by a certain time, you really want to think about other things and use reference materials, you usually have a couple of chapters going at the same time and it's virtually just the guide questions, problems and the exercises and you have to get through those and there is no opportunity to do anything else (class no. 24).

I would argue that such a uniformity of activities indicates that the learning environment was not responsive to the intellectual needs of each student, a prerequisite already noted in Chapter 4 for the arousal of intrinsic motivation.

It was often the students of higher cognitive readiness who expressed dissatisfaction with both the uniform and restrictive nature of the curriculum presented by their teacher. Students of higher cognitive readiness tended to also criticise two further aspects of the learning environment which are relevant to the discussion:

1) the majority of these students said that the nature of the laboratory manual was such that they found the practical exercises anything but challenging. The series of questions contained within
these exercises were generally quite simple, needing little interpretation, and able to be answered without the experiments being done. For example, the following student of higher cognitive readiness remarked at the conclusion of one laboratory exercise:

We knew from the start exactly what was meant to happen, it therefore lost a lot of interest ... in most of our experiments we know what is meant to happen and we can rig the experiments if we wish, and just write down what we were meant to have done (class no. 19).

Consequently as a source of conflict generation and subsequent arousal of intrinsic motivation the practical exercises can be considered deficient. While most students appeared to be active in the laboratory, such activity was not of the sort likely to generate cognitive conflict and lead to an integrated understanding of the curriculum. For such learning to occur, as has been discussed in Chapter 2, 'activity' must involve the student in co-ordinating, reorganising and integrating abstractions as he operates upon his environment. 6

ii) this group of students often commented that the rigid adherence to the set school program prevented them from becoming interested in particular topics and trying to resolve problems that arise in a meaningful way. Of those students of higher cognitive readiness who were interviewed, the students who scored highest on the intrinsic motivation scale felt most restricted by the school organisation. One such student expressed her feelings quite frankly:

You are told to do something, and you have to get it done in a set time, and crap if you can't get it done because you have to go somewhere else, stop the experiment half-way through and finish it later, you have to stop your calculations half-way through, stop whatever you are doing, change your whole train of thought to whatever subject you are doing next (class no. 21).

6 The review by Shulman and Tamir (1973) is relevant. These authors have argued that the practical exercises in the American version of B.S.C.S. leave the student little opportunity to arrange his own learning experience. Of 62 exercises analysed, only four exercises of the B.S.C.S. blue version were found by Heron reported in Shulman and Tamir (1973) to pose a problem to students in such a way that the student could choose his own methods of solving the problem; further, of these 62 exercises, 45 were written in such a way that not only were the methods of solving a given problem given to the student but also the answers themselves.
Apparently, even if cognitive conflict was generated in the minds of the students of higher intrinsic motivation, school organisational properties such as timetables, etc. often led to early or premature resolution of such conflicts.

An examination of both the interview and observational data suggests that while it was possible to rate the learning environments on the dimension facilitation of intrinsic motivation, the levels of intellectual freedom, etc. that prevailed in classes rated 'high' may themselves have been insufficient to lead to intrinsic-motivated behaviour. Further, a study of the class consensus scores on the classroom perception scale 'facilitation of intrinsic motivation' supports this conclusion. Reference to Appendix 5.8 shows that for no class was there a consensus that the curriculum presentation was likely to lead to the arousal of intrinsic motivation.

A lack of sufficient 'facilitating' properties of the learning environments may then be a possible explanation of why there were no interactive effects upon student performance on the Problems scale, between either intrinsic motivation, facilitation of intrinsic motivation and interest in biology or intrinsic motivation and facilitation of intrinsic motivation, detected in the analyses.

Yet one analysis indicated that the teacher's presentation of the curriculum in a manner likely to arouse intrinsic motivation did, in fact, influence the learning activities of the students. The results of Chapter 6, p.117 demonstrated that facilitation of intrinsic motivation correlated highly with the students' presentation of novel examples to one of two questions contained in the Guide Questions scale. It was noted that the biological concept of adaptation being tested in that question was far more readily generalisable than the biological concept of diffusion being tested in the question where no such correlation was obtained. It may well be that the properties of the learning environment were sufficiently 'arousing' for the development of an integrated knowledge of certain simpler concepts. However, information that generated a greater degree of conflict, in this instance information related to diffusion, required a learning environment which allowed greater opportunity for the meaningful resolution of such conflict. Such an opportunity was not characteristic of the
learning environments in this sample. Consequently, before such a concept could become integrated into the students' broader areas of knowing, early resolution would have typified the learning process.

It was suggested in Chapter 4 that the extent to which the student will maintain and resolve cognitive conflict in an integrated manner will also be dependent upon his level of cognitive readiness. The results relating to this second aspect of the intrinsic-motivated model of learning will now be discussed.

(b) Cognitive readiness and the intrinsic-motivated model of learning

Central to the intrinsic-motivated model of learning was the proposition that when information to be processed by the student is extremely discrepant with pre-existing structure then the student seeks early resolution of conflict; however, when such information is only moderately discrepant conflict might be tolerated, depending upon both the student's level of intrinsic motivation and its subsequent arousal, until such information is meaningfully integrated. It was this general proposition that guided the analysis of Chapter 7, pp. 135-39.

While there was no significant 3-way interactive effect upon student performance on the Problems scale with cognitive readiness, intrinsic motivation and facilitation of intrinsic motivation, there was a significant interactive effect upon student performance on this criterion with cognitive readiness and intrinsic motivation. Of those students of higher cognitive readiness, students of higher intrinsic motivation performed significantly better than did those of lower intrinsic motivation; no such differences existed for students of either intermediate or low cognitive readiness. It is this result which is not only important in establishing the relationship between cognitive readiness and a learning process based upon intrinsic motivation but also in establishing the nature of intrinsic motivation as a cognitive processing variable. For this result must be contrasted with those relating to interest in biology. Firstly, those results indicated a main effect for interest in biology upon student performance on the Guide Questions scale; secondly, some evidence was presented to suggest that for students of higher cognitive readiness their level of interest in biology was related to their performance on the Problems scale.
The differential effect of intrinsic motivation upon student performance, such that it was only directly associated with performance on the Problems scale, supports the proposition that intrinsic motivation is implicit in the equilibratory process of cognitive development. Since this process results in the formation of an integrated knowledge of reality, in this instance concepts contained within the curriculum, then one would not expect intrinsic motivation to be related to the students' development of isolated structures of knowing. The results of Chapter 6 support this expectation. In contrast, the student characteristic interest in biology was less closely associated with a particular form of accommodative activity that the students might adopt. Interest in biology influenced both the students' construction of a knowledge of the constituent elements of the curriculum and for students of higher cognitive readiness the integration of these elements into the students' more general knowing structures. These results are congruent with the notion that interest in the subject matter interacts with the students' learning processes by increasing the students' attention to the information required to be assimilated. This interest in the information per se rather than necessarily the inherent relationships within that information would result in a main effect upon student performance on the Guide Questions scale. And for those students of higher cognitive readiness whose preferred form of accommodative activity is of an integrative type, as evidenced by the interview data, such a focusing of attention would result in heightened performance on the Problems scale. Both these expectations were supported by the results.

The interactive effect of cognitive readiness and intrinsic motivation supports the guiding proposition that if meaningful learning is to occur the degree of conflict generated by the information assimilated must not be so intense as to result in early resolution. Where such conflict was not intense, as in the case of students of high cognitive readiness, the students' level of intrinsic motivation determined the extent to which the conflict

---

7 In contrast one would expect students of higher intrinsic motivation to be more interested in the relationships inherent within the information.
would be maintained. This is theoretically important for it justifies the conceptualisation, in Chapter 4, of intrinsic motivation not being a necessary property of cognitive structures but that it represents a readiness to engage in a particular form of information processing. This point should be merely noted for the moment for it will be reconsidered in the concluding theoretical chapter.

The lack of an interactive effect upon student performance on the Problems scale of intrinsic motivation and the relevant environmental variable poses a problem however for the theoretical interpretation of intrinsic motivation presented in Chapter 4. For if one argues that the learning environment was generally low in 'arousal' properties for intrinsic motivation, as was one in the previous section, then one would not expect the above interactive effect of cognitive readiness and intrinsic motivation to occur at all. The interactive perspective adopted in this study suggested very strongly that the cognitive processes involved in intrinsic-motivated behaviour are aroused by the generation of cognitive conflict which, in turn, is facilitated by particular properties of the learning environment. Hence, if that environment did not facilitate the arousal of intrinsic-motivated behaviour then differences in the students' levels of intrinsic motivation would not be expected to result in differences in the students' development of an integrated understanding of the curriculum. However, the results indicated that this was not the case. Two explanations are possible. Firstly, students of high intrinsic motivation may apply such cognitive processes in their everyday interaction with their environment, regardless of the 'arousal' properties of that environment. Secondly, the general level of applying such processes in assimilating information may be further increased by the degree of intellectual freedom and general responsiveness of that environment; however, due to the low 'arousal' properties of the learning environments in this sample no such increase occurred. In either case, students characterised by a high level of intrinsic motivation would tend to generate cognitive conflict more often, maintain such conflict for a longer time, and resolve such conflict in a more integrative manner than students of lower intrinsic motivation, when found in equivalent
learning environments. The nature of the interaction of the intrinsic-motivated student and his environment will be reconsidered in the following chapter.

In conclusion, the results of Chapter 7 supported both the general accommodative-assimilation model of learning and the proposed cognitive processes of intrinsic-motivated learning. In particular, they have supported the role of optimal cognitive conflict as being an essential element in this learning process and differentiated between the student characteristics of interest in a subject area and intrinsic motivation. However, the failure of the results to detect a significant effect of the environmental variable facilitation of intrinsic motivation upon the students' construction of an integrated knowledge of the curriculum suggests that intrinsic motivation may be considered more a cognitive strategy that typifies a student's everyday interactions with his environment, rather than a predispositional property of the student that needs to be aroused by that environment. This contrasts markedly with the nature of the interaction between the individual and the environment that characterises achievement-orientated behaviour.

In the concluding chapter the underlying theoretical orientations of the study will be re-examined in the light of the discussion of results presented in this chapter.
A model of school-based learning has been proposed that represents a synthesis of both cognitive and social aspects of knowledge construction. Learning was defined in this constructivist framework as accommodative activity and in a manner largely derived from Piagetian theory. However, Piaget's is a developmental theory and not one of learning and consequently its applicability to an understanding of school-based learning was seen to be an indirect one. For example, in Chapter 2 it was noted that Piaget considered the dynamics of each to be quite different. Development is a spontaneous affair, resulting from intrinsic motivation and directed towards the integration of a set of cognitive structures by which 'everyday' experience is known; learning was considered more contrived, whose source of motivation is extrinsic to the learning activity and directed towards the construction of isolated structures by which the individual knows specific details about his experience. However, it was concluded that such a distinction is an unnecessary one and that learning may result in an integrated knowledge of experience, in this instance a curriculum, utilising either student motivation extrinsic to the learning activity itself or intrinsic to that activity. Of course this was not meant to deny the possibility of a form of learning activity similar to that originally envisaged by Piaget. The purpose of the initial section of this chapter will be then to review, in the light of the previous discussions of Chapter 8, the implications of the cognitive theory examined in this work for Piaget's distinction between learning and development. In so doing those aspects of Piagetian psychology that are most applicable to an understanding of school-based learning will be clarified.

The second section of the chapter will reconsider the overall interactive perspective adopted in this study. In particular, it will focus on an understanding of the relationship between the student and his learning environment as he exhibits either intrinsic-motivated or achievement-orientated behaviour. For in
the first chapter it had been suggested that there are various meanings of interaction that may characterise an individual's relationship with his environment; consequently, one must consider whether the research findings and the subsequent discussions of them are congruent with the meanings of interaction attributed to both forms of behaviour in that chapter.

I. Learning and the Construction of Knowledge

The basic Piagetian thesis that it is the accommodation-assimilation process of action that unifies the person with his environment, and out of which the person constructs his knowledge of the world, was evident in the fundamental role played by cognitive readiness in student learning. This is best seen in the previous discussion of the differential effects of teachers specifying different learning goals for students of different levels of cognitive readiness. Such results could only be interpreted within a constructivist framework, whereby novel aspects of the curriculum were assimilated into pre-existing structure, which in turn determined the form of accommodative or learning activity necessary for their integration. For some students two learning activities, or forms of cognitive actions were required; the first involved the construction of fairly isolated structures of knowing and the other an integration of those structures with pre-existing structures. For other students only the second form of cognitive action was necessary for the development of an integrated understanding of the curriculum.

Is not the distinction between these two forms of cognitive action similar to Piaget's distinction between action in physical experience and action in logico-mathematical experience, the former resulting in a knowledge of the properties of an object and the latter of the inter-relationships between those properties? (Beth and Piaget, 1966; Piaget, 1970). The analogy is certainly there. The student's construction of a knowledge of the details of the curriculum, I would suggest, requires a direct focusing upon individual contents of that curriculum. On the other hand, an integrated knowledge requires an abstraction of relationships between different contents and the co-ordination of such relationships. This similarity of the integrative learning process with 'acting in logico-mathematical experience' is evident in Piaget's
description of this latter process: 'acting in logico-mathematical experience is acting upon objects, but the processes of abstraction by which their properties are discovered are directed, not to the objects as such but at the actions that are brought to bear on the objects' (Piaget, 1970).

Now by arguing that students were able to learn by abstracting and co-ordinating relationships, in a manner similar to that suggested by Beilin (1971), one is, of course, proposing that the structural processes involved in an integrative knowledge of the curriculum are similar to those characteristic of development in Piaget's account. This is in keeping with three further aspects of the earlier discussions:

(i) The finding of a relationship between the students' level of intrinsic motivation and the construction of an integrated knowledge of the curriculum, rather than a knowledge of its constituent elements, is important in regard to the Piagetian distinction between learning and development. For by demonstrating such a differential effect of intrinsic motivation upon student learning activities, the results indicate that as a construct intrinsic motivation is analogous to the form of motivation which Piaget proposes to be operative in development. Consequently a distinction between learning and development based upon the presence or absence of intrinsic motivation as a source of structural change would appear to be inappropriate. Is one justified then in differentiating between learning and development by the presence or absence of extrinsic motivation, in this instance achievement motivation, as a source of structural change? This question is more difficult to answer. For while achievement-orientated behaviour may be directed towards an integrated knowledge of the curriculum, it may well be that the person's knowledge of his everyday experience, including such concepts as space, distance and time, is typically constructed out of a process similar to that underlying intrinsic-motivated behaviour. The lack of success in accelerating the development of 'conservation' by use of extrinsic reinforcement would suggest this to be the case.

(ii) Those structures derived from learning appear to be interrelated in a manner similar to those derived from development. Piaget (1964), by proposing that school-based learning results in 'isolated fragments in the mental life of the child' suggests that
organisational properties characteristic of structures 'developed' would not be characteristic of structures 'learnt'. But this was not found to be the case. The finding of an interaction of cognitive readiness and the learning goals presented by the teacher upon student performance on the Problems scale was interpreted as an indication that there were differences in the stability of the set of prerequisite structures that characterised each level of cognitive readiness. This is consistent with the view that cognitive readiness possesses organisational properties when taken as a whole, similar to that of structures developed, and is not reducible to a summation of constituent elements.

(iii) Finally, the form of accommodative activity that characterised the student's construction of an integrated knowledge of the curriculum, both by means of achievement-orientated and intrinsic-motivated behaviour, typified those cognitive processes characteristic of the equilibratory model of development. As already noted, this was evidenced by differences in the learning activities of students of low, intermediate and high cognitive readiness that were conceptually quite similar to those of adolescents at each stage in the transition from concrete operational to formal operational thought (e.g. Inhelder and Piaget, 1958).

I would argue then that the Piagetian model of cognitive development is appropriate for the interpretation of the processes characterising classroom learning, and in a manner far broader than has been proposed by those Piagetian psychologists such as Furth, Wachs and others who are actively involved in education. Is this meant to indicate that those structures resulting from school-based learning are equivalent to those developed during a person's 'everyday' interactions with his environment? Piaget (1964) has suggested that one must examine both the stability and generality of structures that result from learning, for it is on the basis of these properties that they may also be differentiated.

Piaget (1964) maintains that once a structure has developed, 'once it has reached a state of equilibrium', it will continue throughout the individual's life; however, structures 'learnt' will not be stable. Now just as it was possible, in Chapter 2, to differentiate the content from the relational (i.e. operational)
aspect of structures developed, it is possible to do likewise to structures learnt. It is suggested that the content aspect of learning is relatively unstable and that the relational aspect will be more enduring; this will be true so long as the student is interacting with an environment in which such relationships may act as a source of assimilation. While the instability of content is certainly congruent with the Piagetian interpretation of it, the suggested stability of the relational aspect of learning is not. However, a second paper (Piaget, 1972b) proposes that those aspects of the environment to which an adolescent may apply formal operational thinking must be of 'vital interest' to that individual, and hence aspects in which he is constantly interacting. And is not this close association between the existence of formal operational thought in a discipline and an individual's interest in that discipline similar to the above proposal that the continued existence of the relational aspects of structures 'learnt' in a subject area are dependent upon the continued interaction with that subject area?

How much generalisation is possible with concepts that are learnt? Here the property of generalisation is derived from the tendency of cognitive structures to 'extend their field of application'. Perhaps more clearly it is identifiable with the extensive property of a known concept. It has already been noted that the degree of generality of the students' concept of adaptation was greater than that of their concept of diffusion. Further, it would be expected that concepts 'developed' such as time and space would exhibit even greater generalisations. One can also speak of the relationships inherent in such concepts as diffusion and adaptation, that is, their intensive properties, exhibiting varying degrees of generality. What then of the operations inherent in those concepts that are developed? Certainly they are more generalisable. But whereas Piaget would argue that they are completely generalisable the restricted field of application of formal operations has already been commented upon. I would suggest that diversity of application as a feature distinguishing between those structures 'developed' and those 'learnt' is one of degree rather than being the sole property of the former.

It would appear that the differences between cognitive structures 'developed' and 'learnt' are not of a qualitative nature but rather
reflect the greater degree of interaction of the individual with his environment in the construction and maintenance of those structures that arise in the normal course of development. And it is for this reason that as a model the Piagetian theory of cognitive development has proved so useful in the interpretation of student learning in this study.

It is now appropriate to summarise briefly the contribution made by the Piagetian literature to an understanding of school-based learning which emerges from the previous discussions. Most importantly, this literature suggested the conceptualisation of learning within an accommodation-assimilation model. In so doing, it suggested that learning as accommodative activity may result in either the construction of an integrative set of knowing structures or else a set of isolated structures by which the curriculum is known. Thirdly, the role of pre-existing cognitive structures was seen to be fundamental to the form of accommodative activity which characterised the student's learning processes, so emphasising the restrictive nature of interaction. And it was the Piagetian literature on structuralism which suggested the three distinct levels of cognitive readiness, based upon not only the number of prerequisite concepts that could be directly assimilated to it but more importantly, from a theoretical point of view, the organisational properties within that set of cognitive structures. Finally, there is implicit throughout the literature the often overlooked, yet fundamental, integrative relationship between the various bodies of knowledge that the individual possesses.1 However, certain concepts discussed in the Piagetian literature were found to be theoretically deficient in their

---

1 Rarely does Piaget discuss the nature of the relationship between various bodies of knowledge. Yet his intention is quite clear: '... the third kind of equilibrium in cognitive development appears to be fundamental. Little by little there has to be a constant equilibrium established between the parts of the subject's knowledge and the totality of his knowledge at any given moment. There is a constant differentiation of the totality of knowledge into the parts and the integration of the parts back into the whole. This equilibrium between differentiation and integration plays a fundamental biological role' (Piaget, 1972c).
applicability to an understanding of school-based learning. Intrinsic motivation was one such concept; another was the role of social experience in cognitive development. Others could be considered contrary to its understanding. The Piagetian distinctions between development and learning between form and content and between species-specific and individual-specific experience have already been discussed in Chapter 2 in this regard.

Yet it is its supposed inability to cope with individual differences which has, in the past, presented the greatest limitation in applying the Piagetian literature to classroom practice. I would suggest, however, that this literature is directly relevant to an understanding of why particular students adopt particular learning activities and construct a particular knowledge of their curriculum. Indeed it does present a suitable model for the interpretation of individual differences, but only with regard to structural aspects of the learning process and not its social or motivational qualities. In contrast it has been the motivational aspect, where it is theoretically most deficient, that has been most applied to educational practice. This has generally been done without due regard for individual differences at the structural level, upon which intrinsic-motivated behaviour is dependent. This has resulted in an emphasis upon student interaction with concrete experience to the neglect of student reflection and the intellectual processes of abstraction and generalisation. In this regard the teacher's presentation of the 'Web of Life' curriculum in this study has been typical.

However, what is suggested by this study is that the necessity of concrete experience for the arousal of intrinsic-motivated behaviour is very much dependent upon student levels of pre-existing cognitive structures. Certainly, by adolescence much of what might be considered 'concrete' experience is better regarded as the ideas and understandings which characterise their thinking. And it is from these ideas that cognitive conflict may be generated out of social interaction and upon which reflective abstraction might occur.

This concludes an examination of the appropriateness of the Piagetian literature to classroom learning in the light of the present study. The following section will focus on the overall interactive perspective adopted throughout this work. Of course,
such a perspective is implicit in Piagetian psychology but it was also seen in Chapter 1 to underlie the social aspect of knowledge construction, the needs-press model of human behaviour and the concept of intrinsic motivation.

II The Interactive Perspective and Learning

The interactive perspective described in the first chapter concluded by suggesting that there were three possible understandings of the term interaction, of which two are of interest in the present review. The first of these was an understanding of interaction as the combination of two conceptually independent systems such as the motives of the individual and the arousal properties of the environment. The second was an understanding of interaction in a constructivist sense where the individual actively constructs a knowledge of his environment, a process whereby the individual and his knowledge of the environment are conceptually interdependent. It is against these understandings of interaction that the previous discussions of Chapter 8 will be interpreted.

Both the theories of Murray (1938) and Beswick (1971) suggested, in turn, that achievement-orientated and intrinsic-motivated behaviour arose out of the student's interaction with his learning environment. However, the previous discussion of Chapter 8 suggests that there is a fundamental distinction between both these forms of motivation and the meaning of interaction implicit in each. For while achievement motivation was seen to operate very much within an interactive framework of the first type described above, intrinsic motivation was not so conforming, and was seen to act independently of those properties of the learning environment most relevant to its arousal. Is then an interactive perspective appropriate to a study of intrinsic-motivated behaviour?

Two theoretically important consequences of the results relating to the role of intrinsic motivation in student learning have been noted. Firstly, the results justified the change in our understanding of intrinsic motivation from the early Piagetian notion of it being a necessary property of cognitive structures, whereby these structures 'once generated by functioning perpetuate themselves by more functioning' (Flavell, 1963). Instead they supported the more recent understanding of intrinsic motivation as
representing certain cognitive behaviours that individuals may possess. As Beswick (1971) suggests, these behaviours lead to seeking novelty, coping with conflict and assimilating new information in an integrative manner.

Secondly, the results deepened our understanding of the arousal of intrinsic motivation. For they indicated that intrinsic-motivated behaviour could occur even in a learning environment which was not likely to facilitate the generation and maintenance of cognitive conflict. This emphasised that the source of arousal for intrinsic motivation lies in the generation of conflict within the knowing structures of the person and not within the learning environment itself. Intrinsic motivation did not appear to act as a motive in the same way that achievement motivation acted.

These findings are very much in keeping with Ausubel's (1971) dissociation of cognitive drives such as intrinsic motivation from traditional motivational theory, and the suggestion that the intrinsic-motivated individual is one who prefers to process information in a particular way. Intrinsic-motivated behaviour then becomes a preferred cognitive strategy that the individual applies to his environment as a typical means of knowing that environment. By 5th form of high school one might expect such a cognitive strategy to have been stabilised to the extent that only under highly aversive conditions might the student not apply such a strategy to those areas that are of interest to him. At one point Beswick (1974) in discussing its development suggests such a possibility: 'it is not unreasonable to expect that strong habits could be formed that would increase, prolong and resolve cognitive conflicts'.

How then might one regard the intrinsic-motivated student's interaction with his environment? If it is true that the intrinsic-motivated student is more likely to seek out novelty, etc. then one would expect such behaviour to influence his knowledge of the learning environment which he constructs. And indeed this was the case. Students of higher intrinsic motivation were found to be more perceptive of novelty and the opportunity for intellectual freedom in the teacher's presentation of the curriculum. It would appear that while intrinsic motivation may be thought of more as
a trait than a motive, this does not preclude the possibility of
the student interacting with his environment in a manner closer
to the second understanding of interaction described above.

In contrast, the understanding of interaction that character­
ised achievement-orientated behaviour was closer to the first
understanding, this form of behaviour remaining within the needs­
press framework of interaction as originally envisaged by Murray
(1938). But the analyses did add to our understanding of how
Murray's needs-press model can be applied to the classroom situation.
It has already been noted in Chapter 3 that attempts to apply such
a model to an explanation of academic performance have generally
been disappointing, as have been attempts to modify and/or
elaborate the basic theory. However, by placing greater emphasis
upon the goal to which learning was to be directed than is found
in these earlier studies, the needs-press model of achievement­
orientated behaviour seemed better able to explain differences in
the academic performance of the student sample.

Campbell's (1973) conceptualisation of academic motivation
comes close to this model. In particular, those aspects of it
relating to sense of success, difficulty level and the incentive
value of success were found to be fundamentally correct. Just
as the individuals were seen in Atkinson and Feather's studies to
be assessing their chances of success in laboratory-type tasks,
so too the students were seen to be assessing their chances of
success at attaining particular learning goals, based upon both
previous learning experiences and perceptions of their ability to
attain such goals. Yet the emphasis upon the goals is even
greater in this study than is found in Campbell's paper. For it
has attempted to define what some of these learning goals that
operate in the classroom might well be. And it is this definition
of the learning goals which characterise the typical teacher-taught
relationship, and their subsequent effects upon achievement­
orientated behaviour, that increases our understanding of how the
needs-press model can be applied to school-based learning.

Achievement-orientated behaviour, aroused by the 'pressive'
conditions of the environment and directed towards learning goals
specified within that environment, is clearly representative of the
first understanding of interaction. But do the two sytems, the
individual and the environment, in fact remain conceptually independent as was suggested in the first chapter? It would appear not.

Firstly, it will be recalled from Chapter 5 that students under certain conditions tended to construct a knowledge of the 'pressive' characteristics of their learning environment that was dependent on the students' level of achievement motivation. Stern (1970) has described such a finding as a 'projection effect' and argued, as does Gardner (1975), that if such a process occurred it would raise doubts about the validity of students reporting environmental characteristics. Both Stern's and Gardner's objection is methodological and based upon their attempts to measure 'objectively' the students' learning environments. But no such claim has been made for the measurement of each of the environmental dimensions examined in this study. Rather such a projection effect was to be expected. Murray (1938) himself comments that 'the organism frequently seeks for a certain press'. Consequently if the class consensus is that the environmental conditions are indeed 'pressive' then one would expect those students who 'frequently seek for [that] certain press' to construct a different, and more pressive, knowledge of that environment than students who do not seek out such an environment.

Secondly, the incentive value of the learning goal was found to be a function of both the students' previous learning experiences and their perceived ability to attain that goal. Clearly the student and the environment, in this instance the goal to which learning was to be directed, could not be considered conceptually independent. Rather, the specification of learning goals, as well as their attributes such as incentive value, could only be interpreted within the constructivist understanding of interaction, and one incorporating both cognitive and social aspects. It is this latter feature of achievement-orientated behaviour which will now be briefly related to the interactive perspective of the initial chapter.

Central to the ideas expressed in Chapters 1 and 3 is the notion that the interaction between student and teacher is largely governed by a complex of rules and norms of which both are aware. One of these, implicit in the writings of Bernstein and others, is the teacher's role of defining the contents and boundaries of
what constitutes legitimate knowledge, or knowledge to be evaluated. Such an understanding of the relationship between teacher and student was clearly supported throughout the previous discussions. Students in this study did build up a set of expectations as to what were the intentions implicit in the actions of their teacher, and it was this set of expectations which largely guided their learning activities. And this is precisely what Silverman (1974) was proposing when he said that the meanings one assigns to situations have particular implications for action.

It was suggested in the works of Berger, Luckmann and others that those expectations would represent a product of past learning experiences reinterpreted with that of the present. This basic idea of the student reconstructing his present learning experience in terms of previous experiences was most evident in the students' association of a knowledge of details of the curriculum with prospective academic success at the Higher School Certificate examination; an integrated knowledge of the curriculum was associated more with an interest in the subject area. Such an association was derived primarily out of previous learning experiences where the form of knowledge that had been evaluated was of a factual type. As a result, those aspects of teacher behaviour related to the specification of a learning goal of a factual nature were found to be more salient by most students.²

The students' perception of the teacher's role of defining the goals to which learning is directed, and the subsequent student construction of a knowledge of what those goals might be in terms of both present and past learning experiences, best represents the synthesis of both the social and cognitive features of interaction implicit in the achievement-orientated model of learning.

The previous discussions of Chapter 8 have now been related

² Such was the case also with Best's (1974) study of biology classes in South Australia where she found that students generally perceived a greater demand for memorisation than was intended by their teachers. This close association between the knowledge of factual information and academic success was also evident in Tisher and Power's (1974) Queensland study where they found, using the Class Activities Questionnaire (Steele et al., 1971), a factor they termed 'cramming' which included two items 'concern for grades' and 'emphasis on memorising' - there was no relation between concern for grades and emphasis upon higher cognitive processes.
to the interactive perspective outlined in Chapter 1. The constructivist understanding of interaction, already evident in the Piagetian interpretation of the learning process at the structural level, was appropriate in both the intrinsic-motivated and achievement-orientated models of learning. The students' construction of a knowledge of their learning environment was seen in both cases to be related to their levels of motivation. However, the relationship between the student and his environment in each of these forms of behaviour differed in one important way. The source of arousal of achievement motivation remained a property of the students' learning environment. On the other hand, the source of arousal of intrinsic motivated behaviour was the generation of cognitive conflict as the student processed information derived from that environment.

It is the overall usefulness of this interactive perspective which suggests an alternative approach to research into school-based learning to that which has generally applied over the last decade or so in Australia. In the study of teacher behaviour emphasis should be moved away from detailing the elements of that behaviour to an interpretation of it within a social-cognitive framework. In so doing the forms of evidence that are accepted by the research body will need to be more diverse than is currently the practice. This is not meant to indicate the removal of any one form of research technique and its replacement with another, as would appear to be the case with those researchers applying an ethnomethodological approach to classroom analysis. What is suggested is that by use of a variety of techniques greater reliance can be placed upon the researcher's ability to describe the learning environment as perceived by both teachers and students. But in the final analysis it will always be the researcher who makes the relative judgements, etc. and not the measuring instruments per se.

What then of the reliability of these judgements? The reliability, as well as the validity, will be very much dependent upon the overall design of the research activity, as in the case of the more typical approaches to studying classroom learning. However, in the approach that is suggested greater emphasis needs to be placed upon the relationship between the researcher and both
students and teachers, and one which is embedded in the typical functioning of the classroom. This necessitates a more longitudinal research design, including a substantial period of interaction between teachers, students and researcher prior to the period of 'data collection'. But one must be wary of distinguishing too clearly between these two periods, for this may result in the latter period not being representative of what typically occurs in the classroom. The sample size of students and teachers will be necessarily smaller than has characterised earlier studies. Indeed the size of the sample used in this study was too large at times for the researcher to cope with last minute timetable changes, teacher illnesses and student absences, all of which are typical of classroom learning. Reliability may also be increased by using more than one researcher in the study of a classroom. However, the obvious danger in such a design is that by increasing the number of researchers studying a particular classroom one is transforming the classroom situation more into a research situation, the very problem one is trying to avoid.

Given the approach, what then are those areas of research into student characteristics and teacher behaviour suggested by this study? Already it has been indicated that such student and teacher characteristics must be relatable to the learning process, either directly, as in the case of intrinsic motivation, or indirectly as with achievement motivation. It is further suggested that those student characteristics likely to be most important in typical classroom learning are those which are operative in the student's everyday interactions with his environment. Consequently there would not appear to be the need, for the present anyway, to generate a whole new set of educational psychological constructs as has been the tendency of recent years. The construct 'cognitive preference' is a case in point. Much of its mystique may be explained in terms of the student's level of pre-existing structure, level of intrinsic motivation and other more fundamental psycho-social concepts.

Both the motivational and (cognitive) structural characteristics of students examined in this study would appear to warrant further consideration, particularly in the light of current educational debate. For the findings of the study indicate that an intrinsic-motivated model of learning is inappropriate for many students.
Where it was appropriate the effect of intrinsic motivation upon learning, under the conditions observed, was not great. How might those adolescent students, whose tendency to seek out novelty, create conflict, etc. has been reduced, once again be encouraged to adopt such a form of cognitive processing? The development and subsequent diversification of intrinsic-motivated behaviour throughout the student's childhood and adolescence would appear then to be an important area of research. This is particularly so if inquiry-centred curriculum and a discovery method of instruction are to be successful. Alternatively, if most teaching at the high school level remains quite didactic and close to a 'reception' model of instruction, then the role played by different extrinsic needs throughout the student's school experience would be of interest. In this study achievement motivation was examined and found to be relevant to classroom learning at the senior high school level, where examinations were still external and the prospects of unemployment not too far distant. However one might expect those same 'pressive' conditions not to be operative in junior classes. Rather, social needs might be more relevant to the context in which learning occurs at this level. Would the goals to which the junior high school student directs his learning activities be similar to those found in this study when, for example, the student might be seeking warmth and assistance from his teacher?

The possible effect of extrinsic reward upon the student's tendency to approach novelty, create cognitive conflict and maintain such conflict until meaningful integration can occur, is increasingly an important topic in education. Already Deci and his colleagues (e.g. Deci, 1972; Deci, Cascio and Krusell, 1975) have alerted us to the possible negative effects of extrinsic reward upon the students' levels of intrinsic motivation. If, in fact, Ausubel is correct in describing our society as becoming increasingly competitive, status seeking, etc., then one might well expect students to less readily display a cognitive processing strategy of the type necessary for the assimilation of enquiry-based curricula.

Yet I would suggest it is not the future research questions raised, nor perhaps the findings themselves, that are of major importance in this study, but rather the successful demonstration of an alternative approach to the study of those processes which characterise classroom learning.
The propositions, suggested teaching activities and teaching notes relevant to the teaching of the biological concept **diffusion**—taken from the Teachers Guide (1973, pp.71-72).

### Single Proposition | Suggested Student Activities | Notes
--- | --- | ---
Liquids and gases consist of molecules and ions. 3(a) | **Text Reading - Molecular Properties of Water (pp. 140-143)**. |  
Molecules and ions in liquids and gases are in constant motion. 3(a) |  
*Molecules and ions tend to become evenly distributed through the liquid or gas space in which they occur; thus they tend to diffuse out from regions of high concentration. 3(g) | **Exercise 6.2 - Diffusion Through a Membrane**. One period to set up and one to observe and discuss next day.  
**Text Reading - Diffusion (pp. 143-149).**  
*The scientist may use models to explain observations. 1(c) | **Guide Questions: Nos. *4, 5.**  
*Water and many solutes are capable of diffusing through membranes, including membranes of living cells. 3(g) | **Guide Questions: Nos. *4, 5, 6, *7, 8.**  
*Many membranes are differentially permeable to solutes. 3(g) |  
*In certain circumstances, water and mineral nutrients will tend to diffuse into or out of cells; this phenomenon may affect the functioning of an organism 3(g) | **Exercise 6.3 - Effects of Diffusion on Organisms**. One or two periods. *Guide Question: No. 6  
*Problem: No. 9

**Note:** Those activities and propositions that are marked with an asterisk are considered by the authors of the curriculum basic to a student's development of the concept **diffusion**.
Appendix 5.2

The Assessment of the Students' Level of Cognitive Readiness

5.2(a) The list of prerequisite concepts considered necessary for the students' development of an understanding of Chapters 6 and 7 in *B.S.C.S.: Web of Life*.

5.2(b) The Cognitive Readiness Test

5.3(c) A summary of the statistics related to the construction of the Cognitive Readiness Test
The set of prerequisite concepts considered necessary for the development by students of an understanding of Chapters 6 and 7 of the *B.S.C.S.: Web of Life* course.

The following groups of prerequisite concepts are developed either in Chapter 4 (Food Materials and Organisms) and Chapter 5 (Organism and Community) and should obviously relate to the 'Required Student Background' stated in the text; or else they have been developed in the School Certificate Science course (Form 4) and/or at lower FORM levels of Science curricula.

These concepts were tested in the Cognitive Readiness Test administered to the students prior to the teaching of Chapters 6 and 7 of the *B.S.C.S.: Web of Life* course.

**Group I**

The following concepts relate to biological prerequisites that are assumed necessary to be developed prior to Chapters 6 and 7:

1. Specific food materials are required for the normal functioning of organisms.
2. The food materials are taken by organisms from their surroundings which include both living and non-living components.
3. These food materials will comprise either organic or inorganic compounds and will include \( \text{H}_2\text{O} \), \( \text{CO}_2 \), \( \text{O}_2 \) as well as mineral ions and complex compounds.
4. Inorganic compounds may be taken in by organisms directly, in ionic form, in solution or from the eating of other organisms.
5. Animals are unable to synthesize basic organic compounds from inorganic compounds and hence are dependent upon other organisms for their supply of organic requirements.
6. Organisms consist of both inorganic and organic compounds which on death are passed to the surroundings. Further, unused and waste products are also passed to the surroundings, often in the faeces and urine.
7. Organisms of different species occur together in nature as communities.
8. The habitat of an organism or community represents its 'living-place'.
9. Within communities a variety of relationships exist; one important relationship is that based on transfer of energy.
10. The interrelationships of organism with organism can often be described within a food web complex, based upon the transfer of energy from one organism to another.
11. Organisms may be classified according to their functional status in the community, e.g. autotrophs, heterotrophs, producers, consumers.

12. The reproductive cycles of organisms differ markedly between species (for example, frog, non-vascular plants and angiosperms).

13. Homoiothermic organisms possess a constant body temperature and are often referred to as warm-blooded (cf. cold-blooded organisms).

14. Organisms living in water use oxygen dissolved in the water and not the oxygen chemically combined with hydrogen in the molecules of water.

15. Respiration is a process in which the chemical energy of food is made available for life processes.

16. Respiration is a process carried out by all living things in which \( O_2 \) is usually absorbed and \( CO_2 \) and \( H_2O \) are given off.

17. Photosynthesis is a process in which \( CO_2 \) and \( H_2O \) form food and oxygen; the process requires light energy and the presence of chlorophyll.

18. Organisms may be classified according to differing characteristics into various categories, e.g. PHYLAE, classes. These characteristics may be either structural or physiological.

**Group II**

The following concepts relate to physical and chemical prerequisites that are assumed developed prior to Chapters 6, 7:

19. The structure of matter can conveniently be described in terms of particles called atoms.

20. There are different kinds of atoms.

21. Concept of an element: a substance made up of atoms of the same kind.

22. Atoms may combine to form molecules.

23. Some elements exist as molecules containing more than one atom.

24. Concept of an ion: an electrically charged atom or group of atoms.

25. Concept of a compound: a substance which consists of two or more different kinds of atoms.

26. Concept of a mixture: substances which are not elements or compounds.

27. Concept of a force: a push or pull in a specified direction.


**Group III**

The following concepts relate to mathematical and methodological prerequisites that are assumed developed prior to Chapters 6 and 7:
29. Given a set of observations, or a situation, the student should be able to i) formulate a question or problem from these observations, ii) formulate a hypothesis to answer the question or solve the problem, iii) design an experiment to test his hypothesis.

30. Given a set of results, either in table or graphical form, the student should be able to interpret these results with respect to a particular hypothesis.

31. The control experiment provides data on one variable at a time.

Group IV

The following prerequisite concept relates to measurement:

32. The concept of concentration. Concentrations of substances dissolved in a liquid are often measured either in grams per litre or presented as molar concentrations.
Appendix 5.2(b)

COGNITIVE READINESS TEST

DIRECTIONS

NAME ____________________________________________

CLASS 5th FORM BIOLOGY

SCHOOL ___________________________________________

This test is designed to help discover any difficulties and misunderstandings you may have in particular areas of your course of study. It is not intended to allocate a grade or mark to you as a result of taking this test.

When answering the questions keep these points in mind.

(1) For each question, you should select the alternative which best answers the question asked, unless otherwise requested.

(2) Circle the letter (A, or B, or C etc.) which corresponds to the answer you have selected, e.g.

A
B
C

(3) Do not spend too much time on any one question. If it seems too difficult omit it and go on to the next question.

(4) Do not write in the right-hand column.

(5) Suggested Time - 40 minutes.
1. The distinguishing characteristic of a typical producer is that it is and organism which:
   A. is eaten by consumers
   B. can convert light energy to chemical energy
   C. can absorb food direct from the soil
   D. is green in colour.

2. A scientist discovered an unfamiliar organism and had difficulty in deciding whether the organism should be called a plant or an animal. Which one of the following pieces of information about the organism would be of greatest value to the scientist in solving this problem.
   A. the habitat of the organism
   B. the organism's ability to produce carbon dioxide
   C. whether the organism is capable of movement
   D. the organism's inability to synthesize basic organic compounds from inorganic compounds.

Information relevant to Questions 3 and 4

A laboratory experiment was conducted in which duckweed plants were being grown in several jars, one containing full nutrient solution, each of the others deficient in a different mineral element. There was unoccupied water surface area still present in all jars at the end of the experiment. The results of successive weekly population counts were graphed on semi-logarithmic paper as shown.

3. Which graph probably represents the population in the full nutrient solution?
   A. B. C. D. E.

4. It is suspected that one of the deficient solutions became contaminated with the deficient element during the experiment.
   This was probably the solution represented by:
   A. B. C. D. E.
5. Which of the following hypotheses is probably being tested in this experiment?
   A. specific food requirements are different for different species
   B. specific food materials are necessary for the normal growth of organisms
   C. availability of sufficient surface area is necessary for the growth of floating plants
   D. specific food requirements are different for different individuals in a species

6. Food materials can be classified according to various criteria and hence in various ways. Eight such food materials were grouped accordingly:
   Group A. sugar, starch, protein, fat
   Group B. mineral ions, water, carbon dioxide, oxygen
   The most likely basis for this classification was:
   A. substances that contain carbon versus those that do not contain carbon
   B. substances that are food requirements for plants versus those that are food requirements for animals
   C. substances that are required for photosynthesis versus those that are produced by photosynthesis
   D. substances that are called organic versus those that are called inorganic.

7. Which of the following cycles is the best representation of the relationship between living things and the gases in the atmosphere?
   A. animals and plants
   B. animals and plants
   C. animals
   D. animals
   
   A. oxygen carbon dioxide plants
   B. carbon dioxide plants
   C. oxygen carbon dioxide animals and plants
   D. carbon dioxide animals

8. A force is best described as:
   A. the total pressure exerted
   B. something that produces movement
   C. a push or a pull in a stated direction
   D. weight which acts vertically downwards.
9. A biologist was writing up the following set of field notes:

Notonecta or water back-swimmer was found in shallow, vegetation choked areas of a large lake. Little light was able to penetrate past the floating water lilies and the water was being continuously stirred up by large perch. What was the biologist describing?

A. the ecosystem of the Notonecta  
B. the community of the Notonecta  
C. the habitat of the Notonecta  
D. the ecological niche of the Notonecta

10. Insectivorous plants are noted for their ability to trap small insects, secrete juices and slowly digest the insects. Often they are found in poor quality soils deficient in nitrogen.

This observation provides evidence for which of the following propositions:

A. food requirements can be taken by organisms from both the living and non-living components of their environment
B. food requirements can be taken by organisms from only living components of the environment
C. insectivorous plants derive their organic food requirements from insects they eat
D. insectivorous plants derive all their mineral requirements from insects they eat.

11. The process of reproduction in the frog involves a stage in which:

A. the female frog gives birth to tadpoles
B. eggs are laid in the water and are then fertilised by the male frog
C. fertilised eggs are laid in the water; these develop into tadpoles.

12. A student classified a set of plants into two groups, viz.:

Group A: mosses, toadstools, seaweeds
Group B: flowering plants, pines, ferns

Which of the following criteria did he most likely use?

A. the size of the plants
B. the presence of an internal transport system
C. the method of reproduction of the plants
D. external structural characteristics

13. Nearly all living things require oxygen. There are many animals that can live entirely in water. These animals can do this because:

A. water is a compound containing oxygen as a chemical constituent
B. they use oxygen which is dissolved in the water
C. plants liberate tiny bubbles of oxygen that water creatures can gulp
D. they do not require oxygen for respiration
14. If a few drops of concentrated manganese sulphate solution and a few drops of sodium hydroxide solution are added to a solution containing oxygen a brown precipitate will result. The greater the oxygen content of the test solution the deeper the brown colour that is produced.

Three tubes marked X, Y, Z respectively were filled with water. An actively growing sprig of Elodea (a green aquatic plant) was placed in tubes X and Y. Tubes X and Z were placed in sunlight, tube Y in the dark. The tubes had been sealed with a cork.

After 3 hours the Elodea was removed, and a few drops of manganese sulphate and sodium hydroxide were added to each tube.

The precipitate of darkest colour was most likely found in:
A. tube X
B. tube Y
C. tube Z
D. tubes X and Y

15. A biologist investigating the effect of temperature change on the internal (or body) temperature of organisms graphed his results as follows. The graph shows the variation in body temperature of the two organisms over a period of 24 hours, during which time the environmental temperature was steadily increased.

From his results we can conclude that:
A. Organism A is a homoiothermic organism such as a lizard
B. Organism B is a homoiothermic organism such as a bird
C. Organism B is a poikilothermic organism such as a bird
D. Organism A is a homoiothermic organism such as a bird

16. Which of the following is the best definition of respiration?
A. the breathing of plants and animals
B. the intake of oxygen and production of carbon dioxide by all living things
C. the process by which the chemical energy of food is made available for the processes of life
D. the oxidation of food by animals to produce their energy needs
A survey was conducted along the south shore of Long Island, New York where D.D.T. has been used for the past twenty years to control mosquitoes. Scientists measured the concentration of D.D.T. in organisms of this area in parts per million (pp.m) of body weight. They were able to draw up the following food web. (Organisms not drawn to scale).

17. An example of a food chain from this food web would be:
A. Eel → Cladophora → Flounder
B. Sea Eagle → Cormorant → Merganser
C. Cladophora → Mud Snail → Blowfish
D. Merganser → Eel → Flounder → Blowfish

18. There are usually less than 5 members in a food chain. Of the following, the best explanation for this is:
A. there is not enough food available for higher order consumers
B. each member of the food chain radiates more heat than it absorbs
C. there are no predators on organisms at the top of the food chain
D. higher order consumers would become too large and slow-moving to be successful predators.
19. For this food web to be complete, in terms of cycling of matter such as carbon and nitrogen atoms:
   A. consumers of a higher order than those shown need to be identified
   B. decomposers of all organisms need to be included
   C. the waste products of all higher order consumers must be accounted for
   D. parasites of both consumers and producers must be considered

20. The concentration of D.D.T. in the flounder is most likely to be:
   A. less than 0.08 ppm.
   B. approximately 0.08 ppm.
   C. between 0.08 and 26.4 ppm.
   D. greater than 26.4 ppm.

Questions 21 – 25

For each of the following circle
   A. if it is a raw material in photosynthesis
   B. if it is a product of photosynthesis
   C. if it is a catalyst in photosynthesis
   D. if it is required in photosynthesis but not as a raw material
   E. if it is not directly involved with photosynthesis at all

21. Light energy  A  B  C  D  E
22. Water       A  B  C  D  E
23. Oxygen      A  B  C  D  E
24. Carbon dioxide A  B  C  D  E
25. Chlorophyll A  B  C  D  E

26. Which of the following statements about atoms is true?
   A. all atoms are identical
   B. no two atoms are similar
   C. atoms of different elements are different
   D. all atoms of elements are the same but atoms of compounds differ
27. Which of the following sentences best shows the difference between the terms atom and molecule?

A. atoms are made of smaller particles called molecules
B. a hydrogen chloride molecule contains a hydrogen atom and a chlorine atom
C. atoms of water contain two hydrogen molecules and one oxygen molecule
D. compounds contain molecules; mixtures contain atoms

28. The following symbols describe particles:

<table>
<thead>
<tr>
<th>I</th>
<th>C</th>
<th>III</th>
<th>Na⁺</th>
</tr>
</thead>
<tbody>
<tr>
<td>II</td>
<td>H₂</td>
<td>IV</td>
<td>NO₃⁻</td>
</tr>
</tbody>
</table>

Which of these particles are ions?

A. I and II only
B. III and IV only
C. I and II only
D. all of them

Questions 29 – 30

In the following diagrams, the small black circles represent hydrogen atoms; the larger open circles represent oxygen atoms.

29. Which of the above diagrams best represent a mixture of hydrogen molecules and oxygen molecules?

A. B. C. D.

30. Which of the above diagrams best represents a mixture of two compounds of hydrogen and oxygen?

A. B. C. D.
31. Three objects were initially at room temperature:  
   Object N is an iron nail  
   Object W is a 10-gallon tank of water  
   Object X is a 1-gallon bucket of water  

N was heated on a gas flame for 1 minute until it glowed red  
W was heated on the same gas flame for 2 hours until it boiled  
Then X was heated until it boiled; this required 15 minutes  

After each has been heated as described:  
A. Object N contains the greatest amount of heat  
B. Object W has gained the same amount of heat as Object X  
C. Both statements A and B are true  
D. Neither statement A nor B is true  

32. Which one of the following statements best describes the concentration of a certain solution in a bottle?  
A. the bottle contains 750 ml of salt solution  
B. the bottle contains 6 gm of salt in solution  
C. the contents of the bottle have a mass of 756 gm.  
D. the bottle contains 8 gm/litre of salt in solution  

Information relevant to Questions 33 and 34  

A biologist was testing the hypothesis that removal of the hair of a camel increases the rate of evaporation from its skin. The results of his investigation are summarized in graphs 1 and 2. The results in graph 1 were obtained when camel X was shorn and camel Y left with its natural hair.  

33. What was the control for the experiment summarized in Graph 1?  
A. the removal of hair from one camel  
B. the camel with hair  
C. the two camels being in the same environment  
D. the two camels having equal surface areas  

34. The experimental variable for the experiment summarized in Graph 1 was:  
A. evaporation rate  
B. temperature  
C. hair  
D. body weight
A large fresh water lake contained algae whose population density varied with the time of the year. The oxygen concentration of the lake water was measured when the algal population was low and when it was high. The results are illustrated in the graph below.

35. Investigation showed that the fish in the lake died when the oxygen concentration dropped below 3 ppm for more than 4 hours.

From the data it could reasonably be concluded that:

A. at 5 p.m. more fish would tend to die when the algal population is high than when it is low
B. more fish would tend to die in the early morning when the algal density is high
C. no fish would die between 9 a.m. and 11 p.m.
D. the algae produce a poison which kills the fish
36. In which one of the groups of three organisms below would you expect to observe the greatest amount of structural and reproductive diversity?

A. a marine lobster, a marine shrimp, and a land dwelling crab  
B. a kangaroo, a spiny anteater, and a platypus  
C. a snake, a lizard, and a sea turtle  
D. a tube worm, a crab, and a limpet, all living in the intertidal zone.

37. Botanists can group plants into various categories, e.g.

Category A: algae, mosses, ferns  
Category B: conifers, angiosperms

Which of the following statements applies to the above classification of plants?

A. Category A plants are characterised by a non-sexual mode of reproduction  
B. Category B plants possess seeds that are contained within a carpel  
C. Category B plants are not characterised by an alternation of generations in their reproductive cycle  
D. Category A plants possess a free-swimming stage which requires the presence of water for survival

38. A newly discovered animal has an adult body that is not similar to any known phylum. The larvae (immature organism) has an exoskeleton, jointed appendages and an underdeveloped ventral nerve cord. The newly discovered animal should be classified as:

A. a chordate  
B. an arthropod  
C. an annelid  
D. a member of a new phylum
Appendix 5.2(c)

A summary of the relevant statistics used to construct the 'Cognitive Readiness' scale. Also included in this table are a list of those prerequisite concepts most related to each of the items comprising that scale.

**COGNITIVE READINESS TEST**

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Most Related Prerequisites</th>
<th>Degree of Difficulty</th>
<th>Discrimination Index (φ coefficient)</th>
<th>Correlated Item-Total Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>11</td>
<td>.45</td>
<td>.41</td>
<td>.31</td>
</tr>
<tr>
<td>2</td>
<td>11,5</td>
<td>.51</td>
<td>.32</td>
<td>.20</td>
</tr>
<tr>
<td>3*</td>
<td>1,(4),30</td>
<td>.75</td>
<td>.28</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>1,(4),30</td>
<td>.37</td>
<td>.64</td>
<td>.49</td>
</tr>
<tr>
<td>5</td>
<td>1,30,29</td>
<td>.81</td>
<td>.50</td>
<td>.33</td>
</tr>
<tr>
<td>6</td>
<td>3,5,17</td>
<td>.56</td>
<td>.32</td>
<td>.23</td>
</tr>
<tr>
<td>7</td>
<td>5,16,17</td>
<td>.31</td>
<td>.43</td>
<td>.33</td>
</tr>
<tr>
<td>8*</td>
<td>27</td>
<td>.49</td>
<td>.15</td>
<td>-</td>
</tr>
<tr>
<td>9</td>
<td>8,7,9</td>
<td>.69</td>
<td>.28</td>
<td>.24</td>
</tr>
<tr>
<td>10</td>
<td>2</td>
<td>.61</td>
<td>.37</td>
<td>.25</td>
</tr>
<tr>
<td>11*</td>
<td>12</td>
<td>.52</td>
<td>.25</td>
<td>-</td>
</tr>
<tr>
<td>12</td>
<td>12,18</td>
<td>.44</td>
<td>.49</td>
<td>.35</td>
</tr>
<tr>
<td>13</td>
<td>14</td>
<td>.47</td>
<td>.56</td>
<td>.44</td>
</tr>
<tr>
<td>14</td>
<td>16,17,30</td>
<td>.52</td>
<td>.54</td>
<td>.38</td>
</tr>
<tr>
<td>15*</td>
<td>13,30</td>
<td>.58</td>
<td>.20</td>
<td>-</td>
</tr>
<tr>
<td>16</td>
<td>15</td>
<td>.33</td>
<td>.31</td>
<td>.19</td>
</tr>
<tr>
<td>17</td>
<td>10</td>
<td>.90</td>
<td>.28</td>
<td>.23</td>
</tr>
<tr>
<td>18*</td>
<td>10,11</td>
<td>.20</td>
<td>.12</td>
<td>-</td>
</tr>
<tr>
<td>19</td>
<td>6,11</td>
<td>.54</td>
<td>.27</td>
<td>.23</td>
</tr>
<tr>
<td>20*</td>
<td>30</td>
<td>.78</td>
<td>.27</td>
<td>-</td>
</tr>
<tr>
<td>21*</td>
<td>17</td>
<td>.33</td>
<td>.11</td>
<td>-</td>
</tr>
<tr>
<td>22*</td>
<td>17</td>
<td>.37</td>
<td>.24</td>
<td>-</td>
</tr>
<tr>
<td>23</td>
<td>17</td>
<td>.61</td>
<td>.53</td>
<td>.35</td>
</tr>
<tr>
<td>24</td>
<td>17</td>
<td>.50</td>
<td>.64</td>
<td>.43</td>
</tr>
<tr>
<td>25</td>
<td>17</td>
<td>.33</td>
<td>.49</td>
<td>.34</td>
</tr>
<tr>
<td>26</td>
<td>19,20,21</td>
<td>.66</td>
<td>.54</td>
<td>.40</td>
</tr>
<tr>
<td>27</td>
<td>22</td>
<td>.49</td>
<td>.67</td>
<td>.51</td>
</tr>
<tr>
<td>28</td>
<td>24</td>
<td>.69</td>
<td>.50</td>
<td>.34</td>
</tr>
<tr>
<td>29</td>
<td>23,25,26</td>
<td>.24</td>
<td>.35</td>
<td>.31</td>
</tr>
<tr>
<td>30</td>
<td>23,25,26</td>
<td>.43</td>
<td>.46</td>
<td>.33</td>
</tr>
<tr>
<td>31</td>
<td>28</td>
<td>.31</td>
<td>.40</td>
<td>.34</td>
</tr>
<tr>
<td>32</td>
<td>32</td>
<td>.66</td>
<td>.50</td>
<td>.36</td>
</tr>
<tr>
<td>33</td>
<td>31,30</td>
<td>.51</td>
<td>.55</td>
<td>.42</td>
</tr>
<tr>
<td>34</td>
<td>31,30</td>
<td>.29</td>
<td>.46</td>
<td>.34</td>
</tr>
<tr>
<td>35</td>
<td>30</td>
<td>.46</td>
<td>.34</td>
<td>.24</td>
</tr>
<tr>
<td>36</td>
<td>18</td>
<td>.61</td>
<td>.40</td>
<td>.23</td>
</tr>
<tr>
<td>37</td>
<td>18,12</td>
<td>.14</td>
<td>.31</td>
<td>.25</td>
</tr>
<tr>
<td>38</td>
<td>18</td>
<td>.52</td>
<td>.40</td>
<td>.23</td>
</tr>
</tbody>
</table>

* Not included in final Cognitive Readiness Scale
Notes: (i) for the calculation of the degree of difficulty the following procedure was used:

\[
\text{Degree of difficulty} = \frac{\text{no. of students giving right answer}}{\text{total no. of students}}
\]

(ii) the discrimination index was calculated using the upper tertile and lower tertile of the students' total scores and applying the procedure described in Ferguson (1966)
Appendix 5.3

The assessment of the students' knowledge of the specific details of the curriculum.

Appendix 5.3(a) The Guide Questions scale contained in the Achievement Test

Appendix 5.3(b) The scoring procedures used for assessing student answers on the Guide Questions scale

Appendix 5.3(c) A summary of the relevant statistics used in the construction of the Guide Questions scale
<table>
<thead>
<tr>
<th>Item No.</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Q.1 What is phytoplankton and what is zooplankton? (4 lines)</td>
</tr>
<tr>
<td>2</td>
<td>Q.2 Of what importance is plankton within the community of a freshwater pond? (5 lines)</td>
</tr>
<tr>
<td>3-4</td>
<td>Q.3 What do we mean by diffusion and give some evidence in support of the idea that it occurs. (7 lines)</td>
</tr>
<tr>
<td>5</td>
<td>Q.4 What is meant by a differentially permeable membrane? (2 lines)</td>
</tr>
<tr>
<td>6</td>
<td>Q.5 Where in the sea might you expect to find the greatest concentrations of organisms: near the surface, at a depth of several hundred metres or on the bottom? Why? (5 lines)</td>
</tr>
<tr>
<td>7</td>
<td>Q.6 A red blood cell placed in salt water will (A) shrink and appear shrivelled (B) burst (C) remain unchanged (D) divide</td>
</tr>
<tr>
<td>8</td>
<td>6a In the above question, in which direction has there been a nett movement of water? (2 lines)</td>
</tr>
<tr>
<td>9</td>
<td>Q.14 What does a biologist mean by the word: adaptation? (2 lines)</td>
</tr>
<tr>
<td>10-13</td>
<td>Q.15 From what you know of organisms, give an example of: (i) a structural adaptation of an animal (ii) of a plant (iii) a physiological (functional) adaptation of an animal (iv) of a plant (8 lines)</td>
</tr>
<tr>
<td>14</td>
<td>Q.16 Why do land animals and plants have a water problem? (5 lines)</td>
</tr>
<tr>
<td>15</td>
<td>Q.17 Losing water can be an advantage to land organism. How? (2 lines)</td>
</tr>
</tbody>
</table>

Note: Question number refers to the number on the Achievement Test. Item number refers to the code number of that particular question.
SCORING PROCEDURE FOR GUIDE QUESTIONS

Question 1. What is phytoplankton and what is zooplankton?

0: one attribute of only one type of the plankton
1: one attribute of each type of plankton
2: as above plus either another attribute or the environment they live in
3: two attributes of each type of plankton and mention of them being members of a pond community
4: as in 3 above but also including an example of each type of plankton

Question 2. Of what importance is plankton within the community of a freshwater pond?

0: a general statement mentioning that survival of the pond is dependent on it
1: a statement mentioning first links in the food chain
2: as above but elaboration of the consequent idea of change in the food web if they died off, etc.
3: both of 1 and 2, and idea of being the entry point of oxygen, light energy, etc. into the pond community.

Question 3. What do we mean by diffusion?

1: random movement of particles
2: random movement of particles plus a final equal distribution of particles
3: the textbook definition found on p.
4: a definition in terms of concentration gradients, including the idea of random movement of particles

Question 3A. ... and give some evidence in support of the idea that it occurs.

1: no explanation but the presentation of an example
2: brief statement linking an example with the concept of diffusion
3: an explanation linking the exemplar with the concept of diffusion.
Question 4. What is meant by a differentially permeable membrane?

1: the idea of movement of particles
2: the idea of differential movement of particles across a membrane
3: the idea of differential movements of particles across a membrane and being regulated by the size of the particle vis-a-vis the size of the pore of the membranes.

Question 5.

0: a statement of locality
1: near surface because of one feature (light, temp. etc.)
2: near surface because of the relationship of one physical feature with a biological process
3: near the surface because of a physical feature, its related biological process and a consequent effect on other organisms
4: as in 3 above but also including specific examples

N.B. a similar set of scoring procedures were applied to those few students who argued for the greatest population to be at the bottom and decomposes.

Question 6.

0: B, C, D
1: A - shrink and appear shrivelled

Question 6A.

1: movement of water was out of the cell.

Question 14. What does a biologist mean by the word adaptation?

1: one attribute of the textbook definition
2: two attributes of the textbook definition
3: a detailed definition of adaptation, e.g. the textbook definition of adaptation, often including the latin derivative.
Question 15. From what you know of organisms, give an example of:

(i) a structural adaptation of an animal
(ii) a structural adaptation of a plant
(iii) a physiological adaptation of an animal
(iv) a physiological adaptation of a plant

1: for a correct exemplar of each type of adaptation, regardless of amount of detail presented.

Question 16. Why do plants and animals have a water problem?

1: the idea that due to intermittent water supply, storage is a problem (particularly in deserts)
2: as above and also the problem of loss of water through various bodily processes
3: as in 2 above but also including specific examples

Question 17. Losing water can be an advantage to a land organism. How?

1: action is one of cooling the organism
2: action is one of cooling the organism via perspiration, etc.
3: as in above but also includes its use in excretion.
### Appendix 5.3(c)

**SUMMARY STATISTICS FOR GUIDE QUESTIONS TEST**

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Guide Question Chapter No.</th>
<th>Degree of Difficulty</th>
<th>Discrimination Index (ϕ coefficient)</th>
<th>Corrected Item Total Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3-6</td>
<td>.60</td>
<td>.67</td>
<td>.49</td>
</tr>
<tr>
<td>2</td>
<td>3-6</td>
<td>.45</td>
<td>.59</td>
<td>.50</td>
</tr>
<tr>
<td>3</td>
<td>4-6</td>
<td>.43</td>
<td>.67</td>
<td>.47</td>
</tr>
<tr>
<td>4</td>
<td>4-6</td>
<td>.52</td>
<td>.58</td>
<td>.43</td>
</tr>
<tr>
<td>5</td>
<td>* 6</td>
<td>.60</td>
<td>.70</td>
<td>.57</td>
</tr>
<tr>
<td>6</td>
<td>8-6</td>
<td>.64</td>
<td>.50</td>
<td>.46</td>
</tr>
<tr>
<td>7</td>
<td>6-6</td>
<td>.66</td>
<td>.48</td>
<td>.28</td>
</tr>
<tr>
<td>8</td>
<td>6-6</td>
<td>.56</td>
<td>.56</td>
<td>.37</td>
</tr>
<tr>
<td>9</td>
<td>6-7</td>
<td>.57</td>
<td>.63</td>
<td>.41</td>
</tr>
<tr>
<td>10</td>
<td>6-7</td>
<td>.86</td>
<td>.51</td>
<td>.44</td>
</tr>
<tr>
<td>11</td>
<td>6-7</td>
<td>.80</td>
<td>.52</td>
<td>.39</td>
</tr>
<tr>
<td>12</td>
<td>6-7</td>
<td>.62</td>
<td>.63</td>
<td>.38</td>
</tr>
<tr>
<td>13</td>
<td>6-7</td>
<td>.51</td>
<td>.65</td>
<td>.38</td>
</tr>
<tr>
<td>14</td>
<td>2-7</td>
<td>.50</td>
<td>.56</td>
<td>.46</td>
</tr>
<tr>
<td>15</td>
<td>5-7</td>
<td>.53</td>
<td>.56</td>
<td>.47</td>
</tr>
</tbody>
</table>

K-R 20 \( \alpha = .82 \)

* This item comprised a 'word to know' and hence is strictly not a guide question.
Appendix 5.4

The assessment of the student's development of an integrated understanding of the curriculum

Appendix 5.4(a) The Problems scale contained in the Achievement Test

Appendix 5.4(b) The scoring procedures used for assessing student answers on the Problems scale

Appendix 5.4(c) The propositions derived from the Teacher's Guide (1973), tested in the Problems scale

Appendix 5.4(d) A summary of the statistics relevant to the construction of the Problems scale
Q.7 Mineral nutrients brought to the surface of the ocean by currents would have:

A. been released by the activities of decomposer organisms in the deep.
B. been dissolved out of the sand at the bottom.
C. sunk down from the surface waters because minerals are heavier than water.
D. reached the bottom by the action of ocean currents.

Information relevant to Question 8

A lake received as its inflow a steady stream of water draining a large boggy area. Water falling on and draining into a bog is absorbed by the large mass of bog vegetation and released slowly throughout the year. The water of the lake and the water draining into it from the bog is dark brown in colour and contains a high proportion of dissolved organic substances.

In the diagram which follows, the area of each rectangle represents the relative total masses of fish, zooplankton, and phytoplankton living in this lake.

Q.8 The most likely reason for the greater total mass of zooplankton in the lake compared with phytoplankton is that:

A. feeding by the large zooplankton population keeps the numbers of phytoplankton low.
B. there are few fish feeding on the zooplankton.
C. the zooplankton are feeding on organic matter in the water.
D. there is a large population of bacteria living on the organic matter in the water.
Q. 9  A farmer wants to know whether it would be better to plant species X or Y as a cereal crop on his property. The Department of Agriculture investigated the soil and found that it had a minimum sodium chloride content equivalent to 0.2M. They tested seeds of the two species suggested and obtained the following results.

<table>
<thead>
<tr>
<th>Concentration of sodium chloride</th>
<th>Species X</th>
<th>Species Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>0M</td>
<td>x</td>
<td>o</td>
</tr>
<tr>
<td>0.1M</td>
<td>x</td>
<td>o</td>
</tr>
<tr>
<td>0.2M</td>
<td>x</td>
<td>o</td>
</tr>
<tr>
<td>0.3M</td>
<td>x</td>
<td>o</td>
</tr>
<tr>
<td>0.4M</td>
<td>x</td>
<td>o</td>
</tr>
<tr>
<td>0.5M</td>
<td>x</td>
<td>o</td>
</tr>
</tbody>
</table>

No. of seeds germinated

On the basis of their salt tolerance only, which species would you recommend to the farmer? Give a reason for your answer.
Questions 10-12 are based on the following information

A scientist collected a number of sandworms from a beach. He selected 50 worms of equal weight and placed equal numbers in five different concentrations of sea-water. After 12 hours he re-weighed the worms and determined the average weight for each group.

The change in weight of groups V. and W. occurred because the worms:

A. lost water
B. gained water
C. gained salt
D. lost salt

The initial salt concentration inside the worms was probably closest to:

A. 1.5 per cent
B. 2.5 per cent
C. 3.5 per cent
D. 4.5 per cent

The body covering of the worms is:

A. equally permeable to both salt and water
B. impermeable to both salt and water
C. more permeable to salt than water
D. more permeable to water than salt
The next question is based on the following information:

Identical pieces of carrot of known weight were placed in beakers labelled A, B, C and D.

Beaker A, contained a strong solution of glucose (10 per cent) kept at a temperature of 1°C.

Beaker B, contained a strong solution of glucose (10 per cent) kept at a temperature of 35°C.

Beaker C, contained distilled water kept at a temperature of 1°C.

Beaker D, contained distilled water kept at a temperature of 35°C.

Q.13 After a period of one hour has elapsed, in which beaker will the carrot show the greatest loss in weight?

A. Beaker A
B. Beaker B
C. Beaker C
D. Beaker D

Reason .................................................................

Q.18 In the cool part of the day a camel's temperature may drop to 32°C and in the hot part it may rise to 42°C. The body temperature of a man under similar environmental conditions remains between 30°C and 39°C. From the above, it would be expected that

A. camels shiver more readily than men
B. men sweat more readily than camels
C. camels generally have a thicker layer of fat than men
D. men absorb more heat from their environment than camels
Q.19 The diagrams below show the outlines and cross-sections of leaves taken from four land plants. Which plant would be least likely to occur in a dry environment?

<table>
<thead>
<tr>
<th>plant</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>outline of leaf</td>
<td><img src="image" alt="Diagram" /></td>
<td><img src="image" alt="Diagram" /></td>
<td><img src="image" alt="Diagram" /></td>
<td><img src="image" alt="Diagram" /></td>
</tr>
<tr>
<td>cross-section at XY</td>
<td><img src="image" alt="Diagram" /></td>
<td><img src="image" alt="Diagram" /></td>
<td><img src="image" alt="Diagram" /></td>
<td><img src="image" alt="Diagram" /></td>
</tr>
</tbody>
</table>

A. Plant A  
B. Plant B  
C. Plant C  
D. Plant D
Q. 20 The elephant is not the largest living animal on earth, but it is the largest animal living on land. Many animals living in the sea are longer, larger, and heavier than the elephant, as can be seen in the following table:

<table>
<thead>
<tr>
<th>Animal</th>
<th>Greatest recorded weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elephant</td>
<td>12 ton</td>
</tr>
<tr>
<td>Blue whale</td>
<td>125 ton</td>
</tr>
<tr>
<td>Whale shark</td>
<td>60 ton</td>
</tr>
<tr>
<td>Giant Squid</td>
<td>(Weight not recorded but a specimen 57 ft long is believed to have weighed more than 15 ton)</td>
</tr>
</tbody>
</table>

Scientists believe that the elephant is very close to being as large as a purely land-dwelling animal can grow. The best reason for holding this belief is that:

A. the air does not provide sufficient oxygen for large animals to respire
B. large animals cannot find sufficient food on land
C. the air does not provide sufficient support for large animals
D. temperatures on land are too high for large animals

Reason (7 lines)
Q.21 Plant adaptation to living on land made several new requirements necessary. Which of the following was not a new adaptation?

A. a means of absorbing water and minerals from the soil 
B. structures to support the plants 
C. a process for linking the gametes 
D. photosynthesis

Q.22 Which one of the following features is most likely to be present in an angiosperm which lives submerged in water.

A. a thick stem 
B. thin leaves 
C. an extensive root system 
D. conspicuous flowers

Reason (8 lines)

Information relevant to Questions 23, 24 and 25

Various means of breathing under water have been investigated. In one series of experiments mice have been completely immersed in a synthetic liquid called fluorocarbon. The concentration of oxygen which dissolves in fluorocarbon at 15°C is about 18%; in water at the same temperature it is about 0.6%. The mice survive unharmed in fluorocarbon for at least an hour, although they are observed to gulp and gasp violently as they inhale and exhale.

It is also possible to 'super-oxygenate' water, and animals have been able to survive in this for short periods. It has been found that salt water is better for this purpose than fresh water, not because of any difference in the oxygen content attained, but because animals breathing in fresh water invariably suffer serious lung damage.

In still other experiments small mammals have survived under water quite satisfactorily when enclosed in air-filled containers with walls of very thin silicone rubber membrane.

Q.23 If fluorocarbon was heated to 30°C we could reasonably predict that:

A. all the oxygen would bubble out of solution 
B. less oxygen would remain in solution 
C. there would be no change in the oxygen concentration in solution 
D. more oxygen would be able to dissolve
Q.24 Which of the following is the most likely reason for serious lung damage resulting from breathing super-oxygenated fresh water but not super-oxygenated salt water?

A. In fresh water, water would tend to pass into cells lining the lungs, causing them to swell until they burst; in salt water there would not be this tendency.
B. Fresh water is denser than salt water and exerts a much greater pressure on the lung tissues, causing them to rupture.
C. Fresh water contains harmful micro-organisms which are unable to survive in salt water, in addition, salt water has a healing action.
D. Fresh water absorbs heat more readily than salt water; when cold fresh water enters the lungs, the blood vessels contract and the lung tissues are without an adequate blood supply.

Q.25 The silicone rubber membrane in which small mammals can survive under water would have to be permeable to:

A. oxygen and water, but not to carbon dioxide.
B. oxygen and nitrogen, but not to water or carbon dioxide.
C. oxygen, but not to any other substance.
D. oxygen and carbon dioxide, but not to water.

Q.26 Life cannot be maintained by breathing water because:

A. lungs cannot absorb oxygen from water.
B. oxygen molecules cannot diffuse in water.
C. oxygen cannot diffuse into the blood at a sufficient rate.
D. the high water pressure damages the lungs.

Question 27 refers to the following information:

Thermistors for measuring temperature were attached to the bodies of five different animals. The animals, which came from different habitats (e.g. water, air, moist soil) were kept in the laboratory, each animal being kept in a habitat as close as possible to its natural one except that the temperature was varied. The temperature of each animal was recorded for a wide range of environmental temperatures.
Q.27 Which one of the following conclusions concerning animal I is best supported by the data?

A. Animal I probably comes from a terrestrial environment

B. Animal I maintains its temperature relatively constant by shivering when the environmental temperature is below its normal body temperature of 37°C

C. Animal I is homiothermic over the temperature range 0-40°C

D. Animal I is probably a mammal.
Appendix 5.4(b)

SCORING PROCEDURE FOR PROBLEMS

Item No. 16  \[ A = 1, B = 0, C = 0, D = 0 \]

17  \[ A = 0, B = 0, C = 1, D = 0 \]

18  \[ A = 0, B = 0, C = 0, D = 0 \]

No. of mature plants is more important than
no. of plants germinated

2 As above + consideration of a \textit{minimum} soil
concentration of .2M.

19  \[ A = 0, B = 1, C = 0, D = 0 \]

20  \[ A = 0, B = 1, C = 0, D = 0 \]

21  \[ A = 0, B = 0, C = 1, D = 1 \]

22  \[ \text{BEAKER B} \]

23  \[ A = 0, B = 1, C = 0, D = 0 \]

24  \[ A = 0, B = 1, C = 0, D = 0 \]

25  \[ A = 1, B = 0, C = 0, D = 0 \]

26  \[ A = 0, B = 0, C = 1, D = 0 \]

27  \[ A = 0, B = 0, C = 0, D = 1 \]

28  \[ A = 0, B = 0, C = 0, D = 0 \]

29  \[ A = 1, B = 0, C = 0, D = 0 \]

30  \[ A = 0, B = 0, C = 0, D = 1 \]

31  \[ A = 0, B = 1, C = 0, D = 0 \]

32  \[ A = 1, B = 0, C = 0, D = 0 \]

33  \[ A = 0, B = 0, C = 0, D = 1 \]

34  \[ A = 0, B = 0, C = 1, D = 0 \]

35  \[ A = 0, B = 0, C = 1, D = 0 \]

Note: Item Nos, 27, 30. In both these questions it is possible
that there is an alternative answer. Consequently a small
proportion of students who presented well argued and
substantially correct answers were marked accordingly.
Organisms in nature live under widely different sets of conditions; many live in water.

2. Compared to air, water is a viscous medium.

3. Organisms in water may experience considerable upthrust.

4. Oxygen and carbon dioxide may be present in solution in water.

5. Mineral nutrients may be present in solution in water.

6. In freshwater habitats the concentration of mineral nutrients is fairly low.

7. Many photosynthetic organisms can live in water provided that they can obtain sufficient light, carbon dioxide and mineral nutrients.

8. Some organisms in fresh water depend for food on the dead remains of other organisms.

9. Molecules and ions tend to become evenly distributed through the liquid or gas space in which they occur; thus they tend to diffuse out from regions of high concentration.

10. Water and many solutes are capable of diffusing through membranes, including membranes of living cells.

11. Many membranes are differentially permeable to solutes.

12. In certain circumstances, water and mineral nutrients will tend to diffuse into or out of cells; this phenomenon may affect the functioning of an organism.

13. Survival in particular habitats may depend on ability to maintain water and solute concentrations within tolerable limits.

14. Consumer organisms and detritus feeders are not necessarily restricted to illuminated water.

15. Hypotheses are tested by carefully designed experiments.

16. Experiments are designed in ways which try to ensure that the results show clearly whether the hypothesis being tested is supported or disproved.

17. Presentation of data in tabular or graphical form may aid interpretation.
18. Land habitats differ from aquatic habitats in physical factors such as water availability, buoyancy, oxygen availability and temperature variation.

19. Organisms in land habitats tend to lose water to their surroundings.

20. Land organisms show structural and behavioural features which limit water loss or increase water uptake.

21. Land organisms show a variety of features which limit the effects of fluctuations in environmental temperatures.

22. Features which suit an organism to its environment are referred to as adaptations.

23. Land organisms possess adaptations for body support.

### Statistical Summary of 'Problems' Scale

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Most Related Proposition(s)</th>
<th>Degree of Difficulty</th>
<th>Discrimination Index (Ø coefficient)</th>
<th>Corrected Item - Total Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>14, 8</td>
<td>.57</td>
<td>.31</td>
<td>.23</td>
</tr>
<tr>
<td>17</td>
<td>8, 1</td>
<td>.51</td>
<td>.29</td>
<td>.20</td>
</tr>
<tr>
<td>18</td>
<td>13, 15, 16, 17</td>
<td>.45</td>
<td>.44</td>
<td>.31</td>
</tr>
<tr>
<td>19</td>
<td>17, 10, 11</td>
<td>.62</td>
<td>.61</td>
<td>.39</td>
</tr>
<tr>
<td>20</td>
<td>&quot;</td>
<td>.68</td>
<td>.57</td>
<td>.37</td>
</tr>
<tr>
<td>21</td>
<td>&quot;</td>
<td>.56</td>
<td>.49</td>
<td>.28</td>
</tr>
<tr>
<td>22</td>
<td>9, 11</td>
<td>.56</td>
<td>.43</td>
<td>.32</td>
</tr>
<tr>
<td>23</td>
<td>&quot;</td>
<td>.27</td>
<td>.41</td>
<td>.55</td>
</tr>
<tr>
<td>24</td>
<td>21</td>
<td>.68</td>
<td>.40</td>
<td>.31</td>
</tr>
<tr>
<td>25</td>
<td>24, 19, 20</td>
<td>.55</td>
<td>.38</td>
<td>.23</td>
</tr>
<tr>
<td>26</td>
<td>1, 2, 3, 23, 24</td>
<td>.59</td>
<td>.49</td>
<td>.36</td>
</tr>
<tr>
<td>27</td>
<td>&quot;</td>
<td>.30</td>
<td>.46</td>
<td>.57</td>
</tr>
<tr>
<td>28</td>
<td>22, 7</td>
<td>.59</td>
<td>.45</td>
<td>.28</td>
</tr>
<tr>
<td>29</td>
<td>4, 5, 6, 12, 24</td>
<td>.27</td>
<td>.22</td>
<td>.20</td>
</tr>
<tr>
<td>30</td>
<td>&quot;</td>
<td>.19</td>
<td>.27</td>
<td>.43</td>
</tr>
<tr>
<td>31</td>
<td>18</td>
<td>.40</td>
<td>.33</td>
<td>.24</td>
</tr>
<tr>
<td>32</td>
<td>13, 11, 9</td>
<td>.55</td>
<td>.60</td>
<td>.46</td>
</tr>
<tr>
<td>33</td>
<td>11</td>
<td>.60</td>
<td>.56</td>
<td>.39</td>
</tr>
<tr>
<td>34</td>
<td>18</td>
<td>.29</td>
<td>.27</td>
<td>.29</td>
</tr>
<tr>
<td>35</td>
<td>21</td>
<td>.49</td>
<td>.36</td>
<td>.31</td>
</tr>
</tbody>
</table>

\[ \alpha = .79 \]
Appendix 5.5

Stern's (1970) need for achievement scale and the item-total correlations (corrected) for each item.

<table>
<thead>
<tr>
<th>Item</th>
<th>Item-Total Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>I like setting difficult goals for myself</td>
<td>.48</td>
</tr>
<tr>
<td>I like working for someone who will accept nothing less than the best that's in me</td>
<td>.29</td>
</tr>
<tr>
<td>I like setting higher standards for myself than anyone else would, and working hard to achieve them</td>
<td>.48</td>
</tr>
<tr>
<td>I like competing with others for a prize or goal</td>
<td>.37</td>
</tr>
<tr>
<td>I like taking examinations</td>
<td>.26</td>
</tr>
<tr>
<td>I like working on tasks so difficult that I can hardly do them</td>
<td>.49</td>
</tr>
<tr>
<td>I like doing something very difficult in order to prove that I can do it</td>
<td>.51</td>
</tr>
<tr>
<td>I like choosing difficult tasks in preference to easy ones</td>
<td>.53</td>
</tr>
<tr>
<td>I like to sacrifice everything else in order to achieve something outstanding</td>
<td>.29</td>
</tr>
<tr>
<td>I like picking out some hard tasks for myself and doing it</td>
<td>.59</td>
</tr>
</tbody>
</table>

α = .76
### Intrinsic Motivation Scale

<table>
<thead>
<tr>
<th>Item</th>
<th>Matric. Students (Beswick 1975)</th>
<th>Form 5 Biology Students</th>
<th>Corrected Item-Total Correlations Form 5 Biology Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>I visit a library to read material not directly related to my class work</td>
<td>.39</td>
<td>.28</td>
<td>.13</td>
</tr>
<tr>
<td>I would like to watch an astronomer calculate the age of a star</td>
<td>.48</td>
<td>.49</td>
<td>.37</td>
</tr>
<tr>
<td>If I read something which puzzles me, I keep reading until I understand it</td>
<td>.44</td>
<td>.45</td>
<td>.33</td>
</tr>
<tr>
<td>Complicated machinery is fascinating to look at</td>
<td>.41</td>
<td>.47</td>
<td>.32</td>
</tr>
<tr>
<td>When I don't know the answer to a question on a test I look up the answer when the test is completed</td>
<td>.32</td>
<td>.25</td>
<td>.10</td>
</tr>
<tr>
<td>I read for enjoyment during a large part of my spare time</td>
<td>.37</td>
<td>.37</td>
<td>.21</td>
</tr>
<tr>
<td>I am interested in mathematical procedures possible with new calculating machines</td>
<td>.29</td>
<td>.27</td>
<td>.12</td>
</tr>
<tr>
<td>I like to look at pictures which are puzzling in some way</td>
<td>.51</td>
<td>.44</td>
<td>.32</td>
</tr>
<tr>
<td>I read several magazines regularly</td>
<td>.30</td>
<td>.32</td>
<td>.14</td>
</tr>
<tr>
<td>It is interesting to try to figure out how an unusual piece of machinery works</td>
<td>.39</td>
<td>.44</td>
<td>.31</td>
</tr>
<tr>
<td>Some truths can only be expressed in paradoxical statements</td>
<td>.44</td>
<td>.37</td>
<td>.26</td>
</tr>
<tr>
<td>I like to look at rocks which are made of many kinds of minerals</td>
<td>.43</td>
<td>.45</td>
<td>.31</td>
</tr>
<tr>
<td>I have had experiences which inspired me to write a poem or a story, make up a humourous tale or paint a picture</td>
<td>.47</td>
<td>.51</td>
<td>.36</td>
</tr>
<tr>
<td>I think about how strange plants grow</td>
<td>.47</td>
<td>.45</td>
<td>.34</td>
</tr>
<tr>
<td>At times I have focussed on something so hard that I went into a kind of benumbed state of consciousness, and at other times into a state of extraordinary calm and serenity</td>
<td>.45</td>
<td>.38</td>
<td>.23</td>
</tr>
<tr>
<td>If I come across something interesting I drop everything and study it, it is never a waste of time</td>
<td>.47</td>
<td>.41</td>
<td>.30</td>
</tr>
<tr>
<td><strong>K-R20</strong></td>
<td>.68</td>
<td>.41</td>
<td>.65</td>
</tr>
</tbody>
</table>
Appendix 5.6 (continued)

Items used to assess the students' interest in biology.

Generally, how interesting do you find subjects of the following types:

<table>
<thead>
<tr>
<th></th>
<th>Very boring</th>
<th>Rather Dull</th>
<th>Fairly Interesting</th>
<th>Very Interesting</th>
<th>Extremely Interesting</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Art</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>b) Biology</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>c) Commerce</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>d) English</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>e) Foreign Languages</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>f) Humanities and Social Sciences</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>g) Industrial Arts and Crafts</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>h) Mathematics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>i) Music</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>j) Physics or Chemistry</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>k) Secretarial Studies</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
Teachers differed not only in the intensity of emphasis of this learning goal but also in the manner in which their behaviour denoted such a goal. Some teachers, for example, presented series of notes summarising the content of the curriculum, other teachers set and marked all the guide questions of each chapter and others expected their students to know precise definitions, etc. Individual examples of teacher behaviour will now be considered in regard to the teacher's emphasis on specific detail.

Firstly, an excerpt from the notes taken in class no. 12 is presented:

---

**Teacher No. 12**
**Time:** 1st period 9 a.m.
**Start of period:** 6 pupils are in classroom - a few more are walking in - very noisy

**9.05:** Teacher: Alright, today's Tuesday - you know what that means - look at your duckweed experiment for 10 minutes.

**9.09:** Students have wandered back to desks, some jotting down results - most casually talking. Another 10 students have entered the room.

**9.15:** Teacher: Now for the rest of the period you've to get stuck into the guide questions. I want them all done by next week. So do them now - all of them.

Student: What chapter?

Teacher: Chapter 6, look, I set three of them for today. Next period I want to give you some notes on the problems - some of them are very difficult. Go ahead with those guide questions now and hurry up about it.

Student: When do the guide questions need to be done by?

Teacher: I want all guide questions done by end of next week.

Teacher wanders around room, urging students to 'get on with guide questions'. This behaviour continues till about 9.35. Students occasionally ask where to find the answer to a particular question - stock reply is to 'look for it in the chapter'.

**9.35:** Teacher: Now you know what you have to get done by next week. Also you had better start bringing your books for a change, and that means also anything you
need - texts, manuals, pencils, rulers, rubbers, paper, anything at all - don't leave them in your bag, at home, in your bedroom, under your bed or in the car. Alright, we'll do those notes next period.

The next period

Teacher: Everyone with pen in hand and book open. First of all we'll start with a few definitions for Chapter 6.

Student: Will we write this down?

Teacher: I'm giving you a few points for Chapter 6, I'm starting off with a few definitions — first one is plankton: 'microscopic organisms that inhabit the water'

Student: Would you repeat that again?

Teacher: Write quickly — 'microscopic ....'

Student: Is that it? [no reply]

Teacher continues: ... and a subheading of what is a a) phytoplankton - are tiny photosynthetic organisms, tiny photosynthetic organisms.

At the mention of the word 'photosynthetic' students ask the teacher what it means, how to spell it, say they have never heard of it and then one student comments:

Why do we have to write this down - this is already one of the guide questions?

Another student asks: What chapter is this?

Teacher: You'll have to keep up as I can't turn the roll around — it's on the wrong way.

Teacher: e.g. algae, dictoms - they are the major producers of the pond, b) zooplankton - tiny consumers in a water community e.g. alicts, tiny crustaceans. Not all are 1st order consumers - some eat other consumers.

Teacher: Hands up if you haven't finished that

Teacher: Heading under that - properties of water

Student: Are we still on definitions?

Teacher: Water provides an upthrust to objects in it.

This form of lesson continued for the remainder of the double period and was typical of the learning environment for these students. Mostly they spent their lesson time writing down notes; when they were not, they were setting up practical exercises or doing guide questions. During this segment of the curriculum, neither the teacher nor the students actually discussed the problems or the practical exercises; rather, the students generally asked
the teacher a specific question and the teacher gave a specific answer. Yet as two students commented:

Well, I asked [the teacher] what the word adaptation meant and what were physiological examples of it, but she couldn't do it either. So I left it.

Yes, I didn't know what that [physiological adaptation] meant. We weren't given notes on it.

While the learning environment was considered by the researcher to be very factually-orientated the emphasis by the teacher on the retention of those facts was not as high as in some other classes. For example, students were not always sure about what they were expected to do. This was particularly evident in the above lesson and noted by the following student, after that lesson:

Most of the time you don't know what you are doing. You read it but you don't understand it, you don't know why you are doing it. There's also so much chaos in the class.

Further, these students of class no. 12 felt that they were not expected to invest large amounts of intellectual 'energy' in the learning of biology; in fact quite a 'laissez-faire' attitude often prevailed —

It's a fun period, no great strain on the brain. You look on it different than english or maths where you have to use your brains more.

This teacher was subsequently rated 3 on the scale 'emphasis on specific detail'

Teachers used different techniques to emphasise 'recall' of information. Both teachers nos. 16 and 11 often asked questions in such a way that they became 'sentence-completion' tasks, with the words to be filled in denoted by voice inflexions:

e.g. Food requirements in the plant are made in the__________ due to the process of ________ which is the process whereby ________ to give ____________ (No. 11)*

Teacher no. 11 also employed techniques which he referred to as 'key' words to summarise the text and described this learning process to his class as follows:

Out of page 164, pick out what you think are the important words of that section - I don't want sentences - shouldn't take long ...
Main words that effectively summarise the

* This number refers to the class in which the student was found.
text. By this stage you should be able to flick through pages, not reading every word, but able to pick out those things that stand out ... for example, reproduction and development - think of eggs, frog ....

A final example of the diversity of those aspects of the learning environment likely to lead to the specification of this particular learning goal characterised class no. 13. On reading through some student biology folders the researcher noticed that often a set of guide questions had been done by the students on two occasions, and on each occasion had been marked by the teacher. The students explained that their section - or topic - 'tests' were usually a repetition of the guide questions that they had done in class. Two further points need to be made with regard to this class:

a) Following the presentation of the Cognitive Readiness Test, these students remained quite hostile to the researcher for the first week. The form of biological knowledge that the teacher had defined as likely to be evaluated in their school assessments was incongruent with the biological knowledge evaluated by the Cognitive Readiness Test. Later the researcher learnt that in the subsequent period, which he had not attended for the above reason, this teacher gave another test of a very factual nature to appease the students.

b) In this class, the researcher's presence brought about the greatest change over the period of this work. This was particularly evident following the Achievement Test. This test itself seemed to broaden the learning goals of the student as well as the construction of the teacher's own tests, a point noted during the subsequent interview period.

In nearly all classes there was some emphasis on the retention of specific detail dealt with in the curriculum. Only in the case of classes 18 and 26 did the researcher consider that the teacher did not emphasise to any degree this learning goal.

In Appendix 5.8(f) are the researcher's ratings for each of the classes on this dimension together with the class consensus scores obtained by means of the Biology Students and Classroom Perceptions Questionnaire.
Emphasis on the meaningful integration of course material was not as widespread throughout the sample as was the learning goal 'emphasis on specific detail'. The following excerpt, taken from the notes of class no. 24, is one case where there was a high degree of integration. An expository approach to instruction, similar to that of teachers nos. 16 and 11 in the previous section, characterised this teacher's behaviour:

Teacher No. 24
Time: 1st period 9 a.m.
Start of period: Most students present.

Teacher: Some preliminaries ... I'd like you to do problems 1, 3, 6, 7, 8, 13. These are to be done during this chapter and should help you understand the topic ....

The teacher then presented to the class, using an overhead transparency, a passage concerning a description of oceans - taken from Cousteau. It is closely integrated with the chapter topic and the planned-exursion, and is used by the teacher to raise questions and to give the underlying themes to the chapter.

Teacher: Now these questions are not specifically found in the text but I'd like to consider them as a way of orienting ourselves to the topic ...

Where do oceans come from?
Why are they salty?
Where is most production occurring? and
Which zone is most prolific?

Before we look at these problems we must look at some important properties of water ....

The teacher then introduces the term biosphere as he relates the land and water environment. Teacher introduces many new facts as he builds up a picture of the ocean ....

... how many molecules of water are found in the oceans ... how much water is contained in the glaciers, ice caps ... what percentage of the earth's environment is made up of water ...

Now what are the specific properties of water that make it so important ... its unique [teacher then describes molecular structure] ... its a liquid ... its specific heat ... and this results in, because of a time (e.g. warm masses of water for most of winter and colder, relatively, masses of water in
the early summer) ... and thirdly, water has a particular ability to dissolve substances ...

In this section the teacher has been questioning students, asking students for their own examples, etc. To illustrate the properties of water that are being discussed there is a presentation of slides, taken near Robe, S.A. to show the effect of the sea and weather on the coastline. Note:

(i) there is a great emphasis on details of type of rock, etc.

(ii) the slides are related to earlier chapters - from when we were doing work on plant classification what type of plant would you expect to be present on [that] rock?
What is the food requirements of these [low salty bushes]?

(iii) very clear explanations given to student question re slides. The teacher is a) looking for and presenting evidence b) then developing the idea or answer.

Student: Sir, why are the rocks hollowed out like that?
Teacher: Well, in the background [of the slide] there is the sea ... What are the rocks made of?
Student: Sandstone.
Teacher: What will happen to the sandstone?
Student: Weather away the sides of the rocks.

This was an introductory lesson to Chapter 6 and it was directed at placing the topic in relation to both the earlier chapters and also the students' general knowledge of the sea. Yet apart from teachers nos. 20, 24 and 27 such an introduction to the topic was rare, as were introductory comments to laboratory exercises and discussions in general. For example, prior to the students setting up two laboratory exercises, teacher no. 16 commented as follows:

(i) You are setting up exercise 6.5 in this period. You should have read it for homework - I won't waste time going through the introduction or discussing its purpose ... If you haven't read that, then do it tonight ...

(ii) Quickly, last night you should have read 7.2. I won't comment on that ... any questions, quickly. Right, quickly, get yourselves organised.
In both these instances, there was no attempt to integrate the concepts dealt with in the laboratory exercise either before the laboratory exercise was commenced, or in the subsequent period, with the course as a whole or more general biological knowledge. And this lack of emphasis on integration was also typical of this teacher's introduction to the topic, as described by the following student:

Well, [teacher no. 16] walked in, yelled out that we were to set up exercise 6.2 and that was all.

The difference in approach between teachers rated high and low on this dimension was best summed up by a student in a class rated low on emphasis on integration who compared her class (no. 28) with a parallel class where the teacher had been rated high on emphasis on integration (No. 27):

Well I think they are taught better, I mean [teacher no. 27], before he starts a lesson he tells them what they are doing and how they are to apply it and everything. Sometimes I come in here and I don't know what I am supposed to be doing, why, and how it fits in ... [teacher no. 28] says alright go on with this work ... whereas with [teacher no. 27] everything must be explained and they must know why they are doing it ... [teacher no. 27] always wants the students to use extra books ... they enjoy it more ...' (no. 28)

Teacher no. 27 introduced Chapters 6 and 7 in a manner similar to teacher no. 24, but with one major and interesting difference. He stated to the students quite clearly the 'major ideas' outlined in the Teachers Guide (1973), that would be developed throughout the topic - a type of global 'advance organiser' approach. The meaning of each of these major ideas was discussed and the prescribed activities in 'Living in Water' and 'Living on Land' were related to each of these 'major ideas'. Apart from this 'introductory' type of lesson this teacher generally did not apply an expository approach to instruction, as will be demonstrated in the following section of this appendix. This teacher did, in fact, relate the contents of the topic to far broader areas of knowledge than did teacher no. 24, who had also been rated high on this dimension.

Major ideas are described as major generalisations in biological science (Teacher's Guide, 1973).
For example, in discussing laboratory exercise 7.1, dealing with heat loss in biological systems, teacher no. 27 referred to a wide range of applications of this principle, including Norwegian string singlets, woollen and synthetic jumpers, hypothermia, the evolution of social habits such as siestas, and biological changes that could be brought about by variability in the atmosphere. Yet this discussion was not planned in advance; it occurred as the teacher moved informally around the groups of students in his class, and typified very much this teacher's interaction with his students.

On only a few occasions did this teacher answer directly student questions; rather, by use of a variety of examples, and many suggested by the students themselves, he would assist the student in 'constructing' an answer, and usually an answer that was relevant not only to the prescribed curriculum but also to the student's general knowledge.

Teacher no. 27 was rated low on the dimension of 'emphasis on specific detail'. Yet some teachers presented their curricula so as to emphasise both learning goals. Teacher no. 20 was a case in point, and represented the best example of the necessity of the researcher to be present during many lessons and to build up, over that period of time, an understanding of the learning environment. On the initial visits it was clearly evident that this teacher emphasised integration of the topic being studied within the curriculum and beyond it e.g. in the laboratory exercise 7.4 dealing with support systems in organisms the following notes were made:

a) only teacher in sample to refer back to exercise 4.1, 'the chemical composition of food materials', in discussing the presence of lignin in flowering plants

b) when the students walked into the classroom they were confronted with a great diversity of skeletons - by far more than I have ever seen in any classroom.

Yet it soon became evident that as well as integrating this material the teacher also expected the students to be able to

2 The teacher had rearranged the order of the curriculum and placed this exercise earlier, and broadened it to include fish and other animal skeletons, not prescribed in the exercise.
recall many of the specific aspects of the curriculum which she presented. The relationship between both these learning goals was evident in the types of assessment used throughout this period:

1) spontaneous little questions which the students answered and handed in, e.g.
   a) what do you think evolution is?
   b) list all the different aspects of the environment that an organism may need to adapt to

2) spontaneous formal questions, generally taken from the external Higher School Certificate examinations.

While not explicitly requiring the student to recall details, etc. (notice the words 'you think') the method of marking these questions and the spontaneity of them resulted in the students believing that they were expected to know many details of the curriculum which she presented, as well as to integrate the underlying concepts in that curriculum. One student discussed this relationship as follows:

If she wants us to talk about evolution she asks us to think of some practical examples of evolution, to see it actually working, and we come up with a couple of examples, bacteria and insects are always constantly evolving, you can give insecticides and bacteriocides and the like, small things like this which are fact and which back up a statement in an essay for example ... what she expects of us are scientific answers (no. 20)

Teacher no. 20 was rated high on both emphasis on integration and emphasis on specific detail.

In Appendix 5.8(e) are the researcher's ratings for each of the classes on this dimension together with the class consensus scores obtained by means of the Biology Students and Classroom Perceptions Questionnaire.
Appendix 5.7(c)

The Assessment of the Learning Environment with respect to those Properties likely to Facilitate the Arousal of Intrinsic Motivation

The assessment of this aspect of the learning environment was found to be more difficult than in the case of the learning goals, possibly because there was a lesser degree of variation between teachers in their presentation of the curriculum in a manner likely to facilitate the arousal of intrinsic motivation. For example, it was only in classes nos. 17, 20 and 27 was the researcher not surprised to see students reading books related to their curriculum (other than, of course, the textbook and laboratory manual). This researcher can only recall two occasions when a student from the remaining classes actually consulted a reference book. The following student summarised his teacher's presentation of the curriculum accordingly:

We don't need any reference materials - we don't have to go past the book. The stuff in the book is laid out cut and dry and there is nothing beyond it really. Certainly the way it is presented to us there is no need for us to go beyond it, to the library or to our scientific magazines (no. 19).

Yet in class no. 27, rated high on this dimension, it was common to see students reading library books such as the Time-Life series, e.g. researcher's notes:

i) student reading 'Odum' [Fundamentals of Ecology] when writing up pondwater excursion

ii) psychology book on intelligence being studied - intelligence as an example of adaptation.

Student freedom to seek out information in order to solve problems, etc. generally was not encouraged. This was apparent to the researcher in a number of ways. For instance, the pace of some lessons (and teachers) was intense - teacher no. 16 used the command 'quickly' thirty-two times in a 50-minute lesson, in giving directions and asking questions:

Quickly, get the answers to the questions and then top up 6.5. Quickly, have a look at those questions 1, 3 up to 7. At least think about them quickly so that we can discuss them. Hurry up now.

The intense pace of this lesson continued with the teacher asking
questions, but often not waiting for a student reply. The discussion of the questions and answers to exercise 6.2 [a short but theoretically fundamental exercise] lasted seven minutes. In this time each question contained in that exercise was read aloud by the teacher. Similarly the discussion of exercise 7.4 lasted eighteen minutes. (Researcher's note: many students not aware of which question teacher is up to). This teacher was subsequently rated low on the dimension facilitation of intrinsic motivation.

Alternatively this lack of freedom was more covert, as in the case of teacher no. 18. This teacher had allocated, at the beginning of the school year, a prescribed activity for each period throughout the year. For example:

<table>
<thead>
<tr>
<th>Week</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>7.7.75</td>
<td>8.7.75</td>
<td>9.7.75</td>
<td>10.7.75</td>
</tr>
<tr>
<td></td>
<td>Ex. 7.1</td>
<td>Ex. 7.1 (cont.)</td>
<td>Ex. 7.2</td>
<td>Ex. 7.4</td>
</tr>
<tr>
<td>9</td>
<td>14.7.75</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ex. 7.4 (cont.)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This emphasis upon the laboratory exercises and its restricting aspect upon the students' intellectual freedom was evident in two ways:

a) At the beginning of each laboratory exercise the teacher read verbatim the entire exercise as it is written in the laboratory manual. (Researcher's note: check with students and teacher to see if this is typical - answer yes). This procedure often occupied 20 minutes during which time the students remained quite passive.

b) At no time during this research period were problems set and discussed. At the conclusion of the study, a group of students asked me why there were problems at the end of each chapter and whether it was necessary that they did them. The students confirmed that at no stage during the year had problems been set by their teacher. Due to the highly structured nature of their 'learning programme' the students and teacher never perceived the opportunities for divergence and elaboration.

Yet it is not sufficient for the facilitation of intrinsic-motivated behaviour just to give students the opportunity to seek other sources of information, etc. Students must also be encouraged to resolve cognitive conflict, once generated in a meaningful manner. Hence the following student's comment typified the approach of teacher no. 20, who received a high rating on this dimension:
... [the teacher] would always give you [the teacher's] point of view but would never force it on you ... wants us to make up our own minds ... produce our own answers.

This attempt on the teacher's part, to maintain conflict until it could be meaningfully resolved contrasts markedly with the following incident, recorded in class no. 12:

Student: Have we an eye glass thing?
Teacher: Yes - can't you find it?
Student: No
Teacher: Can you see the root hairs if you hold it up to the light?
Student: No (holding it up)
Teacher: Would you expect to find root hairs on it?
Student: Aw yes, will that do?
Teacher: Yes, you should be able to answer the question.

Teacher no. 12 received a low rating on the dimension facilitation of intrinsic motivation.

For many students the major portion of their classtime was spent in doing laboratory exercises. Yet it was during these learning activities that the students expressed most dissatisfaction with the curriculum, often complaining that the laboratory manual failed 'to come up with any surprises'. This lack of conflict generation was evident in the following student's comment:

You know what is going to happen, it takes the interest away knowing what is going to happen all the time. (No. 22)

Did the questions prescribed in the laboratory manual generate conflict in the minds of the students? Were the questions sufficiently arousing for the students to seek meaningful resolution of cognitive conflict, if generated? Again, the majority of students found these questions tedious:

Eventually ... you usually don't feel like doing them ... If the teacher says we have to hand in a set of questions [exercises], [friend] and I whip it up in one night and hand it in the next day ... typically for experiments we answer the questions after about three weeks (of doing them) (No. 23)

Two further factors, relevant to the usefulness of these laboratory exercises as a means of arousing intrinsic motivation, became obvious throughout the study. The first related to the school
'organisation' and the second to the teacher's usage of these laboratory exercises. Many of the practical exercises, commenced by the students, were never completed due to the restrictions of the school timetable. Class no. 20 was an exception in this regard.

In a school which operated on a 'rotating' timetable this problem was still evident:

You usually go halfway through a prac. and that's it ... the timing is all wrong in biology. If you are doing an experiment in biology and the bell goes you just leave it and that's it. Usually you do not get around to coming back to it, so it is left unfinished ... there have been a real lot of unfinished experiments that I would have liked to have done. (No. 26)

A second factor militating against intrinsic-motivated behaviour was the teachers' tendencies to mark students' answers to questions contained in the laboratory exercise on the basis of 'correct results'. Most students interviewed copied other students' results if their experiment was not 'successful'. The following statement was typical:

If the experiment doesn't work we go to somebody else and get their results ... you have to hand it up and it looks better when you get results that you are supposed to. When you read the aim of the experiment you get a good idea of the type of result you are expected to get. And if you don't get that result and put it down, it's pretty obvious you won't get as good a mark as someone who got it to work. (No. 13)

An emphasis on marking all student activities typified the sample - although there were a couple of exceptions, e.g. classes 20 and 27. The effect of marking upon the meaningful resolution of conflict aroused by the Problems was apparent:

We have to write half a page on each problem and they are worth 20 marks each. I thought they would be useful but ... well, it's lousy, you think about them and reckon you have got some good ideas but [the teacher's] got her opinion - and you write a whole page on two problems and look [14/20] - and no comments. (No. 13)

Throughout the observational period it was apparent that many teachers felt that all student activities needed to be marked. However, this was time-consuming and often led to marks being given
without reasons, etc. accompanying them (e.g. above student's comment). Alternatively, a few teachers appeared to mark student answers on 'quantity rather than quality'. Consider the following comments:

i) [the teacher] gives tick, tick ... expand, question mark here and there, that sort of stuff and marks it out of 1, 2, 3 ... it would be better if you found out what you had done wrong ... but [the teacher] never discusses it with you, also [the teacher] takes a long time to mark it and by the time you get them back you have forgotten what they are about. (No. 23)

ii) 9 out of 10, 10 out of 10, so what's the point - [the teacher] never reads them. (No. 28)

Neither class no. 23 or class no. 28 were subsequently given a high rating on the facilitation of intrinsic motivation.

The form of marking that typified many classes in the sample was judged by the researcher to be detrimental to the facilitation of intrinsic motivation.

In Appendix 5.8(g) are the researcher's ratings for each of the classes on this dimension together with the class consensus scores obtained by means of the Biology Students and Classroom Perceptions Questionnaire.
## Appendix 5.8(a)

### Learning Goal Expectancy and Facilitation of Intrinsic Motivation

#### Rating Scale

<table>
<thead>
<tr>
<th>Class No.</th>
<th>Date:</th>
<th>********************</th>
</tr>
</thead>
</table>

The scale contains a number of statements about teaching practices employed in the presentation of the Biology curriculum. Consider each statement and decide whether it describes what happens, or is stressed in the biology class. Of course, only some will be appropriate to any one lesson.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>?</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

<p>| Questions asked by the teacher require the recall of specific information | 1 | 2 | 3 | 4 | 5 |
| Answers accepted by the teacher are characterised by the recall of specific information | 1 | 2 | 3 | 4 | 5 |
| Questions asked by the students are characteristically fact seeking | 1 | 2 | 3 | 4 | 5 |
| Answers given by the teacher are characterised by the recall of specific information | 1 | 2 | 3 | 4 | 5 |
| Teacher sets guide questions to be done during class time | 1 | 2 | 3 | 4 | 5 |
| Teacher marks the guide questions done by students | 1 | 2 | 3 | 4 | 5 |
| Teacher marks the problems done by students | 1 | 2 | 3 | 4 | 5 |
| Students write detailed answers to the guide questions | 1 | 2 | 3 | 4 | 5 |
| Teacher dictates notes summarising the contents of the curriculum | 1 | 2 | 3 | 4 | 5 |
| Students refer to reference books during the lesson | 1 | 2 | 3 | 4 | 5 |
| The teacher encourages the students to seek their own answers to problems that arise in the lesson | 1 | 2 | 3 | 4 | 5 |
| The teacher encourages the students to give their own opinions in discussion periods | 1 | 2 | 3 | 4 | 5 |</p>
<table>
<thead>
<tr>
<th></th>
<th>Strongly Agree</th>
<th>?</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>The teacher encourages the students to attempt the 'For Further Investigation'</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Students are given assignments that allow them to explore possibilities and state their own opinions</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Teacher emphasises the forthcoming H.S.C. examination</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Students are free to pursue those activities that are of interest to them</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Students are free to pursue those activities that are prescribed by the teacher at their own rate</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Teacher indulges in explanation as a method of presenting information or answering specific questions</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Teacher uses materials derived from sources that are not specifically prescribed</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Teacher explicitly uses more than one related prescribed activity during a lesson</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Teacher uses only one form of prescribed activity in any one lesson¹</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Integration of course material with materials outside of the set curriculum</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Integration of course material with material dealt with in earlier sections of course, or with future sections</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Presentation of materials in an implicitly non-integrative manner (generally passive presentation)</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Extra comments:
Appendix 5.8(b)

Classroom Perception Scale: Emphasis on Specific Detail

<table>
<thead>
<tr>
<th>Item</th>
<th>Corrected Item-Total Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>We are expected to memorise most of what the teacher tells us</td>
<td>.45</td>
</tr>
<tr>
<td>Our teacher often repeats almost exactly what the textbook says</td>
<td>.33</td>
</tr>
<tr>
<td>When reading the text, we are expected to learn most of the details that are stated there</td>
<td>.41</td>
</tr>
<tr>
<td>Our practical work often consists of thoroughly learning the names of specific structures and specific sequence of events</td>
<td>.36</td>
</tr>
<tr>
<td>We are expected to write down and pretty well memorise what is contained in the guide question</td>
<td>.37</td>
</tr>
</tbody>
</table>

\[ \alpha = .63 \]
<table>
<thead>
<tr>
<th>Item</th>
<th>Corrected Item-Total Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Our practical exercises usually seem relevant to the topic that we are studying</td>
<td>.33</td>
</tr>
<tr>
<td>When reading the textbook, we are usually expected to look for the main ideas and for the evidence that supports them</td>
<td>.28</td>
</tr>
<tr>
<td>When studying a new section of work we often talk about related ideas we have studied before</td>
<td>.53</td>
</tr>
<tr>
<td>We often discuss the problems faced by scientists in the discovery of a scientific principle</td>
<td>.46</td>
</tr>
<tr>
<td>We sometimes discuss practical applications of biological knowledge</td>
<td>.38</td>
</tr>
<tr>
<td>We often discuss the evidence that is behind statements made in the textbook</td>
<td>.50</td>
</tr>
<tr>
<td>When we learn about a new biological concept or principle we are not just told about it; the teacher explains the evidence and the reasoning behind it very carefully</td>
<td>.48</td>
</tr>
<tr>
<td>We sometimes talk about the kind of evidence that is behind a scientist's conclusion</td>
<td>.36</td>
</tr>
<tr>
<td>When reading the textbook, we are expected to look for the main ideas and think how they relate to preceding sections of our course</td>
<td>.41</td>
</tr>
<tr>
<td>When studying a new section of work we usually talk about how it fits into the study of biology as a whole</td>
<td>.41</td>
</tr>
</tbody>
</table>

$\alpha = .76$
Appendix 5.8(d)

Classroom Perception Scale: Facilitation of Intrinsic Motivation

<table>
<thead>
<tr>
<th>Item</th>
<th>Corrected Item-Total Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>We sometimes do some additional experimenting of our own when we have finished the set practical exercises</td>
<td>.44</td>
</tr>
<tr>
<td>We are encouraged to use reference materials, go to the library, etc. to investigate problems and topics that come up in class</td>
<td>.49</td>
</tr>
<tr>
<td>We are encouraged to use the laboratory to investigate problems that come up in class</td>
<td>.54</td>
</tr>
<tr>
<td>We are sometimes able to choose which problems we will discuss</td>
<td>.49</td>
</tr>
<tr>
<td>For some of the work we are given a programme to follow so that we can work at our own pace</td>
<td>.38</td>
</tr>
<tr>
<td>We are often given assignments that allow us to explore possibilities and state our own thoughts even if we are not certain if they are correct</td>
<td>.40</td>
</tr>
<tr>
<td>All students in the class do the same exercises and the same problems</td>
<td>.31</td>
</tr>
<tr>
<td>There is ample opportunity to do 'follow-up' studies and investigations into topics that we find particularly interesting</td>
<td>.36</td>
</tr>
<tr>
<td>We sometimes design our own experiments to seek answers to questions that puzzle us</td>
<td>.42</td>
</tr>
<tr>
<td>We never have the chance to try our own ways of doing the practical work</td>
<td>.37</td>
</tr>
</tbody>
</table>

\[ \alpha = .76 \]
Appendix 5.8(e)

Researcher's Ratings and Class Consensus Scores for Emphasis on Integration

<table>
<thead>
<tr>
<th>Class Number</th>
<th>Researcher's Ratings</th>
<th>Emphasis on Integration</th>
<th>Classroom Perception Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Class Mean</td>
</tr>
<tr>
<td>11</td>
<td>2</td>
<td>23.22</td>
<td>5.92</td>
</tr>
<tr>
<td>12</td>
<td>6</td>
<td>23.84</td>
<td>3.23</td>
</tr>
<tr>
<td>13</td>
<td>7</td>
<td>28.06</td>
<td>4.75</td>
</tr>
<tr>
<td>15</td>
<td>4</td>
<td>24.05</td>
<td>4.55</td>
</tr>
<tr>
<td>16</td>
<td>5</td>
<td>27.33</td>
<td>5.28</td>
</tr>
<tr>
<td>17</td>
<td>2</td>
<td>24.23</td>
<td>4.12</td>
</tr>
<tr>
<td>18</td>
<td>7</td>
<td>30.44</td>
<td>6.14</td>
</tr>
<tr>
<td>19</td>
<td>4</td>
<td>25.28</td>
<td>6.01</td>
</tr>
<tr>
<td>20</td>
<td>1</td>
<td>22.90</td>
<td>4.35</td>
</tr>
<tr>
<td>21</td>
<td>2</td>
<td>23.87</td>
<td>3.62</td>
</tr>
<tr>
<td>22</td>
<td>3</td>
<td>23.67</td>
<td>2.62</td>
</tr>
<tr>
<td>23</td>
<td>6</td>
<td>24.74</td>
<td>5.91</td>
</tr>
<tr>
<td>24</td>
<td>1</td>
<td>23.00</td>
<td>3.95</td>
</tr>
<tr>
<td>25</td>
<td>3</td>
<td>24.60</td>
<td>4.87</td>
</tr>
<tr>
<td>26</td>
<td>4</td>
<td>27.71</td>
<td>6.32</td>
</tr>
<tr>
<td>27</td>
<td>1</td>
<td>23.45</td>
<td>2.95</td>
</tr>
<tr>
<td>28</td>
<td>5</td>
<td>26.29</td>
<td>4.30</td>
</tr>
</tbody>
</table>
Appendix 5.8(f)

Researcher's Ratings and Class Consensus Score for Emphasis on Specific Detail

<table>
<thead>
<tr>
<th>Class Number</th>
<th>Researcher's Ratings</th>
<th>Classroom Perception Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Class Mean</td>
</tr>
<tr>
<td>11</td>
<td>2</td>
<td>14.07</td>
</tr>
<tr>
<td>12</td>
<td>3</td>
<td>13.68</td>
</tr>
<tr>
<td>13</td>
<td>3</td>
<td>15.30</td>
</tr>
<tr>
<td>15</td>
<td>4</td>
<td>15.54</td>
</tr>
<tr>
<td>16</td>
<td>2</td>
<td>15.60</td>
</tr>
<tr>
<td>17</td>
<td>5</td>
<td>16.88</td>
</tr>
<tr>
<td>18</td>
<td>7</td>
<td>16.25</td>
</tr>
<tr>
<td>19</td>
<td>3</td>
<td>16.48</td>
</tr>
<tr>
<td>20</td>
<td>2</td>
<td>13.97</td>
</tr>
<tr>
<td>21</td>
<td>4</td>
<td>14.78</td>
</tr>
<tr>
<td>22</td>
<td>6</td>
<td>14.11</td>
</tr>
<tr>
<td>23</td>
<td>5</td>
<td>13.90</td>
</tr>
<tr>
<td>24</td>
<td>1</td>
<td>14.58</td>
</tr>
<tr>
<td>25</td>
<td>3</td>
<td>14.53</td>
</tr>
<tr>
<td>26</td>
<td>7</td>
<td>17.20</td>
</tr>
<tr>
<td>27</td>
<td>6</td>
<td>16.40</td>
</tr>
<tr>
<td>28</td>
<td>5</td>
<td>15.89</td>
</tr>
</tbody>
</table>
### Appendix 5.8(g)

Researcher's Ratings and Class Consensus Scores for Facilitation of Intrinsic Motivation

<table>
<thead>
<tr>
<th>Class No.</th>
<th>Researcher's Ratings</th>
<th>Classroom Mean</th>
<th>Perception Scale Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>4</td>
<td>35.50</td>
<td>4.2111</td>
</tr>
<tr>
<td>12</td>
<td>6</td>
<td>34.31</td>
<td>5.2074</td>
</tr>
<tr>
<td>13</td>
<td>3</td>
<td>30.00</td>
<td>5.7321</td>
</tr>
<tr>
<td>15</td>
<td>3</td>
<td>34.47</td>
<td>4.9145</td>
</tr>
<tr>
<td>16</td>
<td>6</td>
<td>37.87</td>
<td>5.5532</td>
</tr>
<tr>
<td>17</td>
<td>2</td>
<td>33.82</td>
<td>5.5532</td>
</tr>
<tr>
<td>18</td>
<td>5</td>
<td>35.67</td>
<td>4.9229</td>
</tr>
<tr>
<td>19</td>
<td>5</td>
<td>34.89</td>
<td>5.7178</td>
</tr>
<tr>
<td>20</td>
<td>1</td>
<td>31.85</td>
<td>6.1668</td>
</tr>
<tr>
<td>21</td>
<td>4</td>
<td>35.67</td>
<td>5.7280</td>
</tr>
<tr>
<td>22</td>
<td>2</td>
<td>33.07</td>
<td>3.5349</td>
</tr>
<tr>
<td>23</td>
<td>6</td>
<td>37.89</td>
<td>5.7629</td>
</tr>
<tr>
<td>24</td>
<td>4</td>
<td>35.39</td>
<td>5.1236</td>
</tr>
<tr>
<td>25</td>
<td>5</td>
<td>38.13</td>
<td>5.1235</td>
</tr>
<tr>
<td>26</td>
<td>2</td>
<td>31.36</td>
<td>7.0668</td>
</tr>
<tr>
<td>27</td>
<td>1</td>
<td>32.82</td>
<td>3.3755</td>
</tr>
<tr>
<td>28</td>
<td>3</td>
<td>33.43</td>
<td>4.7671</td>
</tr>
</tbody>
</table>
Appendix 5.8(h)

Results of ANOVA used to test the sensitivity of the classroom perception scales to differences in the learning environments on each of three dimensions.

1. **ANOVA for classroom perception scale: emphasis on specific detail**

   **ANOVA Table**

<table>
<thead>
<tr>
<th>Sum of squares</th>
<th>Degrees of freedom</th>
<th>Mean square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>347.1830</td>
<td>( 16)</td>
</tr>
<tr>
<td>Within groups</td>
<td>2536.9733</td>
<td>( 284)</td>
</tr>
<tr>
<td>Total</td>
<td>2884.1563</td>
<td>( 300)</td>
</tr>
</tbody>
</table>

   \[ F = 2.4291 \ (p < .01) \]

2. **ANOVA for classroom perception scale: emphasis on integration**

   **ANOVA Table**

<table>
<thead>
<tr>
<th>Sum of squares</th>
<th>Degrees of freedom</th>
<th>Mean square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>1379.2098</td>
<td>( 16)</td>
</tr>
<tr>
<td>Within groups</td>
<td>6426.3156</td>
<td>( 282)</td>
</tr>
<tr>
<td>Total</td>
<td>7805.5254</td>
<td>( 298)</td>
</tr>
</tbody>
</table>

   \[ F = 3.7827 \ (p < .01) \]

3. **ANOVA for classroom perception scale: facilitation of intrinsic motivation**

   **ANOVA Table**

<table>
<thead>
<tr>
<th>Sum of squares</th>
<th>Degrees of freedom</th>
<th>Mean square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>1566.0427</td>
<td>( 16)</td>
</tr>
<tr>
<td>Within groups</td>
<td>7806.5393</td>
<td>( 281)</td>
</tr>
<tr>
<td>Total</td>
<td>9372.5820</td>
<td>( 297)</td>
</tr>
</tbody>
</table>

   \[ F = 3.5232 \ (p < .01) \]
Appendix 5.8(1)

VARIMAX ROTATED FACTOR MATRIX

<table>
<thead>
<tr>
<th></th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>VAR54</td>
<td>0.52940</td>
<td>0.00923</td>
<td>0.01002</td>
</tr>
<tr>
<td>VAR72</td>
<td>0.53691</td>
<td>0.20108</td>
<td>-0.09971</td>
</tr>
<tr>
<td>VAR49</td>
<td>0.61403</td>
<td>0.14312</td>
<td>-0.03953</td>
</tr>
<tr>
<td>VAR58</td>
<td>0.57328</td>
<td>0.07455</td>
<td>-0.04618</td>
</tr>
<tr>
<td>VAR60</td>
<td>0.42553</td>
<td>0.15312</td>
<td>-0.02822</td>
</tr>
<tr>
<td>VAR67</td>
<td>0.45479</td>
<td>0.09957</td>
<td>-0.00152</td>
</tr>
<tr>
<td>VAR56</td>
<td>0.38369</td>
<td>-0.05350</td>
<td>-0.04781</td>
</tr>
<tr>
<td>VAR66</td>
<td>0.39906</td>
<td>0.19569</td>
<td>-0.01394</td>
</tr>
<tr>
<td>VAR51</td>
<td>0.44717</td>
<td>0.15644</td>
<td>-0.09924</td>
</tr>
<tr>
<td>VAR53</td>
<td>0.41388</td>
<td>0.06673</td>
<td>-0.12058</td>
</tr>
<tr>
<td>VAR37</td>
<td>-0.14369</td>
<td>0.14311</td>
<td>0.60330</td>
</tr>
<tr>
<td>VAR52</td>
<td>-0.05234</td>
<td>0.07395</td>
<td>0.41389</td>
</tr>
<tr>
<td>VAR44</td>
<td>-0.02489</td>
<td>0.09288</td>
<td>0.55949</td>
</tr>
<tr>
<td>VAR41</td>
<td>-0.19908</td>
<td>-0.17287</td>
<td>0.44261</td>
</tr>
<tr>
<td>VAR62</td>
<td>0.02945</td>
<td>0.01100</td>
<td>0.48262</td>
</tr>
<tr>
<td>VAR63</td>
<td>0.27155</td>
<td>0.42766</td>
<td>0.10912</td>
</tr>
<tr>
<td>VAR69</td>
<td>0.14983</td>
<td>0.42135</td>
<td>0.09563</td>
</tr>
<tr>
<td>VAR40</td>
<td>0.07400</td>
<td>0.45076</td>
<td>-0.06500</td>
</tr>
<tr>
<td>VAR70</td>
<td>0.10292</td>
<td>0.53112</td>
<td>-0.02177</td>
</tr>
<tr>
<td>VAR43</td>
<td>0.10489</td>
<td>0.55376</td>
<td>0.13244</td>
</tr>
<tr>
<td>VAR59</td>
<td>0.32567</td>
<td>0.38065</td>
<td>0.03114</td>
</tr>
<tr>
<td>VAR38</td>
<td>0.03260</td>
<td>0.53401</td>
<td>0.10927</td>
</tr>
<tr>
<td>VAR42</td>
<td>0.12704</td>
<td>0.58005</td>
<td>-0.02054</td>
</tr>
<tr>
<td>VAR45</td>
<td>0.02327</td>
<td>0.34057</td>
<td>0.10251</td>
</tr>
<tr>
<td>VAR50</td>
<td>0.05151</td>
<td>0.39139</td>
<td>-0.17300</td>
</tr>
</tbody>
</table>
Appendix 5.9

Student Characteristics and their Perceptions of the Learning Environment

Students within classes differed in their perceptions of the learning environment as measured by the classroom perception scales contained within the Biology Students and Classroom Perception Questionnaire (BSCPQ). An examination of the class variances for each scale indicates that in a number of cases these differences were quite marked (e.g. see Appendix 5.8). This suggests an alternative approach to the analysis of the interactive perspective that underlies this study. This approach focuses directly upon the student's construction of a knowledge of the learning environment as a function of his interaction with that environment. For the question arises as to whether student perceptions of the learning environment as indicated by the BSCPQ were, in fact, influenced by the levels of intrinsic motivation, interest in biology, achievement motivation and cognitive readiness that characterised the respondents. Evidence of a relationship between these student characteristics and student perceptions of the learning environment would support the interactive perspective adopted in this study.

These relationships could be of two types:

a) the students' perception of his learning environment could be considered an additive function of both the personality variables that characterise the student and the environment itself. This understanding of the relationship closely resembles the notion of 'projection' described by Stern (1970) and Gardner (1975). However, the interactive perspective outlined in Chapter 1 leads to a different view of the possible relationship between student characteristics and student perceptions of the learning environment. It suggests that:

b) the relationship could itself be an interactive one if the personality variable is considered as interacting with a

---

1 As described in Chapter 5. These were used to check the reliability of the researcher's ratings of the learning environment.
particular dimension of the learning environment to produce a particular pattern of behaviour. As a result the student's perception of his learning environment could be considered an *interactive* function of both the personality variables that characterise the student and the environment itself.

The following analyses to be presented consider the relationship between the student's knowledge of his learning environment and those student characteristics examined in this study within this general framework. Firstly, an additive model, including both student characteristics and the researcher's ratings of the learning environment as independent variables is examined as a means of explaining student differences in their knowledge of that environment. Secondly, the interactive model, incorporating the interaction between both these sets of independent variables, will be considered.

a) **Student perceptions of their learning environment - an additive model**

A multiple stepwise regression analysis was used to examine the relationships between the students' levels of intrinsic motivation, achievement motivation, interest in biology and cognitive readiness and their perceptions of those dimensions of the learning environment relevant to this study. The following 2-term regression model was proposed:

\[
\text{Student score on particular classroom} = \beta_1 \text{ researcher's rating of corresponding classroom dimension} + \beta_2 \text{ student characteristic rating of corresponding classroom dimension}
\]

The simple correlations between the students' perceptions of their learning environment and each of the student characteristics are reported in Table 1. However, it is the partial correlation between each student characteristic and his score on a particular classroom perception scale, that results following the entry of the researcher's rating of that dimension in the regression equation, which is of interest.

After controlling for the effects of the researcher's rating

2 In the case of achievement press this was the consensual (class mean) press score.
of the relevant dimensions of the learning environment, four significant relationships were present. The students' perception of the teacher's emphasis on integration was positively related to the students' levels of both interest in biology and achievement motivation.

Table 1

Correlations between the Students' Levels of Intrinsic Motivation, Achievement Motivation, Cognitive Readiness, Interest in Biology and their Perceptions of Four Dimensions of the Learning Environment

<table>
<thead>
<tr>
<th>Classroom Perception Scale</th>
<th>Emphasis on Emphasis on Facilitation Achievement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intrinsic Motivation</td>
<td>.09</td>
</tr>
<tr>
<td>Achievement Motivation</td>
<td>.14**</td>
</tr>
<tr>
<td>Cognitive Readiness</td>
<td>-.05</td>
</tr>
<tr>
<td>Interest in Biology</td>
<td>.25***</td>
</tr>
</tbody>
</table>

* p < .05, ** p < .01, *** p < .001

After entering the researcher's rating of the classroom in the equation, the partial correlation between the students' perception of their teachers' emphasis on integration and their level of interest in biology was .26; and between the students' perception of emphasis on integration and achievement motivation the partial correlation was .13. The students' perception of their teacher's emphasis on specific detail was negatively related to the students' level of cognitive readiness: students of low cognitive readiness tended to perceive their teacher's presentation of the curriculum as placing greater emphasis on the retention of specific detail than did their peers of higher cognitive readiness (partial correlation = .28). Finally, the students' interest in biology was positively related to their perception of the learning environment as facilitating the arousal of intrinsic motivation (partial
correlation = .24). The relationship between the students' level of cognitive readiness and their perception of the achievement press of the school, apparent in Table 7.1, was found not to be significant; after controlling for the consensual achievement press of the environment the partial correlation between each of these variables was reduced to .09.

These results indicate that the students' levels of achievement motivation, interest in biology and cognitive readiness influence their perceptions of certain aspects of their learning environment, and hence support the additive model that has been proposed. However, no such main effect was found in the case of the students' level of intrinsic motivation. In the following analyses the interactive model is examined as a means of further explaining student differences in their perceptions of the learning environment.

b) Student perceptions of their learning environment – the interactive model

Two procedures were used to investigate the relationships between student characteristics and student perceptions of the learning environment in terms of an interactive model. The first was a stepwise multiple regression procedure with a 3-term regression model and including an interactive term. Because of multicollinearity there were four relationships where such a procedure was inappropriate viz., the relationships between achievement motivation and the students' perception of both the achievement press of the school and the teacher's emphasis on specific detail; the relationship between interest in biology and the students' perception of the achievement press of the school; and finally, between intrinsic motivation and the students' perception of the learning environment as facilitating intrinsic-motivated behaviour. The procedure used for these analyses will be described in the following section.

(i) The multiple regression analysis using a 3-term model

The following 3-term regression model was used to investigate the interactive effect upon the students' perception of the learning environment between the environment as rated by the researcher and the student characteristics of intrinsic motivation, achievement motivation, interest in biology and cognitive readiness:
This multiple regression procedure demonstrated that the students' perception of his teacher's emphasis on integration was a function of the interaction of his level of cognitive readiness and the researcher's rating of the environment on the corresponding dimension \( (6.31 > 3.86 = F_{1,273,.05}) \). This relationship is represented in Fig. 1 and will now be discussed. Consider the differences in student perception of those learning environments rated by the researcher high on the dimension emphasis on integration. This corresponds to slope \( \alpha \) in Fig. 1. The small positive gradient of slope \( \alpha \) indicates that students of higher cognitive readiness perceived these classes as characterised by only a slightly greater emphasis on integration than did students of lower cognitive readiness. Contrast this with those classes rated 'low' on this dimension by the researcher which corresponds to slope \( \gamma \). Students of higher cognitive readiness perceived these classes as being far lower in their emphasis on integration than did students of lower cognitive readiness. Finally, a comparison of slopes \( \beta \) and \( \delta \) indicates that students of higher cognitive readiness were far better able to discriminate between classes characterised by different emphases on integration than were students of lower cognitive readiness. These results are relevant to the discussion of Chapter 8 concerning the forms of accommodative activity that typify students of different levels of cognitive readiness.

There was no significant interactive effects in the case of each of the remaining relationships tested using this procedure. However, it has already been noted that this multiple regression procedure was inappropriate for the investigation of a further four

---

3 As with the previous analysis, in the case of achievement press the consensual achievement press score was used.
The regression surface representing the interaction of cognitive readiness and the researcher's rating of the dimension emphasis on integration upon the students' perception of that dimension. The regression equation, using raw regression weights, was as follows:

$$\text{Student perception} = 24.8 - .23x - .17y + .06xy$$

where

$$x = \text{researcher's rating} \quad y = \text{cognitive readiness}$$
relationships. These will be the concern of the following section.

(ii) Heterogeneity of correlation coefficients

For those classes where the above procedure was inappropriate the following form of analysis was adopted. Firstly, the classes were grouped on each dimension into two categories, 'high' or 'low' as was done in the previous analyses of Chapters 6 and 7 for the ANOVA. Secondly, the correlations between the students' scores on the classroom perception scales and their scores on each of the student characteristic measures were calculated. This was done for students found in classes grouped 'high' on the corresponding classroom dimension, and then for those students found in classes grouped 'low'. Thirdly, the heterogeneity of each of these pairs of correlation coefficients was tested.

Table 2 contains the correlations between the student characteristics and the students' perceptions of the four dimensions of the learning environment for classes grouped high or low on each of these dimensions. All such correlations are included in Table 2; however, this analysis is concerned only with testing the heterogeneity of those four pairs of correlations describing the four relationships that could not be tested using the previous procedure.

A multiple regression procedure with dummy variables was used to test the heterogeneity of each pair of correlation coefficients. The following 3-term model was proposed:

$$\text{Student's score on particular classroom perception scale} = \beta_1 \text{ dummy variable} + \beta_2 \text{ characteristic variable} + \beta_3 \text{ student characteristic}$$

where the dummy variable refers to the corresponding dimension of the learning environment and grouped either 'high' or 'low'. Details of these analyses are contained in Table 3 at the end of this Appendix.

Of the four relationships examined using this procedure, three were found to be significant. Firstly, for students found in classes characterised by a high level of facilitation of intrinsic motivation, those students of higher intrinsic motivation perceived classes as higher on this dimension than did students of lower
intrinsic motivation; no such relationship existed for those students found in classes characterised by a low level of facilitation of intrinsic motivation ($4.88 > 3.86 = F_{1,273,.05}$). A similar relationship existed for the students' perception of the achievement press of the school. Students of higher achievement motivation rated their learning environments higher on the dimension achievement press than students of lower achievement motivation, but only in those classes where the consensus was that the achievement press was in fact high ($3.98 > 3.86 = F_{1,273,.05}$). Further, students of higher achievement motivation rated their learning environment higher on the dimension emphasis on specific detail than did students of lower achievement motivation only in those classes grouped as 'high' emphasis on specific detail ($4.69 > 3.86 = F_{1,273,.05}$). There was no significant relationship between the students' perception of the achievement press of the school and the interaction of interest in biology and the consensual achievement of the school ($0.51 < 3.86 = F_{1,264,.05}$).

This concludes the analysis of the effects of student characteristics upon the students' response to the classroom perception scales contained within the Biology Students and Classroom Perception Questionnaire. These analyses have shown that both main effects and interactive effects were operative in the students' construction of a knowledge of their learning environment. Such findings are particularly relevant to the interactive perspective adopted in this study and are discussed in Chapter 9.
Correlations between student characteristics and their perceptions of four dimensions of the learning environment grouped according to whether they are found in classes 'high' or 'low' on each of these dimensions

<table>
<thead>
<tr>
<th>Students' Classroom Perceptions of the Dimensions:</th>
<th>Student Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intrinsic Motivation</td>
</tr>
<tr>
<td>Emphasis on Integration</td>
<td></td>
</tr>
<tr>
<td>Classes rated high by the researcher on this dimension</td>
<td>.23</td>
</tr>
<tr>
<td>Classes rated low by the researcher on this dimension</td>
<td>.03</td>
</tr>
<tr>
<td>Emphasis on Specific Detail</td>
<td></td>
</tr>
<tr>
<td>Classes rated high by the researcher on this dimension</td>
<td>.07</td>
</tr>
<tr>
<td>Classes rated high by the researcher on this dimension</td>
<td>.02</td>
</tr>
<tr>
<td>Facilitation of Intrinsic Motivation</td>
<td></td>
</tr>
<tr>
<td>Classes rated high by the researcher on this dimension</td>
<td>.22</td>
</tr>
<tr>
<td>Classes rated low by the researcher on this dimension</td>
<td>-.04</td>
</tr>
<tr>
<td>Achievement Press</td>
<td></td>
</tr>
<tr>
<td>Classes rated high by the researcher on this dimension</td>
<td>.12</td>
</tr>
<tr>
<td>Classes rated low by the researcher on this dimension</td>
<td>.06</td>
</tr>
</tbody>
</table>

Table 2
Table 3

Results of Multiple Regression Analysis with Dummy Variables used to Examine the Heterogeneity of each of Four Pairs of Correlation Coefficients, described in Section b(ii) of this Appendix

<table>
<thead>
<tr>
<th>Dimension of Learning Environment</th>
<th>Student Characteristic</th>
<th>Analysis of Variance for the full 3-term model, including the interactive term compared to that of the 2-term additive model</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td></td>
<td>Analysis of Variance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>df</td>
</tr>
<tr>
<td>Dimension of Learning Environment</td>
<td>emphasis on specific detail</td>
<td>3</td>
</tr>
<tr>
<td>Student Characteristic:</td>
<td>achievement motivation</td>
<td></td>
</tr>
<tr>
<td>Analysis of Variance</td>
<td></td>
<td>275</td>
</tr>
<tr>
<td>Improvement due to</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>interactive term</td>
<td></td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>facilitation of intrinsic motivation</td>
<td></td>
</tr>
<tr>
<td>Student Characteristic:</td>
<td>intrinsic motivation</td>
<td></td>
</tr>
<tr>
<td>Analysis of Variance</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Regression</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residual</td>
<td></td>
<td>272</td>
</tr>
<tr>
<td>Improvement due to</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>interactive term</td>
<td></td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>achievement press</td>
<td></td>
</tr>
<tr>
<td>Student Characteristic:</td>
<td>achievement motivation</td>
<td></td>
</tr>
<tr>
<td>Analysis of Variance</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Regression</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residual</td>
<td></td>
<td>272</td>
</tr>
<tr>
<td>Improvement due to</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>interactive term</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
IV Dimension of Learning Environment: achievement press

Student Characteristic: interest in biology

Analysis of Variance for the full 3-term model including the interactive term, compared to that of the 2-term additive model.

<table>
<thead>
<tr>
<th>Analysis of Variance</th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>3</td>
<td>929.91</td>
<td>309.96</td>
<td>25.45</td>
</tr>
<tr>
<td>Residual</td>
<td>264</td>
<td>3313.40</td>
<td>12.18</td>
<td></td>
</tr>
<tr>
<td>Improvement due to</td>
<td>1</td>
<td>6.28</td>
<td>6.28</td>
<td>.51</td>
</tr>
<tr>
<td>interactive term</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix 5.10

The assessment of the consensual achievement press of the school using a reduced form of Stern's (1970) achievement press scale

<table>
<thead>
<tr>
<th>Item</th>
<th>Corrected Item-Total Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>There is a lot of competition for marks</td>
<td>.39</td>
</tr>
<tr>
<td>Few students try hard to get on the honour roll, come top or do very well</td>
<td>.24</td>
</tr>
<tr>
<td>Most students around here expect to go on to university or a college</td>
<td>.27</td>
</tr>
<tr>
<td>In this school there are few contests in such things as speaking, chess, essays, etc.</td>
<td>.52</td>
</tr>
<tr>
<td>Pupils seldom take part in extra projects in Science, English, History</td>
<td>.27</td>
</tr>
<tr>
<td>There are awards or special honours for those who do the best work or get the best marks</td>
<td>.33</td>
</tr>
</tbody>
</table>

K-R 20 $\alpha = .61$
Appendix 5.11

BIOLOGY STUDENT AND CLASSROOM PERCEPTIONS QUESTIONNAIRE

Name ____________________________________________

Ident. Code No. ________________________________

1. The purpose of this questionnaire is to find out what is happening in biology classes in the A.C.T.

You may, quite rightly, feel hesitant about providing information about yourself and your classroom activities to an outsider. This is quite understandable. You should therefore note the following points:

* The information you provide will not be shown to your teacher

* As soon as all the information required by the project has been received and transferred to computer cards, the original answer sheets will be destroyed. No record will be kept which will allow individuals ever to be identified.

* When the report of the project is written up, individual students, teachers and schools will not, of course, be identified by name.

It would be greatly appreciated, therefore, if you would try to respond to the statements in this questionnaire as accurately as possible. You should feel free to say what you really think.

2. Please answer as quickly as you can, and please give an answer to every statement.
PART A

Listed below are some statements that can be applied to your life. Read each statement carefully and then circle the number opposite which indicates whether you agree or disagree with the statement.

Draw a circle around

1 if you STRONGLY AGREE with the statement
2 if you AGREE with the statement
3 if you cannot decide whether you agree or disagree with the statement
4 if you DISAGREE with the statement
5 if you STRONGLY DISAGREE with the statement

<table>
<thead>
<tr>
<th>PRACTICE STATEMENT</th>
<th>Strongly Agree</th>
<th>?</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I like setting difficult goals for myself</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Suppose that you disagree with the statement you would then circle 4

NOW GO AHEAD AND DO THE REST

1. I like setting difficult goals for myself
2. I like working for someone who will accept nothing less than the best that's in me
3. I like setting higher standards for myself than anyone else would, and working hard to achieve them
4. I like competing with others for a prize or goal
5. I like taking examinations
6. I like working on tasks so difficult I can hardly do them
7. I like doing something very difficult in order to prove I can do it
8. I like choosing difficult tasks in preference to easy ones
9. I like sacrificing everything else in order to achieve something outstanding
10. I like picking out some hard task for myself and doing it
PART B

To what extent do the following statements apply to you? Again, circle the number below the column headings which best describe the extent to which the statement applies to you, e.g. True, and typical of me ... (1)

<table>
<thead>
<tr>
<th>Statement</th>
<th>True, and Often or typical of me</th>
<th>True for me</th>
<th>Not true sometimes</th>
</tr>
</thead>
<tbody>
<tr>
<td>I visit a library to read material not directly related to my class work</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>I would like to watch an astronomer calculate the age of a star</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>If I read something that puzzles me, I keep reading until I understand it</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Complicated machinery is fascinating to look at</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>When I don't know the answer I look up the answer when the test is completed</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>I read for enjoyment during a large part of my spare time</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>I am interested in mathematical procedures possible with new calculating machines</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>I like to look at pictures which are puzzling in some way</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>I read several magazines regularly</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>It is interesting to try to figure out how an unusual piece of machinery works</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Some truths can only be expressed in paradoxical statements</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>I like to look at rocks which are made of many kinds of minerals</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>I have had experiences which inspired me to write a poem or a story, make up a humorous tale or paint a picture</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>I think about how strange plants grow</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>At times I have focussed on something so hard that I went into a kind of benumbed state of consciousness, and at other times into a state of extraordinary calm and serenity</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>If I come across something interesting, I drop everything and study it, it is never a waste of time</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>
PART C

Listed below are some statements which may or may not be true of your school. Read each statement carefully and then circle the number opposite which indicates whether you agree or disagree that the statement is typical of your school.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Agree</th>
<th>?</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>There is a lot of competition for marks</td>
<td>1</td>
<td>2</td>
<td>3 4 5</td>
</tr>
<tr>
<td>Students generally manage to pass even if they don't work hard during the year</td>
<td>1</td>
<td>2</td>
<td>3 4 5</td>
</tr>
<tr>
<td>Most teachers give a lot of homework</td>
<td>1</td>
<td>2</td>
<td>3 4 5</td>
</tr>
<tr>
<td>Few students try hard to get on the honour roll, come top or do very well</td>
<td>1</td>
<td>2</td>
<td>3 4 5</td>
</tr>
<tr>
<td>Examinations really test how much a student has learned</td>
<td>1</td>
<td>2</td>
<td>3 4 5</td>
</tr>
<tr>
<td>Most students around here expect to go on to university or a college</td>
<td>1</td>
<td>2</td>
<td>3 4 5</td>
</tr>
<tr>
<td>In this school there are very few contests in such things as speaking, chess, essays, etc.</td>
<td>1</td>
<td>2</td>
<td>3 4 5</td>
</tr>
<tr>
<td>Pupils seldom take part in extra projects in Science, English, History</td>
<td>1</td>
<td>2</td>
<td>3 4 5</td>
</tr>
<tr>
<td>Popularity and bluff gets many students through courses</td>
<td>1</td>
<td>2</td>
<td>3 4 5</td>
</tr>
<tr>
<td>There are awards or special honours for those who do the best work or get the best marks</td>
<td>1</td>
<td>2</td>
<td>3 4 5</td>
</tr>
</tbody>
</table>

PART D

This section of the questionnaire contains a number of statements about biology teachers, students and classes. You are to read each statement and decide whether it describes what happens, or is stressed, in your biology class. Your answers to the statements should be given by circling the appropriate symbol beside the statement.

Draw a circle around

1 if you STRONGLY AGREE with the statement
2 if you AGREE with the statement
3 if you cannot decide whether you agree or disagree with the statement
4 if you DISAGREE with the statement
5 if you STRONGLY DISAGREE with the statement.

Please answer as quickly as you can, and please give an answer to every statement.
<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th></th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

We are expected to memorise most of what the teacher tells us

We often discuss the problems faced by scientists in the discovery of a scientific principle

We spend a lot of time in biology lessons going over tests

We sometimes talk about the kind of evidence that is behind a scientist's conclusion

Our teacher often repeats almost exactly what the textbook says

When studying a new section of work we often talk about related ideas we have studied before

We often discuss the evidence that is behind statements made in the textbook

When reading the text, we are expected to learn most of the details that are stated there

When reading the textbook, we are usually expected to look for the main ideas and for the evidence that supports them

The textbook and notes given by the teacher are generally the only source of scientific knowledge that are discussed in class

We often read scientific books and magazines, as well as our textbook

Our teacher does not like us to doubt information contained in our textbook

We are encouraged to use the laboratory to investigate problems that come up in class

Our practical exercises usually seem relevant to the topic that we are studying
<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>?</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

We sometimes design our own experiments to seek answers to questions that puzzle us

Our practical work often consists of thoroughly learning the names of specific structures and specific sequences of events

We never have the chance to try our own ways of doing the practical work

We sometimes do some additional experimenting of our own when we have finished the set practical exercises

Our teacher usually tells us what the results of our experiments should be

All students in the class do the same exercises and the same problems

In writing answers to the problems at the end of each chapter we are free to give our own ideas even if we are not sure if they are correct

We are sometimes able to choose which problems we will discuss

We sometimes discuss practical applications of biological knowledge

For some of the work we are given a programme to follow so that we can work at our own pace

The teacher prefers the students to know general principles rather than specific details

We are expected to write down and pretty well memorise what is contained in the guide question

When studying a new section of work we usually talk about how it fits into the study of biology as a whole
<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Agree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Our teacher seems to have a very deep understanding of biology</td>
<td>1 2 3 4 5</td>
<td>64</td>
</tr>
<tr>
<td>We are expected to know fairly precisely the definitions of most terms used in the text</td>
<td>1 2 3 4 5</td>
<td>65</td>
</tr>
<tr>
<td>There is ample opportunity to do 'follow-up' studies and investigations into topics that we find particularly interesting</td>
<td>1 2 3 4 5</td>
<td>66</td>
</tr>
<tr>
<td>We are often given assignments that allow us to explore possibilities and state our own thoughts even if we are not certain if they are correct</td>
<td>1 2 3 4 5</td>
<td>67</td>
</tr>
<tr>
<td>There is a lot of competition for marks in this class</td>
<td>1 2 3 4 5</td>
<td>68</td>
</tr>
<tr>
<td>When reading the textbook, we are expected to look for the main ideas and think how they relate to preceding sections of our course</td>
<td>1 2 3 4 5</td>
<td>69</td>
</tr>
<tr>
<td>When we learn about a new biological concept or principle we are not just told about it; the teacher explains the evidence and the reasoning behind it very carefully</td>
<td>1 2 3 4 5</td>
<td>70</td>
</tr>
<tr>
<td>In our class mention is made of the importance of doing the work because of the Higher School Certificate requirements</td>
<td>1 2 3 4 5</td>
<td>71</td>
</tr>
<tr>
<td>We are encouraged to use reference materials, to go to the library, etc. to investigate problems and topics that come up in class</td>
<td>1 2 3 4 5</td>
<td>72</td>
</tr>
</tbody>
</table>
Generally, how interesting do you find subjects of the following types:

<table>
<thead>
<tr>
<th></th>
<th>Very boring</th>
<th>Rather dull</th>
<th>Fairly interesting</th>
<th>Very interesting</th>
<th>Extremely interesting</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Art</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>b) Biology</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>c) Commerce</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>d) English</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>e) Foreign Languages</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>f) Humanities and Social Sciences</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>g) Industrial Arts and Crafts</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>h) Mathematics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>i) Music</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>j) Physics or Chemistry</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>k) Secretarial Studies</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
The results of the ANOVA procedure used to investigate the presence of a 3-way interactive effect upon student performance on the Guide Questions scale and between achievement motivation, achievement press and emphasis on specific detail.

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main effects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Achievement press</td>
<td>513.246</td>
<td>1</td>
<td>513.246</td>
<td>14.027</td>
<td>0.001</td>
</tr>
<tr>
<td>Achievement motivation</td>
<td>24.169</td>
<td>1</td>
<td>24.169</td>
<td>0.661</td>
<td>0.999</td>
</tr>
<tr>
<td>Emphasis on specific detail</td>
<td>504.217</td>
<td>1</td>
<td>504.217</td>
<td>13.780</td>
<td>0.001</td>
</tr>
<tr>
<td><strong>2-way interactions</strong></td>
<td>125.112</td>
<td>3</td>
<td>41.704</td>
<td>1.140</td>
<td>0.334</td>
</tr>
<tr>
<td>Achievement press . Achievement</td>
<td>2.061</td>
<td>1</td>
<td>2.061</td>
<td>0.056</td>
<td>0.999</td>
</tr>
<tr>
<td>press . Motivation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Achievement press . Emphasis on</td>
<td>14.210</td>
<td>1</td>
<td>14.210</td>
<td>0.388</td>
<td>0.999</td>
</tr>
<tr>
<td>press . specific detail</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Achievement motivation . Emphasis on</td>
<td>113.499</td>
<td>1</td>
<td>113.499</td>
<td>3.102</td>
<td>0.076</td>
</tr>
<tr>
<td>motivation . specific detail</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>3-way interactions</strong></td>
<td>159.051</td>
<td>1</td>
<td>159.051</td>
<td>4.347</td>
<td>0.036</td>
</tr>
<tr>
<td>Achievement press . Achievement</td>
<td>159.051</td>
<td>1</td>
<td>159.051</td>
<td>4.347</td>
<td>0.036</td>
</tr>
<tr>
<td>press . motivation on specific detail</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explained</td>
<td>1397.766</td>
<td>7</td>
<td>199.681</td>
<td>5.457</td>
<td>0.001</td>
</tr>
<tr>
<td>Residual</td>
<td>9732.916</td>
<td>266</td>
<td>36.590</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>11130.682</td>
<td>273</td>
<td>40.772</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Group means on Guide Questions
scale for testing 3-way interaction
of Press, Motivation and Goal Specification

<table>
<thead>
<tr>
<th>Condition</th>
<th>Mean</th>
<th>T-value</th>
<th>df</th>
<th>1-Tail prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Achievement Press - Low Goal Specification</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Achievement Motivation</td>
<td>17.06</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low &quot; &quot;</td>
<td>19.45</td>
<td>1.69</td>
<td>39</td>
<td>.05</td>
</tr>
<tr>
<td>Low Achievement Press - Low Goal Specification</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Achievement Motivation</td>
<td>14.90</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low &quot; &quot;</td>
<td>14.41</td>
<td>.31</td>
<td>69</td>
<td>.38</td>
</tr>
<tr>
<td>High Achievement Press - High Goal Specification</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Achievement Motivation</td>
<td>21.74</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low &quot; &quot;</td>
<td>18.25</td>
<td>2.54</td>
<td>50</td>
<td>.005</td>
</tr>
<tr>
<td>Low Achievement Press - High Goal Specification</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Achievement Motivation</td>
<td>17.76</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low &quot; &quot;</td>
<td>17.62</td>
<td>.09</td>
<td>64</td>
<td>.47</td>
</tr>
</tbody>
</table>
Multiple Regression Analysis, using Dummy Variables, to Investigate the Overall Model Represented in the ANOVA Results that Relate to the Presence of a 3-way Interaction between Achievement Press, Achievement Motivation and Emphasis on Specific Detail

1. Analysis of Variance for full 7-term Model

<table>
<thead>
<tr>
<th>Analysis of Variance</th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>7</td>
<td>1397.77</td>
<td>199.68</td>
<td>5.46</td>
</tr>
<tr>
<td>Residual</td>
<td>266</td>
<td>9732.92</td>
<td>36.59</td>
<td></td>
</tr>
</tbody>
</table>

2. Analysis of Variance for reduced 3-term Model

<table>
<thead>
<tr>
<th>Analysis of Variance</th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>3</td>
<td>1221.42</td>
<td>407.14</td>
<td>11.09</td>
</tr>
<tr>
<td>Residual</td>
<td>270</td>
<td>9909.25</td>
<td>36.70</td>
<td></td>
</tr>
</tbody>
</table>

Summary Table after Final Step of Regression Procedure

Dependent Variable: student performance on the Guide Questions scale

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mult- R</th>
<th>Rsq</th>
<th>Sim- R</th>
<th>Raw Regression Coeff.</th>
<th>Beta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achievement Press.</td>
<td>0.27</td>
<td>0.07</td>
<td>0.27</td>
<td>2.41</td>
<td>0.13</td>
</tr>
<tr>
<td>Achievement Motivation.</td>
<td>0.30</td>
<td>0.09</td>
<td>0.23</td>
<td>2.17</td>
<td>0.17</td>
</tr>
<tr>
<td>Emphasis on Specific</td>
<td>0.33</td>
<td>0.10</td>
<td>0.22</td>
<td>2.03</td>
<td>0.16</td>
</tr>
<tr>
<td>Detail</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>15.13</td>
</tr>
</tbody>
</table>
APPENDIX 6.2a

Results of multiple regression analysis used to examine the 2-way interactive effect upon student performance between cognitive readiness and achievement press

1. Analysis of Variance for full 5-term model

<table>
<thead>
<tr>
<th>Analysis of Variance</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>5</td>
<td>2619.00</td>
<td>523.80</td>
<td>16.49</td>
</tr>
<tr>
<td>Residual</td>
<td>268</td>
<td>8511.68</td>
<td>31.76</td>
<td></td>
</tr>
</tbody>
</table>

2. Analysis of Variance for reduced 3-term model including both independent variables and the 2-way interactive term

<table>
<thead>
<tr>
<th>Analysis of Variance</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>3</td>
<td>2584.93</td>
<td>861.64</td>
<td>27.22</td>
</tr>
<tr>
<td>Residual</td>
<td>270</td>
<td>8545.75</td>
<td>31.65</td>
<td></td>
</tr>
</tbody>
</table>

Summary Table after entry of final term in regression equation

Dependent Variable: Student Performance on Guide Questions Scale

<table>
<thead>
<tr>
<th>Variable</th>
<th>Multiple R</th>
<th>R Square</th>
<th>Rsq Change</th>
<th>Simple $r$</th>
<th>Raw Regression Coefficient</th>
<th>Beta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive readiness</td>
<td>0.47</td>
<td>0.22</td>
<td>0.22</td>
<td>0.47</td>
<td>-0.24</td>
<td>-0.22</td>
</tr>
<tr>
<td>Achievement press</td>
<td>0.47</td>
<td>0.22</td>
<td>0.00</td>
<td>-0.26</td>
<td>-0.88</td>
<td>-0.40</td>
</tr>
<tr>
<td>Cognitive readiness . Achievement press</td>
<td>0.48</td>
<td>0.23</td>
<td>0.01</td>
<td>0.39</td>
<td>0.03</td>
<td>0.60</td>
</tr>
</tbody>
</table>

Constant
27.13
Results of multiple regression analysis used to examine the 2-way interactive effect upon student performance between cognitive readiness and the teacher's emphasis on specific detail

1. Analysis of variance for full 5-term model

<table>
<thead>
<tr>
<th>Analysis of Variance</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>4</td>
<td>3106.66</td>
<td>776.66</td>
<td>26.04</td>
</tr>
<tr>
<td>Residual</td>
<td>269</td>
<td>8024.02</td>
<td>29.83</td>
<td></td>
</tr>
</tbody>
</table>

2. Analysis of variance for reduced 3-term model including both independent variables and 2-way interactive term

<table>
<thead>
<tr>
<th>Analysis of Variance</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>3</td>
<td>3101.83</td>
<td>1033.94</td>
<td>34.77</td>
</tr>
<tr>
<td>Residual</td>
<td>270</td>
<td>8028.85</td>
<td>29.74</td>
<td></td>
</tr>
</tbody>
</table>

Summary Table after entry of final term in regression equation

Dependent Variable: Student Performance on Guide Questions Scale

<table>
<thead>
<tr>
<th>Variable</th>
<th>Multiple R</th>
<th>R Square</th>
<th>Rsq Change</th>
<th>Simple r</th>
<th>Raw Regression Coefficient</th>
<th>Beta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive readiness</td>
<td>0.47</td>
<td>0.22</td>
<td>0.22</td>
<td>0.47</td>
<td>0.20</td>
<td>0.18</td>
</tr>
<tr>
<td>Emphasis on specific detail</td>
<td>0.52</td>
<td>0.27</td>
<td>0.05</td>
<td>-0.29</td>
<td>-1.87</td>
<td>-0.51</td>
</tr>
<tr>
<td>Cognitive readiness</td>
<td>0.53</td>
<td>0.28</td>
<td>0.01</td>
<td>-0.12</td>
<td>0.07</td>
<td>0.37</td>
</tr>
<tr>
<td>Emphasis on specific detail</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>17.95</td>
</tr>
</tbody>
</table>
APPENDIX 6.2c

The results of the ANOVA procedure used to investigate the presence of a 2-way interactive effect between cognitive readiness and achievement motivation upon student performance on the Guide Questions scale.

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main effects</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cognitive readiness</td>
<td>1749.847</td>
<td>2</td>
<td>874.923</td>
<td>25.239</td>
<td>0.001</td>
</tr>
<tr>
<td>Achievement Motivation</td>
<td>20.719</td>
<td>1</td>
<td>20.719</td>
<td>0.598</td>
<td>0.999</td>
</tr>
<tr>
<td>2-way interactions</td>
<td>48.328</td>
<td>2</td>
<td>24.164</td>
<td>0.697</td>
<td>0.999</td>
</tr>
<tr>
<td>Cognitive Readiness.</td>
<td>48.328</td>
<td>2</td>
<td>24.164</td>
<td>0.697</td>
<td>0.999</td>
</tr>
<tr>
<td>Achievement Motivation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explained</td>
<td>1840.446</td>
<td>5</td>
<td>368.089</td>
<td>10.618</td>
<td>0.001</td>
</tr>
<tr>
<td>Residual</td>
<td>9290.236</td>
<td>268</td>
<td>34.665</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>11130.682</td>
<td>273</td>
<td>40.772</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX 6.3(a)

Results of the multiple regression analysis used to investigate the 3-way interactive effect of cognitive readiness, intrinsic motivation and its arousal upon student performance on the Guide Questions scale.

### Analysis of Variance of the 4-term model

<table>
<thead>
<tr>
<th>Analysis of Variance</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>4</td>
<td>2592.96</td>
<td>648.24</td>
<td>20.67</td>
</tr>
<tr>
<td>Residual</td>
<td>263</td>
<td>8247.56</td>
<td>31.36</td>
<td></td>
</tr>
</tbody>
</table>

Summary Table after the entry of the final term in the regression equation

Dependent Variable: Student performance on Guide Questions scale

<table>
<thead>
<tr>
<th>Variable</th>
<th>Multiple R</th>
<th>R Square</th>
<th>Rsq Change</th>
<th>Simple r</th>
<th>Raw Regression Coeff.</th>
<th>Beta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive readiness</td>
<td>0.47</td>
<td>0.22</td>
<td>0.22</td>
<td>0.47</td>
<td>0.69</td>
<td>0.64</td>
</tr>
<tr>
<td>Facilitation of intrinsic motivation</td>
<td>0.48</td>
<td>0.23</td>
<td>0.01</td>
<td>-0.06</td>
<td>0.39</td>
<td>0.11</td>
</tr>
<tr>
<td>Intrinsic motivation</td>
<td>0.48</td>
<td>0.23</td>
<td>0.00</td>
<td>0.14</td>
<td>0.12</td>
<td>0.08</td>
</tr>
<tr>
<td>3-way interaction term</td>
<td>0.49</td>
<td>0.24</td>
<td>0.01</td>
<td>0.23</td>
<td>-0.00</td>
<td>-0.29</td>
</tr>
<tr>
<td>constant</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.63</td>
<td></td>
</tr>
</tbody>
</table>
Appendix 6.3(b)

Results of the multiple regression analysis used to investigate the presence of an interactive effect upon student performance and between cognitive readiness and the facilitation of intrinsic motivation

1. Analysis of Variance obtained by entering both independent variables first and the interactive term last into the regression equation

<table>
<thead>
<tr>
<th>Analysis of Variance</th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>3</td>
<td>2590.96</td>
<td>863.65</td>
<td>27.31</td>
</tr>
<tr>
<td>Residual</td>
<td>270</td>
<td>8539.72</td>
<td>31.63</td>
<td></td>
</tr>
</tbody>
</table>

Summary Table after entry of first term in regression equation

Dependent Variable: student performance on Guide Questions scale

<table>
<thead>
<tr>
<th>Variable</th>
<th>Multiple R</th>
<th>Rsq</th>
<th>Sim- Raw R</th>
<th>Change R</th>
<th>Regression Beta</th>
<th>Raw Coeff.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive Readiness</td>
<td>0.47</td>
<td>0.22</td>
<td>0.22</td>
<td>0.47</td>
<td>0.74</td>
<td>0.68</td>
</tr>
<tr>
<td>Facilitiation of Intrinsic Motivation</td>
<td>0.47</td>
<td>0.22</td>
<td>0.01</td>
<td>-0.06</td>
<td>0.63</td>
<td>0.18</td>
</tr>
<tr>
<td>Cognitive Readiness Facilitiation of Intrinsic Motivation</td>
<td>0.48</td>
<td>0.23</td>
<td>0.01</td>
<td>0.21</td>
<td>-0.06</td>
<td>-0.35</td>
</tr>
<tr>
<td>constant</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7.39</td>
</tr>
</tbody>
</table>
Appendix 6.3(b) (cont.)

2. Analysis of Variance obtained by entering cognitive readiness first and the interactive term second into a 2-term regression model

<table>
<thead>
<tr>
<th>Analysis of Variance</th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full 2-term model</td>
<td>2</td>
<td>2545.14</td>
<td>1272.57</td>
<td>40.17</td>
</tr>
<tr>
<td>Reduced 1-term model</td>
<td>1</td>
<td>2421.08</td>
<td>2421.08</td>
<td>75.61</td>
</tr>
<tr>
<td>Improvement due to interactive term</td>
<td>1</td>
<td>124.06</td>
<td>124.06</td>
<td>3.92</td>
</tr>
<tr>
<td>Residual</td>
<td>271</td>
<td>8585.54</td>
<td>31.68</td>
<td></td>
</tr>
</tbody>
</table>

Summary Table after entry of final term in regression equation

Dependent Variable: student performance of Guide Questions scale

<table>
<thead>
<tr>
<th>Variable</th>
<th>Multiple R</th>
<th>R sq</th>
<th>Rsq Change</th>
<th>Sim- Raw Change</th>
<th>Regression Beta Coeff.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive Readiness</td>
<td>0.47</td>
<td>0.22</td>
<td>0.22</td>
<td>0.47</td>
<td>0.60</td>
</tr>
<tr>
<td>Cognitive Readiness. Facilitation of Intrinsic Motivation</td>
<td>0.48</td>
<td>0.23</td>
<td>0.01</td>
<td>0.21</td>
<td>-0.02</td>
</tr>
<tr>
<td>constant</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The regression surface representing the interaction of cognitive readiness and facilitation of intrinsic motivation upon student performance on the Guide Questions scale. The regression equation, using raw regression weights, was as follows:

\[ \text{Student performance} = 9.68 + 0.6x - 0.03xy \]

where

- \( x \) = cognitive readiness
- \( y \) = facilitation of intrinsic motivation
Results of ANOVA for examining the relationship between student performance on the Guide Questions scale and those variables that constitute the intrinsic-motivated model of learning (in particular the interactions of 'cognitive readiness.intrinsic motivation' and 'facilitation of intrinsic motivation.intrinsic motivation')

Performance on Guide Questions scale

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Significance of F</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main Effects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C.R.</td>
<td>1931.702</td>
<td>5</td>
<td>386.340</td>
<td>11.481</td>
<td>0.001</td>
</tr>
<tr>
<td>INT</td>
<td>1542.618</td>
<td>2</td>
<td>771.309</td>
<td>22.921</td>
<td>0.001</td>
</tr>
<tr>
<td>IM</td>
<td>88.171</td>
<td>1</td>
<td>88.171</td>
<td>2.620</td>
<td>0.103</td>
</tr>
<tr>
<td>AROUS</td>
<td>50.853</td>
<td>1</td>
<td>50.853</td>
<td>1.511</td>
<td>0.218</td>
</tr>
<tr>
<td><strong>2-Way Interactions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C.R. INT</td>
<td>0.000</td>
<td>9</td>
<td>46.654</td>
<td>1.386</td>
<td>0.194</td>
</tr>
<tr>
<td>C.R. IM</td>
<td>419.885</td>
<td>2</td>
<td>49.003</td>
<td>1.456</td>
<td>0.234</td>
</tr>
<tr>
<td>C.R. AROUS</td>
<td>98.007</td>
<td>2</td>
<td>46.585</td>
<td>1.384</td>
<td>0.251</td>
</tr>
<tr>
<td>INT. IM</td>
<td>123.279</td>
<td>2</td>
<td>61.640</td>
<td>1.832</td>
<td>0.160</td>
</tr>
<tr>
<td>INT. AROUS</td>
<td>7.617</td>
<td>1</td>
<td>7.617</td>
<td>0.226</td>
<td>0.999</td>
</tr>
<tr>
<td>IM. AROUS</td>
<td>1.879</td>
<td>1</td>
<td>1.879</td>
<td>0.056</td>
<td>0.999</td>
</tr>
<tr>
<td><strong>3-Way Interactions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C.R. INT IM</td>
<td>84.189</td>
<td>7</td>
<td>29.480</td>
<td>0.876</td>
<td>0.999</td>
</tr>
<tr>
<td>C.R. INT AROUS</td>
<td>206.360</td>
<td>2</td>
<td>66.132</td>
<td>1.965</td>
<td>0.140</td>
</tr>
<tr>
<td>C.R. IM AROUS</td>
<td>132.264</td>
<td>2</td>
<td>66.132</td>
<td>1.965</td>
<td>0.140</td>
</tr>
<tr>
<td>C.R. INT AROUS</td>
<td>81.923</td>
<td>2</td>
<td>40.961</td>
<td>1.217</td>
<td>0.298</td>
</tr>
<tr>
<td>INT IM AROUS</td>
<td>4.945</td>
<td>2</td>
<td>2.473</td>
<td>0.073</td>
<td>0.999</td>
</tr>
<tr>
<td><strong>4-Way Interactions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C.R. INT AROUS IM</td>
<td>3.920</td>
<td>1</td>
<td>3.920</td>
<td>0.116</td>
<td>0.999</td>
</tr>
<tr>
<td><strong>Explained</strong></td>
<td>2629.858</td>
<td>23</td>
<td>114.342</td>
<td>3.398</td>
<td>0.001</td>
</tr>
<tr>
<td><strong>Residual</strong></td>
<td>8210.667</td>
<td>244</td>
<td></td>
<td></td>
<td>33.65</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>10840.525</td>
<td>267</td>
<td></td>
<td></td>
<td>40.60</td>
</tr>
</tbody>
</table>
Results of the multiple regression analysis using a 3-term regression model including cognitive readiness, interest in biology and intrinsic motivation to explain student performance on the Guide Questions scale

Analysis of Variance obtained by entering cognitive readiness and interest in biology into the regression equation

<table>
<thead>
<tr>
<th>Analysis of Variance</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>2</td>
<td>2602.51</td>
<td>1301.25</td>
<td>41.86</td>
</tr>
<tr>
<td>Residual</td>
<td>265</td>
<td>8238.01</td>
<td>31.09</td>
<td></td>
</tr>
</tbody>
</table>

Summary Table after the entry of the final term in the regression equation

Dependent Variable: student performance on Guide Question scale

<table>
<thead>
<tr>
<th>Variable</th>
<th>Multiple R</th>
<th>R Square</th>
<th>Simple R</th>
<th>Rsq Change</th>
<th>Simple F</th>
<th>Raw Regression Coeff.</th>
<th>Beta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive readiness</td>
<td>0.47</td>
<td>0.22</td>
<td>0.22</td>
<td>0.47</td>
<td>0.50</td>
<td>0.46</td>
<td></td>
</tr>
<tr>
<td>Interest in biology</td>
<td>0.49</td>
<td>0.24</td>
<td>0.02</td>
<td>0.17</td>
<td>0.89</td>
<td>0.13</td>
<td></td>
</tr>
<tr>
<td>constant</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6.96</td>
<td></td>
</tr>
</tbody>
</table>

1 Due to the low partial correlation of intrinsic motivation with the dependent variable following the entry of interest in biology (r = .003), the program limitations were exceeded. Consequently only the results that relate to the first two steps of the model are presented.
Breakdown: Class by response on item 4 (question 3 - Guide Question scale): types of examples used by students

<table>
<thead>
<tr>
<th>Class Code</th>
<th>Novel Answer</th>
<th>Sugar in Solution</th>
<th>Gas in corner of room</th>
<th>Stock Cars</th>
<th>Bag of Salt</th>
<th>Osmosis</th>
<th>Starch Exit</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>1</td>
<td>1</td>
<td>9</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>14</td>
</tr>
<tr>
<td>12</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>13</td>
<td>1</td>
<td>0</td>
<td>9</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>17</td>
</tr>
<tr>
<td>15</td>
<td>0</td>
<td>1</td>
<td>11</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>16</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>17</td>
<td>0</td>
<td>1</td>
<td>5</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>18</td>
<td>2</td>
<td>1</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>19</td>
<td>4</td>
<td>1</td>
<td>13</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>21</td>
</tr>
<tr>
<td>20</td>
<td>7</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>14</td>
</tr>
<tr>
<td>21</td>
<td>2</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>22</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>23</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>24</td>
<td>1</td>
<td>0</td>
<td>11</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>14</td>
</tr>
<tr>
<td>25</td>
<td>0</td>
<td>0</td>
<td>15</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>26</td>
<td>4</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>27</td>
<td>1</td>
<td>0</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td>28</td>
<td>0</td>
<td>1</td>
<td>13</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>17</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>24</th>
<th>10</th>
<th>126</th>
<th>3</th>
<th>13</th>
<th>25</th>
<th>30</th>
<th>231</th>
</tr>
</thead>
<tbody>
<tr>
<td>% of Total</td>
<td>10</td>
<td>4</td>
<td>55</td>
<td>1</td>
<td>6</td>
<td>11</td>
<td>13</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>
### Appendix 6.6(b)

Number of students using a particular example to illustrate either a plant or animal adaptation

<table>
<thead>
<tr>
<th></th>
<th>Absolute freq.</th>
<th>Relative freq.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Plant Adaptations</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mulga tree as a source of examples</td>
<td>145</td>
<td>34.1</td>
</tr>
<tr>
<td>Stomata as a source of examples</td>
<td>92</td>
<td>21.6</td>
</tr>
<tr>
<td>The long length of roots to seek water</td>
<td>88</td>
<td>20.6</td>
</tr>
<tr>
<td>Other desert vegetation examples in text</td>
<td>61</td>
<td>14.3</td>
</tr>
<tr>
<td>Novel examples</td>
<td>40</td>
<td>9.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>426</td>
<td>100.0</td>
</tr>
</tbody>
</table>

| **Animal Adaptations**   |                |                |
| Cyclorana as a source of examples | 147            | 30.4           |
| Skeletal support         | 83             | 17.5           |
| Adaptations contained in the subsection 'Flight' | 61             | 12.7           |
| Other animal adaptations in text | 89             | 18.8           |
| Novel exemplers          | 100            | 20.6           |
| **Total**                | 480            | 100.0          |
Breakdown: Class by response on items 20 to 23
Types of examples used by students

<table>
<thead>
<tr>
<th>Class Code</th>
<th>Novel Answer No.</th>
<th>Novel Answer %</th>
<th>Other Animals in text</th>
<th>Flight</th>
<th>Cyclorana</th>
<th>Skeleton</th>
<th>Mulga</th>
<th>Stomata-Porcupine Grass</th>
<th>Length of Roots</th>
<th>Other Desert Vegetation Examples</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>5</td>
<td>10.2</td>
<td>2</td>
<td>0</td>
<td>15</td>
<td>3</td>
<td>12</td>
<td>2</td>
<td>5</td>
<td>9</td>
<td>53</td>
</tr>
<tr>
<td>12</td>
<td>3</td>
<td>7.7</td>
<td>1</td>
<td>5</td>
<td>7</td>
<td>1</td>
<td>6</td>
<td>3</td>
<td>8</td>
<td>5</td>
<td>39</td>
</tr>
<tr>
<td>13</td>
<td>6</td>
<td>7.4</td>
<td>3</td>
<td>6</td>
<td>24</td>
<td>4</td>
<td>25</td>
<td>3</td>
<td>6</td>
<td>4</td>
<td>81</td>
</tr>
<tr>
<td>15</td>
<td>6</td>
<td>9.0</td>
<td>4</td>
<td>3</td>
<td>16</td>
<td>5</td>
<td>15</td>
<td>6</td>
<td>8</td>
<td>3</td>
<td>66</td>
</tr>
<tr>
<td>16</td>
<td>2</td>
<td>4.4</td>
<td>6</td>
<td>4</td>
<td>7</td>
<td>3</td>
<td>7</td>
<td>8</td>
<td>5</td>
<td>3</td>
<td>45</td>
</tr>
<tr>
<td>17</td>
<td>15</td>
<td>35.7</td>
<td>6</td>
<td>3</td>
<td>6</td>
<td>0</td>
<td>1</td>
<td>6</td>
<td>2</td>
<td>2</td>
<td>41</td>
</tr>
<tr>
<td>18</td>
<td>6</td>
<td>13.9</td>
<td>3</td>
<td>7</td>
<td>3</td>
<td>4</td>
<td>7</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>43</td>
</tr>
<tr>
<td>19</td>
<td>6</td>
<td>10.3</td>
<td>6</td>
<td>4</td>
<td>13</td>
<td>5</td>
<td>12</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>58</td>
</tr>
<tr>
<td>20</td>
<td>19</td>
<td>29.7</td>
<td>12</td>
<td>1</td>
<td>1</td>
<td>20</td>
<td>2</td>
<td>0</td>
<td>5</td>
<td>4</td>
<td>64</td>
</tr>
<tr>
<td>21</td>
<td>8</td>
<td>16.3</td>
<td>8</td>
<td>1</td>
<td>8</td>
<td>5</td>
<td>5</td>
<td>7</td>
<td>3</td>
<td>4</td>
<td>49</td>
</tr>
<tr>
<td>22</td>
<td>11</td>
<td>26.8</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>9</td>
<td>5</td>
<td>4</td>
<td>41</td>
</tr>
<tr>
<td>23</td>
<td>9</td>
<td>20.0</td>
<td>7</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>46</td>
</tr>
<tr>
<td>24</td>
<td>2</td>
<td>3.6</td>
<td>4</td>
<td>5</td>
<td>7</td>
<td>6</td>
<td>12</td>
<td>10</td>
<td>5</td>
<td>4</td>
<td>55</td>
</tr>
<tr>
<td>25</td>
<td>2</td>
<td>3.1</td>
<td>2</td>
<td>7</td>
<td>13</td>
<td>6</td>
<td>9</td>
<td>11</td>
<td>7</td>
<td>6</td>
<td>63</td>
</tr>
<tr>
<td>26</td>
<td>18</td>
<td>30.5</td>
<td>10</td>
<td>6</td>
<td>7</td>
<td>2</td>
<td>9</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>59</td>
</tr>
<tr>
<td>27</td>
<td>19</td>
<td>34.6</td>
<td>9</td>
<td>2</td>
<td>5</td>
<td>3</td>
<td>7</td>
<td>5</td>
<td>5</td>
<td>0</td>
<td>55</td>
</tr>
<tr>
<td>28</td>
<td>3</td>
<td>6.2</td>
<td>4</td>
<td>4</td>
<td>9</td>
<td>9</td>
<td>5</td>
<td>6</td>
<td>6</td>
<td>2</td>
<td>48</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>140</strong></td>
<td><strong>89</strong></td>
<td><strong>61</strong></td>
<td><strong>147</strong></td>
<td><strong>83</strong></td>
<td><strong>145</strong></td>
<td><strong>92</strong></td>
<td><strong>88</strong></td>
<td><strong>61</strong></td>
<td></td>
<td><strong>906</strong></td>
</tr>
</tbody>
</table>
Appendix 6.6(d)

The correlation between mean number of novel responses on item 15 for each class and the respective class ratings on three learning environment dimensions

<table>
<thead>
<tr>
<th>Class Code</th>
<th>Novel Answer %</th>
<th>Ratings</th>
<th>Facilitation of Intrinsic Motivation</th>
<th>Emphasis on Integration</th>
<th>Emphasis on Specific Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>10.2</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>7.7</td>
<td>6</td>
<td>6</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>7.4</td>
<td>3</td>
<td>7</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>9.0</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>4.4</td>
<td>6</td>
<td>5</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>35.7</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>13.9</td>
<td>5</td>
<td>7</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>10.3</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>29.7</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>16.3</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>26.8</td>
<td>2</td>
<td>3</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>20.0</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>3.6</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>3.1</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>30.5</td>
<td>2</td>
<td>4</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>34.6</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>6.2</td>
<td>3</td>
<td>5</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

Correlation of learning environment with % of novel answer: .69, .41, -.55
Results of ANOVA for examining the relationship between student performance on the Problems scale and achievement press, achievement motivation, emphasis on integration and emphasis on specific detail

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Significance of F</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main Effects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integ.</td>
<td>685.608</td>
<td>4</td>
<td>171.402</td>
<td>7.101</td>
<td>0.001</td>
</tr>
<tr>
<td>Detail</td>
<td>189.293</td>
<td>1</td>
<td>189.293</td>
<td>7.842</td>
<td>0.006</td>
</tr>
<tr>
<td>Press</td>
<td>17.671</td>
<td>1</td>
<td>17.671</td>
<td>0.732</td>
<td>0.999</td>
</tr>
<tr>
<td>Motn</td>
<td>416.350</td>
<td>1</td>
<td>416.350</td>
<td>17.249</td>
<td>0.001</td>
</tr>
<tr>
<td>Morn</td>
<td>59.696</td>
<td>1</td>
<td>59.696</td>
<td>2.473</td>
<td>0.113</td>
</tr>
<tr>
<td><strong>2-way Interactions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integ. Detail</td>
<td>234.762</td>
<td>6</td>
<td>39.127</td>
<td>1.621</td>
<td>0.141</td>
</tr>
<tr>
<td>Integ. Press</td>
<td>175.666</td>
<td>1</td>
<td>175.666</td>
<td>7.278</td>
<td>0.007</td>
</tr>
<tr>
<td>Integ. Motn</td>
<td>9.057</td>
<td>1</td>
<td>9.057</td>
<td>0.375</td>
<td>0.999</td>
</tr>
<tr>
<td>Detail Press</td>
<td>0.277</td>
<td>1</td>
<td>0.277</td>
<td>0.011</td>
<td>0.999</td>
</tr>
<tr>
<td>Detail Motn</td>
<td>33.613</td>
<td>1</td>
<td>33.613</td>
<td>1.393</td>
<td>0.237</td>
</tr>
<tr>
<td>Press Motn</td>
<td>25.166</td>
<td>1</td>
<td>25.166</td>
<td>1.043</td>
<td>0.309</td>
</tr>
<tr>
<td>Motn</td>
<td>2.690</td>
<td>1</td>
<td>2.690</td>
<td>0.111</td>
<td>0.999</td>
</tr>
<tr>
<td><strong>3-way Interactions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integ. Detail Press</td>
<td>361.877</td>
<td>4</td>
<td>90.469</td>
<td>3.748</td>
<td>0.006</td>
</tr>
<tr>
<td>Integ. Detail Motn</td>
<td>77.650</td>
<td>1</td>
<td>77.650</td>
<td>3.217</td>
<td>0.070</td>
</tr>
<tr>
<td>Integ. Press Motn</td>
<td>0.003</td>
<td>1</td>
<td>0.003</td>
<td>0.000</td>
<td>0.999</td>
</tr>
<tr>
<td>Detail Press Motn</td>
<td>34.789</td>
<td>1</td>
<td>34.789</td>
<td>1.441</td>
<td>0.229</td>
</tr>
<tr>
<td>Motn</td>
<td>222.466</td>
<td>1</td>
<td>222.466</td>
<td>9.216</td>
<td>0.003</td>
</tr>
<tr>
<td><strong>4-way Interaction</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integ. Detail Motn</td>
<td>83.136</td>
<td>1</td>
<td>83.136</td>
<td>3.444</td>
<td>0.061</td>
</tr>
<tr>
<td>Explained</td>
<td>1365.383</td>
<td>15</td>
<td>91.026</td>
<td>3.771</td>
<td>0.001</td>
</tr>
<tr>
<td>Residual</td>
<td>6227.614</td>
<td>258</td>
<td>24.138</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>7592.997</td>
<td>273</td>
<td>27.813</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix 7.1(b)

Results derived from the ANOVA reported in Appendix 7.1a used to examine the significance of the variance explained by the interaction of achievement press, achievement motivation and emphasis on specific detail over and above that explained by both main effects and 2-way interaction terms.

Improvement in amount of explained variance due to 3-way interactive term over and above that explained by the reduced model comprising only main effects and 2-way interaction terms.

<table>
<thead>
<tr>
<th></th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Model</td>
<td>11</td>
<td>1142.9</td>
<td>103.9</td>
<td>4.22</td>
</tr>
<tr>
<td>Reduced Model</td>
<td>10</td>
<td>920.44</td>
<td>92.04</td>
<td>3.63</td>
</tr>
<tr>
<td>Improvement due to third-order interactive term</td>
<td>1</td>
<td>222.46</td>
<td>22.46</td>
<td>9.04</td>
</tr>
<tr>
<td>Residual</td>
<td>262</td>
<td>6449.1</td>
<td>24.61</td>
<td></td>
</tr>
</tbody>
</table>
Mean scores on the Problems scale for each of the categories of variables within the 3-way interaction of achievement press, achievement motivation and emphasis on specific detail

<table>
<thead>
<tr>
<th>Condition</th>
<th>High achievement motivation</th>
<th>Low achievement motivation</th>
<th>Mean Score</th>
<th>t-Value</th>
<th>df</th>
<th>2-tail Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>High press - High detail</td>
<td>15.38</td>
<td>11.22</td>
<td>3.59</td>
<td>67</td>
<td>.001</td>
<td></td>
</tr>
<tr>
<td>High press - Low detail</td>
<td>12.29</td>
<td>14.19</td>
<td>-1.60</td>
<td>48</td>
<td>.116</td>
<td></td>
</tr>
<tr>
<td>Low press - High detail</td>
<td>10.56</td>
<td>11.48</td>
<td>-.69</td>
<td>62</td>
<td>.491</td>
<td></td>
</tr>
<tr>
<td>Low press - Low detail</td>
<td>11.71</td>
<td>9.51</td>
<td>1.98</td>
<td>70</td>
<td>.051</td>
<td></td>
</tr>
</tbody>
</table>

Where detail = emphasis on specific detail
press = achievement press
Results derived from the ANOVA reported in Appendix 7.1a used to examine the significance of the variance explained by the interaction of achievement press, achievement motivation and emphasis on integration over and above that explained by both main effects and 2-way interaction terms.

Improvement in amount of explained variance due to 3-way interactive term over and above that explained by the reduced model comprising only main effects and 2-way interaction terms.

<table>
<thead>
<tr>
<th>Analysis of Variance</th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full model</td>
<td>11</td>
<td>998.09</td>
<td>90.73</td>
<td>3.60</td>
</tr>
<tr>
<td>Reduced model</td>
<td>10</td>
<td>920.44</td>
<td>92.04</td>
<td>3.63</td>
</tr>
<tr>
<td>Improvement due to interactive term</td>
<td>1</td>
<td>77.65</td>
<td>77.65</td>
<td>3.09</td>
</tr>
<tr>
<td>Residual</td>
<td>262</td>
<td>6594.90</td>
<td>25.17</td>
<td></td>
</tr>
</tbody>
</table>
Appendix 7.2(a)

Results derived from the ANOVA reported in Appendix 7.1a used to examine the significance of the variance explained by the interaction of both learning goals over and above that explained by the main effects only.


APPENDIX 7.2b

Mean performance scores on the Problems scale for students found in each of the four possible types of learning environment when the 2-way interaction of emphasis on specific detail . emphasis on integration is considered


where detail = emphasis on specific detail
integration = emphasis on integration
A comparison of the amount of variance explained by a 4-term reduced model to the total amount of variance explained by the remaining terms of the 15-term full model reported in Appendix 7.1a

<table>
<thead>
<tr>
<th>Analysis of variance</th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full model</td>
<td>15</td>
<td>1365.38</td>
<td>91.03</td>
<td>3.77</td>
</tr>
<tr>
<td>Reduced Model</td>
<td>4</td>
<td>894.53</td>
<td>223.63</td>
<td>8.98</td>
</tr>
<tr>
<td>Improvement</td>
<td>11</td>
<td>470.85</td>
<td>42.80</td>
<td>1.77</td>
</tr>
<tr>
<td>Residual</td>
<td>258</td>
<td>6227.61</td>
<td>24.13</td>
<td></td>
</tr>
</tbody>
</table>
Appendix 7.4(a)

Results of ANOVA for Examining the Relationship between Student Performance on the Problems Scale and the 3-way Interaction of Cognitive Readiness, Emphasis on Specific Detail and Emphasis on Integration

Performance on Problems scale by Cognitive Readiness (C.R.) Emphasis on Integration (Integration) Emphasis on Specific Detail (Detail)

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Signif. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Effects</td>
<td>2281.72</td>
<td>4</td>
<td>570.43</td>
<td>29.54</td>
<td>0.001</td>
</tr>
<tr>
<td>Detail</td>
<td>1.39</td>
<td>1</td>
<td>1.39</td>
<td>0.07</td>
<td>0.999</td>
</tr>
<tr>
<td>Integration</td>
<td>141.08</td>
<td>1</td>
<td>141.08</td>
<td>7.31</td>
<td>0.007</td>
</tr>
<tr>
<td>C.R.</td>
<td>2120.87</td>
<td>2</td>
<td>1060.43</td>
<td>54.92</td>
<td>0.001</td>
</tr>
<tr>
<td>2-Way Interactions</td>
<td>81.69</td>
<td>5</td>
<td>16.34</td>
<td>0.85</td>
<td>0.999</td>
</tr>
<tr>
<td>Detail.Integration</td>
<td>37.82</td>
<td>1</td>
<td>37.82</td>
<td>1.96</td>
<td>0.159</td>
</tr>
<tr>
<td>Detail.C.R.</td>
<td>32.41</td>
<td>2</td>
<td>16.20</td>
<td>0.84</td>
<td>0.999</td>
</tr>
<tr>
<td>Integration.C.R.</td>
<td>5.94</td>
<td>2</td>
<td>2.97</td>
<td>0.15</td>
<td>0.999</td>
</tr>
<tr>
<td>3-Way Interactions</td>
<td>170.70</td>
<td>2</td>
<td>85.35</td>
<td>4.42</td>
<td>0.013</td>
</tr>
<tr>
<td>Detail.Integration.C.R.</td>
<td>170.70</td>
<td>2</td>
<td>85.35</td>
<td>4.42</td>
<td>0.013</td>
</tr>
<tr>
<td>Explained</td>
<td>2534.11</td>
<td>11</td>
<td>230.37</td>
<td>11.93</td>
<td>0.001</td>
</tr>
<tr>
<td>Residual</td>
<td>5058.89</td>
<td>262</td>
<td>19.31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>7592.98</td>
<td>273</td>
<td>27.81</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix 7.4(b)

Mean performance scores on the Problems scale for students found in each of the six possible categories that result from a consideration of the 3-way interaction of cognitive readiness, emphasis on specific detail, emphasis on integration

<table>
<thead>
<tr>
<th>Category</th>
<th>Mean Score</th>
<th>t-value</th>
<th>df</th>
<th>1-tail Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Cognitive Readiness</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Integration - High Detail</td>
<td>16.03</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Integration - Low Detail</td>
<td>16.75</td>
<td>-.51</td>
<td>44</td>
<td>.30</td>
</tr>
<tr>
<td>Low Integration - High Detail</td>
<td>15.45</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Integration - Low Detail</td>
<td>13.70</td>
<td>1.35</td>
<td>59</td>
<td>.09</td>
</tr>
<tr>
<td>Intermediate Cognitive Readiness</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Integration - High Detail</td>
<td>12.91</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Integration - Low Detail</td>
<td>10.10</td>
<td>1.78</td>
<td>40</td>
<td>.04</td>
</tr>
<tr>
<td>Low Integration - High Detail</td>
<td>9.23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Integration - Low Detail</td>
<td>10.91</td>
<td>-1.79</td>
<td>42</td>
<td>.04</td>
</tr>
<tr>
<td>Low Cognitive Readiness</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Integration - High Detail</td>
<td>9.84</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Integration - Low Detail</td>
<td>8.78</td>
<td>.69</td>
<td>27</td>
<td>.25</td>
</tr>
<tr>
<td>Low Integration - High Detail</td>
<td>6.94</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Integration - Low Detail</td>
<td>9.42</td>
<td>-2.88</td>
<td>42</td>
<td>.003</td>
</tr>
</tbody>
</table>

Where Integration = emphasis on integration
Detail = emphasis on specific detail
Results of multiple regression analysis used to examine the 2-way interactive effect upon student performance between cognitive readiness and achievement press

1. **Analysis of variance for full 5-term model**

<table>
<thead>
<tr>
<th>Analysis of Variance</th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>5</td>
<td>3008.20</td>
<td>601.64</td>
<td>35.17</td>
</tr>
<tr>
<td>Residual</td>
<td>268</td>
<td>4584.79</td>
<td>17.11</td>
<td></td>
</tr>
</tbody>
</table>

2. **Analysis of variance for reduced 3-term model including both independent variables and interactive term**

<table>
<thead>
<tr>
<th>Analysis of Variance</th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>3</td>
<td>2986.68</td>
<td>995.56</td>
<td>58.35</td>
</tr>
<tr>
<td>Residual</td>
<td>270</td>
<td>4606.32</td>
<td>17.06</td>
<td></td>
</tr>
</tbody>
</table>

Summary Table after the entry of the final term in the regression equation

**Dependent Variable: Student Performance on Problems Scale**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Multiple R</th>
<th>R Square</th>
<th>Rsq Change</th>
<th>Simple R</th>
<th>Raw Regression Coeff.</th>
<th>Beta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive readiness</td>
<td>0.62</td>
<td>0.38</td>
<td>0.38</td>
<td>0.62</td>
<td>0.71</td>
<td>0.79</td>
</tr>
<tr>
<td>Achievement press</td>
<td>0.63</td>
<td>0.39</td>
<td>0.01</td>
<td>0.36</td>
<td>0.03</td>
<td>0.01</td>
</tr>
<tr>
<td>Cognitive readiness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Achievement press</td>
<td>0.63</td>
<td>0.39</td>
<td>0.00</td>
<td>0.48</td>
<td>-0.01</td>
<td>-0.20</td>
</tr>
<tr>
<td>Constant</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.50</td>
</tr>
</tbody>
</table>

3. The resultant partial correlations and beta coefficients of achievement press and the interactive term following the entry of cognitive readiness into the 5-term full regression model

<table>
<thead>
<tr>
<th>Variable entered next</th>
<th>Beta coeff.</th>
<th>Partial correlation</th>
<th>F-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achievement press</td>
<td>-.09</td>
<td>-.10</td>
<td>3.20</td>
</tr>
<tr>
<td>Cognitive readiness.</td>
<td>-.17</td>
<td>-.12</td>
<td>3.88</td>
</tr>
</tbody>
</table>
The ANOVA used to examine the relationship between student performance on the Problems scale and the interaction of cognitive readiness and achievement motivation

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Signif. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main effects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cognitive readiness</td>
<td>2102.869</td>
<td>2</td>
<td>1051.434</td>
<td>53.836</td>
<td>0.001</td>
</tr>
<tr>
<td>Achievement motivation</td>
<td>77.563</td>
<td>1</td>
<td>77.563</td>
<td>3.971</td>
<td>0.045</td>
</tr>
<tr>
<td><strong>2-way interactions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cognitive readiness . motivation</td>
<td>142.949</td>
<td>2</td>
<td>71.474</td>
<td>3.660</td>
<td>0.026</td>
</tr>
<tr>
<td>Explained</td>
<td>2358.899</td>
<td>5</td>
<td>471.780</td>
<td>24.156</td>
<td>0.001</td>
</tr>
<tr>
<td>Residual</td>
<td>5234.098</td>
<td>268</td>
<td>19.530</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>7592.997</td>
<td>273</td>
<td>27.813</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>High Cognitive Readiness</td>
<td>Intermediate Cognitive Readiness</td>
<td>Low Cognitive Readiness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>--------------------------</td>
<td>----------------------------------</td>
<td>-------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Score</td>
<td>16.57</td>
<td>10.90</td>
<td>8.51</td>
<td></td>
<td></td>
</tr>
<tr>
<td>t-value</td>
<td>3.02</td>
<td>0.33</td>
<td>-0.57</td>
<td></td>
<td></td>
</tr>
<tr>
<td>df</td>
<td>95</td>
<td>89</td>
<td>73</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-tail Prob.</td>
<td>0.002</td>
<td>0.37</td>
<td>0.28</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mean performance scores on the Problems scale for each category of achievement motivation for students at each level of cognitive readiness.
Appendix 7.7(a)

Results of Multiple Regression Analysis used to Examine the 3-way Interaction of Cognitive Readiness, Intrinsic Motivation and Facilitation of Intrinsic Motivation upon Student Performance on the Problems Scale

<table>
<thead>
<tr>
<th>Analysis of Variance</th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Model</td>
<td>4</td>
<td>2968.33</td>
<td>742.08</td>
<td>43.16</td>
</tr>
<tr>
<td>Reduced Model</td>
<td>3</td>
<td>2948.05</td>
<td>982.68</td>
<td>57.12</td>
</tr>
<tr>
<td>Improvement due to</td>
<td>1</td>
<td>20.28</td>
<td>20.28</td>
<td>1.20</td>
</tr>
<tr>
<td>interactive term</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residual</td>
<td>269</td>
<td>4624.66</td>
<td>17.19</td>
<td></td>
</tr>
</tbody>
</table>
Appendix 7.7(b)

Results of Multiple Regression Analysis used to Examine the 2-way Interactive Effect upon Student Performance between Cognitive Readiness and each of Student Interest in Biology and Facilitation of Intrinsic Motivation

<table>
<thead>
<tr>
<th>Analysis of Variance</th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean Square</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Student Interest in Biology

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Full model</td>
<td>3</td>
<td>2900.53</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduced model</td>
<td>2</td>
<td>2889.62</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improvement due to</td>
<td>1</td>
<td>10.91</td>
<td>10.91</td>
<td>.64</td>
</tr>
<tr>
<td>interactive term</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residual</td>
<td>264</td>
<td>4526.29</td>
<td>17.15</td>
<td></td>
</tr>
</tbody>
</table>

2. Facilitation of Intrinsic Motivation

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Full model</td>
<td>3</td>
<td>2946.86</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduced model</td>
<td>2</td>
<td>2905.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improvement due to</td>
<td>1</td>
<td>41.82</td>
<td>41.82</td>
<td>2.46</td>
</tr>
<tr>
<td>interactive term</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residual</td>
<td>264</td>
<td>4479.94</td>
<td>16.97</td>
<td></td>
</tr>
</tbody>
</table>
Appendix 7.7(c)

Results of ANOVA for Examining the Relationship between Student Performance on the Problems Scale and the 2-way Interaction of Cognitive Readiness and Intrinsic Motivation

Performance on Problems scale
by Cognitive Readiness
Intrinsic Motivation

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main effects</td>
<td>2210.82</td>
<td>3</td>
<td>736.04</td>
<td>37.19</td>
<td>.001</td>
</tr>
<tr>
<td>Intrinsic Motivation</td>
<td>72.48</td>
<td>1</td>
<td>72.48</td>
<td>3.66</td>
<td>.05</td>
</tr>
<tr>
<td>Cognitive Readiness</td>
<td>2000.08</td>
<td>2</td>
<td>1000.04</td>
<td>50.46</td>
<td>.001</td>
</tr>
<tr>
<td>2-way Interaction</td>
<td>71.44</td>
<td>2</td>
<td>35.72</td>
<td>1.80</td>
<td>.17</td>
</tr>
<tr>
<td>Intrinsic Motivation. Cognitive Readiness</td>
<td>71.44</td>
<td>2</td>
<td>35.72</td>
<td>1.80</td>
<td>.17</td>
</tr>
<tr>
<td>Explained</td>
<td>2282.25</td>
<td>5</td>
<td>456.45</td>
<td>23.03</td>
<td>.001</td>
</tr>
<tr>
<td>Residual</td>
<td>5310.75</td>
<td>268</td>
<td>19.82</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>7592.99</td>
<td>273</td>
<td>27.81</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Results of the multiple regression analysis, using dummy variables, examining the heterogeneity of regression slopes for intrinsic motivation, the facilitation of intrinsic motivation and interest in biology at each level of cognitive readiness

<table>
<thead>
<tr>
<th>Analysis of Variance</th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Intrinsic motivation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full model</td>
<td>5</td>
<td>2318.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduced additive model</td>
<td>3</td>
<td>2174.14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improvement due to interactive terms</td>
<td>2</td>
<td>143.98</td>
<td>71.99</td>
<td>3.66</td>
</tr>
<tr>
<td>Residual</td>
<td>268</td>
<td>5274.87</td>
<td>19.68</td>
<td></td>
</tr>
<tr>
<td>2. Facilitation of intrinsic motivation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full model</td>
<td>5</td>
<td>2180.93</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduced additive model</td>
<td>3</td>
<td>2155.17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improvement due to interactive terms</td>
<td>2</td>
<td>25.76</td>
<td>12.88</td>
<td>58</td>
</tr>
<tr>
<td>Residual</td>
<td>268</td>
<td>5412.06</td>
<td>20.19</td>
<td></td>
</tr>
<tr>
<td>3. Interest in biology</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full model</td>
<td>5</td>
<td>2220.51</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduced additive model</td>
<td>3</td>
<td>2133.15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improvement due to interactive terms</td>
<td>2</td>
<td>87.36</td>
<td>43.68</td>
<td>2.20</td>
</tr>
<tr>
<td>Residual</td>
<td>262</td>
<td>5206.30</td>
<td>19.87</td>
<td></td>
</tr>
</tbody>
</table>
Appendix 7.7(e)

The Results of the ANOVA used to Examine the Relationship between Student Performance on the Problems Scale and the 2-way Interaction of Intrinsic Motivation and the Facilitation of Intrinsic Motivation

Performance on Problems scale by Intrinsic Motivation Facilitation of Intrinsic Motivation

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main effects</td>
<td>235.67</td>
<td>2</td>
<td>117.84</td>
<td>4.34</td>
<td>.01</td>
</tr>
<tr>
<td>Intrinsic Motivation</td>
<td>212.89</td>
<td>1</td>
<td>212.89</td>
<td>7.84</td>
<td>.01</td>
</tr>
<tr>
<td>Facilitation of Intrinsic Motivation</td>
<td>24.86</td>
<td>1</td>
<td>24.86</td>
<td>.91</td>
<td>.99</td>
</tr>
<tr>
<td>2-way Interactions</td>
<td>23.89</td>
<td>1</td>
<td>23.89</td>
<td>.88</td>
<td>.99</td>
</tr>
<tr>
<td>Explained</td>
<td>259.56</td>
<td>3</td>
<td>86.52</td>
<td>3.19</td>
<td>.02</td>
</tr>
<tr>
<td>Residual</td>
<td>7333.44</td>
<td>270</td>
<td>27.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>7592.98</td>
<td>273</td>
<td>27.81</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Di Vestra, F.J. 'Theory and Measures of Individual Differences in Studies of Trait by Treatment Interaction'. ERIC No. ED 069 749.


Esland, G. 'Teaching and Learning as the Organization of Knowledge' in Young, M.F.D. (ed.), *Knowledge and Control*, op. cit., 1971, pp. 70-115.


McClelland, D.C. 'The Role of Educational Technology in Developing Achievement Motivation', *Educational Technology*, 9, 1969, pp. 7-16.


McKeachie, W.J. 'Motivation, Teaching Methods and College Learning', *Nebraska Symposium on Motivation*, 9, 1961, pp. 111-42.


'Three Interactive Relationships among Learner Characteristics, Types of Learning, Instructional Methods and Subject Matter Variables', *Journal of Educational Psychology*, 62, 1971, pp. 31-38.


