THE PROMOTION OF AFFECTIVE EDUCATIONAL OBJECTIVES BY MEANS OF AN ENVIRONMENTAL APPROACH TO BIOLOGY TEACHING

BY

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OPSOMMING VAN TESIS.

Hierdie verhandeling is 'n kwantitatiewe waardering van 'n omgewingsbenadering tot die onderrig van Biologie as 'n middel om die kwynende belangstelling van die sekondere hoërskoolleerlinge in Suid Afrika in hierdie vak te stuit en om 'n meer positiewe houding ten opsigte van bewaringsbewustheid; die rol van die wetenskaplike in die gemeenskap; wetenskaplike metodes in die oplossing van probleme en metodes om die oordra van wetenskaplike inligting te bevorder.

Die Onderwysdepartement van die Kaapprovinsie se weergawe van die Kernleerplan vir Senior Biologie is geevalueer in terme van sy doelstellings. Intermediêre affektiewe opvoedkundige doelstellings is hiervoor opgeklaar en 'n reeks van houdingskale is opgestel, verfyn en geldig gemaak vir gebruik in toets en hertoetssituasies.

'n Inheemse interpretasie van die omgewingsbenadering by die onderrig van 'n plaaslike ekosisteem is ontwikkel en waardeverklarende tegnieke is in die program ingesluit om die maksimum positiewe affektiewe ontwikkeling te verseker.

Die ondersoek is versigtig gekontroleer en alle pogings is aangewend om soveel kontroleerbare variante as moontlik konstant te hou. Die hoof-experimentele variant was die twee onderrigstrategieë wat gebruik is, naamlik die normale klaskamer verduidelikende lesing-demonstrasie benadering (Kontrolegroep) en die omgewingsbenadering (Eksperimentele groep).

Ten spyte van die klein omvang van die ondersoek wat beperk was tot een groot blanke hoërskool is dit bewys dat die omgewingsbenadering die verslegtende affektiewe ontwikkeling wat normaalweg teëgekom word, omgekeer het en dat die affektiewe verbetering grootliks volgehou is sonder enige verdere agteruitgang vir ten minste drie maande na die beëindiging van die omgewingsprogram wat dui op aansienlike stabiliteit van die verbeterde gesindhede.

Op die basis van hierdie bevindings is aanbevelings gemaak in verband met die implementering van Biologie kursusse wat gebaseer is op die omgewing en verdere aanverwante navorsings - moontlikhede.

PART ONE:

INTRODUCTION

CHAPTER 1

A STATEMENT OF THE PROBLEM AND THE METHOD OF ITS INVESTIGATION

CHAPTER 1 : A STATEMENT OF THE PROBLEM AND THE METHOD OF IT'S INVESTIGATION

A. THE PROBLEM

1. The educator as a moulder of attitudes

Science education has many different goals which can be broadly grouped into three main categories:

(a) The transmission of knowledge and the development of cognitive skills;

(b) The inculcation of positive values and attitudes;

(c) The development of psychomotor skills and techniques suited to scientific investigation.

Any study of the history of science education will reveal the preoccupation of science educators with the first category and a corresponding recognition of the third category but, until recently no adequate attempt at realisation of goals that are embraced by the second category. *but on a limited scale.*

One of the modern science curriculum trends that has been gaining ground over the past twenty years is the awareness of the scientist's responsibility to society. This has, in part, been a by-product of two world wars and an increasing concern at the immense destructive potential of many new scientific findings of our present age.

Science/...

Science educators are becoming increasingly aware of the need to match technological ability with moral responsibility for the welfare of society. This concern with the social implications of scientific knowledge is reflected in the work of Kuhn (1) and Simon and Harmin (2). They identify three levels at which science topics are being taught. Each level grows out of the level above it in hierarchical nature:

SIMON AND HARMIN	KUHN
1. Fact level	This level does little to prepare students for life and, being irrelevant, is soon forgotten.
2. Concept level	This level is usually associated with enquiry approaches and is the basis of many modern syllabuses
3. Values level	This level aims at teaching for affective objectives and values; it makes science relevant to society.

Table 1.1 <u>A comparison of the findings of Kuhn, Simon and Harmin illustrating the new awareness of the importance of attitudes and values.</u>

Most/...

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(1) Kuhn D.J., "Value systems in life science instruction", <u>Science Education</u> Vol. 57 No. 3. (1973)

(2) Simon, S.B. and Harmin M., "Subject matter with a focus on values" <u>Educational Leadership</u> Vol. 26 No. 2 (1968)

Most of our modern science syllabuses reached the concept level during the 1960's and 1970's. Each level depends on the earlier levels to provide a foundation for building on. Kuhn believes that science teaching at the value level will be the "new science" of the next decade.

These ideas gain considerable support from the current findings of social psychologists working in the field of attitude formation. Triandis (3), Fishbein and Ajzen (4) reviewing research on attitude change point out that there are several ways of influencing values and attitudes through beliefs:

FISHBEIN AND AJZEN	TRIANDIS	LEVEL
Persuasive Communication (Passive)	1. Giving a person information to change beliefs.	Cognitive
Persuasive Communication (Passive)	2. Providing a person with an experience of the attitude object.	Affective
Role Play (Active)	Providing a person with an experience of the attitude object.	Behavioural
Counter attitudinal Behaviour (Active)	3. Forcing a person to behave in an inconsistent way.	Behavioural

Table 1.2 A comparison of some current strategies of attitude change.

As/...

(3) Triandis H.C., Attitude and Attitude Change. (1971).

(4) Fishbein, M. and Ajzen, I., Belief, Attitude and Intention: An Introduction to Theory and Research (1975)

As yet there has been no direct attempt by western science educators to implement <u>all</u> these research strategies in achieving desired attitudes and values and at present some considerable disagreement exists concerning the method by which teachers can legitimately promote positive attitude formation. Some research workers, Brown (5) and Evans (6), conclude that because interests and attitudes are learned, children should not be allowed too much freedom to form their own values. Values should be actively taught using active participation strategies such as role-play, counter-attitudinal behaviour and persuasive communication. They see the teacher in the role of <u>a guide</u> to correct attitudes and values.

On the other hand some educators consider this active value promotion to be an unwarranted manipulation of individual freedom of choice. Swan (7) sees the teacher in a far more passive role:

> ... <u>a midwife</u> who allows the process of value formation to develop at it's own pace. The teacher makes sure that the pupils learn the correct <u>process</u> of value clarification, but never forces values upon people.

It/...

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(5) Brown S., <u>Attitude Goals in Secondary School Science</u>. (1976)

(6) Evans K.M., <u>Attitudes and Interests in Education.</u> (1965)

(7) Swan, J.A. and Stapp, W.B., <u>Environmental Education; Strategies towards a more liveable future</u>. (1976)

It appears that there is an increasing demand for science educators to educate "with responsibility towards society" in mind. Population pressure often expressed through international politics and economics is forcing educators to re-evaluate their modern curricula in terms of values and attitudes. Social psychologists have recently developed the tools to ensure attitude change. It remains for educators to apply these findings at school level, and find out which of these strategies for attitude formation and change is the most effective and socially acceptable within the context of western democratic ideals.

2. The prescribed biology syllabus as a means of forming positive attitudes.

In the Cape Province, the Cape Education Department prescribes both the aims and the content of the Senior Biology Course. All schools whose candidates write the Cape Senior Certificate Examination in Biology (Higher or Standard Grade) follow this prescribed syllabus closely. Although there is currently an attempt being made to experiment with syllabus content this does not extend to experimentation with the aims as prescribed.

The extent to which the Senior Biology course syllabus is intended to achieve positive attitude and value formation can be determined by examining the six aims of the syllabus. (8)

These/...

(8) The Cape Education Department. Senior Secondary Course: Syllabus for Biology (Higher & Standard Grade) (1973)

These six aims are identical for both Higher and Standard Grade candidates. The bracketed titles are this author's own and indicate the abbreviated form by which each of these aims will be referred to in this study.

... AIMS

1. To guide pupils to an understanding and an appreciation of the interdependence of living things (especially man) and their relationship to their physical environment; (THE ECOLOGICAL AIM)
2. to teach pupils to appreciate how the development and application of scientific knowledge affect the progress of civilisation; (THE ROLE OF BIOLOGY AIM)
3. to excite pupils' interest in biological phenomena, to promote their powers of observation and to stimulate imaginative thinking; (THE LOOKING AND THINKING AIM)
4. to enable pupils to grasp the scientific method of approach and to cultivate habits of logical and systematic thinking in them; (THE SCIENTIFIC METHOD AIM)
5. to cultivate a desire in pupils to read more widely and more deeply on biological matters; (THE READING AIM)
6. to foster in pupils a love for the South African flora and fauna and to stress the vital importance of nature conservation. (THE CONSERVATION AIM) .....

On a cursory examination of these six aims we must acknowledge that they are broad aims in the true sense of the word and are wide enough to encompass almost all scientific goals at a cognitive, affective and psychomotor level.

This author compiled a list of cognitive and affective aims from the published articles of thirteen science educators or organisations, appearing between 1933 and 1973, namely:

The Noll/...

The Noll Study (9); Frutchley and Tyler (10); The Science Masters' Association (1938) (11); The Kesslar Study (12); Heil, Kambly, Mainardi, Weisman (13); Burgmeister (14); The American Council on Education (15); The Science Masters' Association (16); The Gulbenkian Foundation (17); Haney (18); Diederich (19); Kelly (20); Hughes (21); (See Table 1.3. A Review of Scientific Educational Objectives 1933 - 1973).

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(9) Noll V.H., "The habit of scientific thinking." Teachers College Record. Vol. 35 No. 1 (1933)

(10) Frutchley, F.P. and Tyler, R.W., "Examinations in the natural sciences". The Construction and use of Achievement Examinations. (1937)

(11) The Science Masters' Association. The Teaching of General Science. (1938)

(12) Kesslar O., "The elements of scientific method" Science Education Vol. 29. No. 5. (1945)

(13) Heil, L.M. Kambly, P.E. Mainardi, M. and Weisman, L., The Measurement of Understanding in Science. (1946)

(14) Burgmeister M.A., "Behaviour involved in critical aspects of scientific thinking." Science Education Vol. 36. No. 5 (1952)

(15) Dressel, P.L. and Mayhew, L.B. "Objectives in science", General Education : Explorations in Evaluation (1954)

(16) The Science Masters' Association. Science and Education : A policy statement. (1961)

(17) The Gulbenkian Foundation Report. Report of an enquiry into the suitability of the G.C.E. - A level syllabus in science. (1959)

(18) Haney R.E., "The development of scientific attitudes." The Science Teacher. Vol. 31. No. 8. (1964)

(19) Diederich P.B., "Components of Scientific Attitude." The Science Teacher Vol. 32. No. 2. (1967)

Kelly/...

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(18) Haney R.E., "The development of scientific attitudes." The Science Teacher. Vol. 31. No. 8. (1964)

(19) Diederich P.B., "Components of Scientific Attitude." The Science Teacher Vol. 32. No. 2. (1967)

Kelly/...

(20) Kelly P., "The nuffield science teaching project" The Science Teacher Vol. 34. No. 1. (1974)

(21) Hughes J.A.R., The New Biology Syllabus (1973)

(22) Kuhn D.J., (1973), Op. Cit.

Table 1.3.

A review of Scientific Educational Objectives 1933 - 1973

(Psychomotor objectives omitted)

	THE NOLL STUDY (1933)	FRUTCHLEY AND TYLER (1937)	SCIENCE MASTERS' ASSOCIATION (1938)	KESSLAR STUDY (1945)	HEIL, KAMBLY, MAINARDI, WEISMAN (1946)	BURGMEISTER (1952)	AMERICAN COUNCIL ON EDUCATION (1954)	SCIENCE MASTERS' ASSOCIATION (1961)	GULBENKIAN FOUNDATION (1963)	HANEY (1964)	DIEDERICH (1967)	KELLY (1967)	HUGHES (1973)
AFFECTIVE DOMAIN													
Accurate observation	●							●	●		●		●
Accurate reporting	●								●		●		
Honesty/Objectiveness	●									●	●		
Open-mindedness	●						●			●	●		●
Suspended judgement	●						●			●	●		
Criticism/scepticism	●				●					●	●		●
Relating science to life			●				●	●				●	●
Responsibility of science							●	●				●	●
Curiosity/interest		●						●	●	●	●		●
Humility/caution					●					●	●		
Appreciates Science. Method.					●		●	●	●		●		
Respects quantification	●										●		
AFFECTIVE/COGNITIVE DOMAIN													
Looks for rational answers	●		●	●	●					●	●		
Facts vs. hypotheses			●		●	●		●			●		●
Recognises problems		●	●	●		●	●		●				●
Hypothesis building and test.		●	●	●	●	●	●		●			●	●
Identifying assumptions					●	●	●				●		●
Mans influence on nature												●	
Interdependance of knowledge													●
COGNITIVE DOMAIN													
Facts/terms/principles/laws		●	●	●		●	●		●				●
Form and structure		●	●										
Verbal communication of ideas			●			●	●	●	●				●
Sources of information		●					●						
Application and generalising			●	●	●	●	●				●		●

This review revealed the clear difference between earlier aims prior to 1954 with their emphasis on cognitive objectives and the recent increasing emphasis on affective objectives with a corresponding reduction in the number of cognitive objectives as already indicated by Kuhn (21) earlier in this chapter.

Compare the purely affective objectives revealed in this review of the literature with the six broad aims of the Senior Secondary Course : Syllabus for Biology (See Table 1.4 A comparison of Affective Objectives.).

AFFECTIVE OBJECTIVES 1933 - 1973	C.E.D. BIOLOGY AIMS					
	1	2	3	4	5	6
1. Desire for accurate observation.			●			
2. Desire for accurate reporting.				●	●	
3. Honesty/Objectivity				●	●	
4. Open-mindedness				●		●
5. Willingness to suspend judgment.				●		●
6. Willingness to seek rational answers.				●	●	
7. Critical judgement/ Scepticism.				●	●	●
8. Awareness of relationship of science to daily life.		●		●	●	●
9. Awareness of problems.			●	●	●	●
10. Appreciation of use and limitations of hypotheses.			●	●		
11. Interest in natural phenomena.			●		●	●
12. Humility and caution in drawing conclusions.				●		
13. Appreciation of the scientific method.		●		●		
14. Respect for quantification.						
15. Awareness of man's influence on other organisms.	●					●
16. Awareness of the interdependance of knowledge.		●				

Table 1.4 A Comparison of Affective Objectives.

it/...

It can be seen that it is possible to interpret these six broad aims in such a way that all but one (No. 14) of the affective objectives culled from the thirteen studies are implicitly represented in the aims of the C.E.D. Senior Biology Course, this single omission being a true reflection on the lack of any mathematical procedures in the prescribed Biology syllabus.

The clear implication of Table 1.4 is that the aims of the prescribed biology syllabus under consideration are in fact a most suitable set of aims for achieving generally acknowledged desirable affective objectives.

<u>The Ecological Aim</u> of the C.E.D. Senior Biology Syllabus was only duplicated in one other recent study (namely Kelly (23)). This is felt to be a reflection on the relatively recent inclusion of ecology as a study topic in school biology courses.

<u>The Scientific Method Aim</u> and the <u>Conservation Aim</u> are particularly well chosen aims as they can be seen to include so many of the affective objectives found in other studies.

In essence it is clear that <u>the prescribed syllabus is rich in affective objectives</u> by international standards, but it remains to be seen if these affective objectives are being realised in the realities of the classroom situation.

(23) Kelly P., (1974), <u>Op Cit</u>.

3. <u>The problem of the past failure of the prescribed biology syllabus to realise all it's stated aims.</u>

(a) The problem is universal

During the last twenty years there have been several studies evaluating the "new" science curricula. Those studies that have concentrated on measuring <u>interest and attitude formation</u> have revealed some disturbing results....

> Most studies of attitude change show most students declining in attitude; most comparisons of "innovative" and "traditional" curricula show little difference between the two, and even when there is a difference, it is not always in favour of the innovative course. Gardner (24)

Gardner concludes that many of the "changes introduced into science curricula during the 1950's and 1960's .... were largely irrelevant or even harmful, as far as attitudes were concerned."

It would appear that there is a steady decline in pupils' attitudes as they grow older. Allen (25) suggests that maturing pupils lose interest as they see the school as an increasingly child-centred institution and hence less relevant to their needs.

Lucas/...

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(24) Gardner P.L., "Science curricula and attitudes to science," <u>The Australian Science Teachers Journal</u> Vol. 21. No. 2. (1975)

(25) Allen E.A., "Attitudes of children and adolescents in school," <u>Educational Research</u> Vol. 3. (1960/61).

Lucas and Broadhurst (26) found that the steady decline in interest in physical science reported by Wynn and Bledsoe (27) was also paralleled in biology.

Strong interest differences have been reported in boys and girls. Clarke (28) found that as boys grow older their preferences shift from biology to physical science while the interests of girls remain with the life sciences. Overall preferences favour the life sciences over the physical sciences.

While no adequate research suggesting reasons for this decline in attitudes with increasing maturity have been conducted to date, Ronneberg (29) suggests that first generation, "modern", science curriculum innovation has been shamefully authoritarian, far too specialised, and unrelated to the experience, interests and future needs of high school pupils.

These/...

(26) Lucas, A.M. and Broadhurst, N.A. "Changes in some content - free skills, knowledge and attitudes during two terms of grade twelve biology instruction in ten South Australian schools," Australian Science Teachers Journal Vol. 18. No. 1 (1972)

(27) Wynn, D.C. and Bledsoe, J.C. "Factors related to gain and loss of scientific interests during high school," Science Education Vol. 51. (1967)

(28) Clarke C.O., "A determination of commonalities of science interests held by intermediate grade children in inner-city, suburban and rural schools", Science Education Vol. 56. No. 2. (1972)

(29) Ronneberg G., "Chaos in science teaching", Chemical and Engineering News Vol. 48 (1970)

These informed comments seem to suggest biology educators need to take cognizance of the need for more relevant courses that emphasize more general interest, more democratic teaching processes and more emphasis on positive attitude formation. They also suggest that in general, biology syllabuses have failed to realise their affective aims to any meaningful degree.

(b) The problem is local

While we have seen that affective objectives are clearly stated in the prescribed biology syllabus (See Table 1.4) an examination of any Senior Certificate Examination Paper in Biology based on this syllabus reveals that the emphasis for promotion purposes is on the cognitive objectives of the syllabus alone. In the light of this official emphasis it is not surprising that many teachers regard the statement of aims as being irrelevant to the academic task at hand and not intended to be taken seriously at all.

As yet there has been no attempt to test, either officially or as part of a research project, whether the affective objectives of this course are being achieved or not. This may be due to the assumption that they are :

1. Being automatically achieved through a realisation of the cognitive objectives.
2. Beyond the scope of current evaluation techniques.
3. Not of particular importance.
4. Beyond the abilities of teachers to teach.

The first assumption, that affective objectives are automatically achieved along with cognitive objectives has been finally repudiated by Shock (30),

> ... the implicit belief, ..., if cognitive behaviours are developed, there will be a corresponding development of affective behaviours, should be discarded...

Shock found when testing high school biology students at several grades and levels of academic ability that there was no significant correlation between cognitive and affective development.

The second assumption, that the affective domain is beyond the scope of current evaluation is equally fallacious. Since the development of rating scales by Thurstone (31), Likert (32) and others in the late 1920's and early 1930's adequate techniques have existed for measuring unidimensional attitude positions and attitude change.

The third assumption, that affective objectives are of no particular importance is an error that is ever being more forcibly brought to our attention as our technological abilities outstrip our sense of moral responsibility. Their very presence in the prescribed statement of aims should be sufficient to repudiate this false assumption.

The/...

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(30) Shock N.H., "Analysis of the relationship which exists between cognitive and affective educational objectives", Journal of Research in Science Teaching. Vol. 10, No. 4 (1973)

(31) Thurstone L., The Measurement of Values (1963)

(32) Likert R., "A technique for the measurement of attitudes", Archives of Psychology No. 140 (1932)

The final assumption, that they are beyond the abilities of teachers to teach is widely shared by many today. Each society has its own affective objectives that it recognises and legitimates. Political and social forces have made demands on administrators to the point where they are wary of expressing affective objectives in any detail. Bloom (33) refers to this as "a retreat to the cognitive domain" at the expense of the affective domain which has been repressed, denied and obscured for too long. He recognises that affective objectives are most potent. They contain the forces that determine the nature of an individual's life and the life of the wider society.

Today many serving teachers may be found to be inadequate for teaching explicit affective objectives but their own implicit attitudes and interests still communicate a powerful message to their classes. The preparation of future teachers in our teachers' colleges and universities may need to take this increasing need for explicit attitudinal education into account, to satisfy the demands of society.

Until the achievement of affective objectives by teachers is officially evaluated it is unlikely that there will be many positive attempts made to achieve the stated affective aims of the syllabus. In order to evaluate them it will be necessary to identify them in much more detail than the present list of six broad aims succeeds in doing. (See Chapter 5 of this study.)

In/...

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(33) Bloom, B.S. Krathwold, D.R. and Masia, B.B. Taxonomy of Educational Objectives : Book 2. Affective Domain. (1964)

In conclusion, the affective objectives of the prescribed syllabus have been neglected due to:

1. Undue emphasis on the evaluation of purely cognitive objectives at the expense of affective objectives.
2. An assumption that affective objectives are implicitly realised in cognitive achievement.
3. A lack of adequate application of the methods of social psychologists to attitude measurements in educational evaluation.
4. A failure to realise the full importance of affective objectives for the welfare of society.
5. A failure to emphasize adequately affective-objective education at teacher training institutions.
6. A failure to clarify affective objectives in such a way that classroom teachers can apply them in a meaningful manner.

4. Summary of the problem.

The preceding information has shown the following summary statement to be valid:

(a) One of the major aims of science curricula is to inculcate positive values and attitudes towards life.

(b) Modern science syllabuses have aims that are rich in affective ojectives and there is an increasing tendency to emphasise them.

(c) Educators have been slow to apply the research findings of social psychologists relating to attitude formation and attitude change.

(d)/...

(d) The Cape Education Department's prescribed Biology Syllabus is rich in affective objectives by any standards.

(e) There is a steady deterioration in science students' attitudes and scientific interests with increasing maturity .

(f) Attitudes are learned phenomena, thus value-level teaching is coming to be seen as the only type that adequately realises affective educational objectives.

(g) New innovative science courses must focus on increasing the relevancy of Biology to the pupil to maintain and build positive attitude and value formation.

(h) At present there is no affective evaluation, no direct value-formative teaching and no general sense of the need of either amongst the teaching body in the Cape.

(i) The affective objectives implicit in the aims of the Biology syllabus are far too generally stated at present to enable teachers to direct or evaluate the affective response to their teaching.

(j) It is broadly assumed that teaching is associated with the attainment of cognitive objectives and any other affective objectives achieved are largely fringe benefits that are intangibly assimilated along the road.

(k) Thus only the cognitive objectives are officially evaluated.

(l) At present no means exists whereby teachers can quantitatively establish whether any of the affective objectives in the prescribed syllabus are being achieved or not.

5. The/...

5. The importance of solving the problem

As there is in South Africa, and indeed worldwide, an increasing call for better trained and more dedicated scientists, any failure of a teaching system to awaken interests and motivate more than a small minority of pupils, many of whom select Biology as a "soft option" initially, is a matter for real concern. This study is an attempt to highlight this problem in the light of recent research findings that offer hope of a practical solution, at least in as much as standard grade pupils are concerned.

It is important to promote a teaching approach that ensures maximal opportunity for value-formation in the context of a high-relevancy curriculum,

This would ensure that:

(a) Teachers consciously teach with attitude-formation and value-building in mind.

(b) The aims of the syllabus become the goals they were intended to be and not a meaningless preamble to the real core that matters.

(c) The high-relevance of the course would ensure a growing interest in all pupils, including those not destined for tertiary training in a scientific direction, and it would not be unreasonable to anticipate an improvement in cognitive learning with increased motivation.

(d) In addition studies in Biology would be viewed as "less academic" and more practical, attracting an increased enrolment in the Senior Secondary Phase. While at the present

time/...

time, the restrictions of the University entrance requirements might hamper the implementation of such a course at Higher Grade level, there is a real need for a high relevancy course which would enable the Standard Grade pupils who often fail to perceive the relevancy of the senior Biology course to achieve a valuable insight into the relevance of Biology to the individual in a rapidly changing world.

B. THE METHOD OF INVESTIGATING THE PROBLEM AND THE FIELD OF RESEARCH

This then, is in part, the task of this study: to identify in detail the affective objectives in a meaningful manner, and to identify and develop a teaching approach that is maximally orientated to the achievement of these affective objectives, in the hope that this will serve as a trigger for further research in this direction in order that Biology pupils may come to perceive the real issues that underly the teaching of science at school and so be better equipped to cope with coming changes.

1. The development of a method for maximal realisation of the affective objectives of the prescribed biology syllabus.

(a) The search for the best teaching approach

Several recent investigations in attitude formation at High School level have shown that most teaching variables have no significant link with the development of attitudes.
Shock (34) proved that age, sex, academic level, cognitive development and motivation have no significant effect on affective development.

Shock/...

(34) Shock N.H., (1973) Op. Cit.

Shock went further to suggest the following possible relationship between cognitive and affective development.

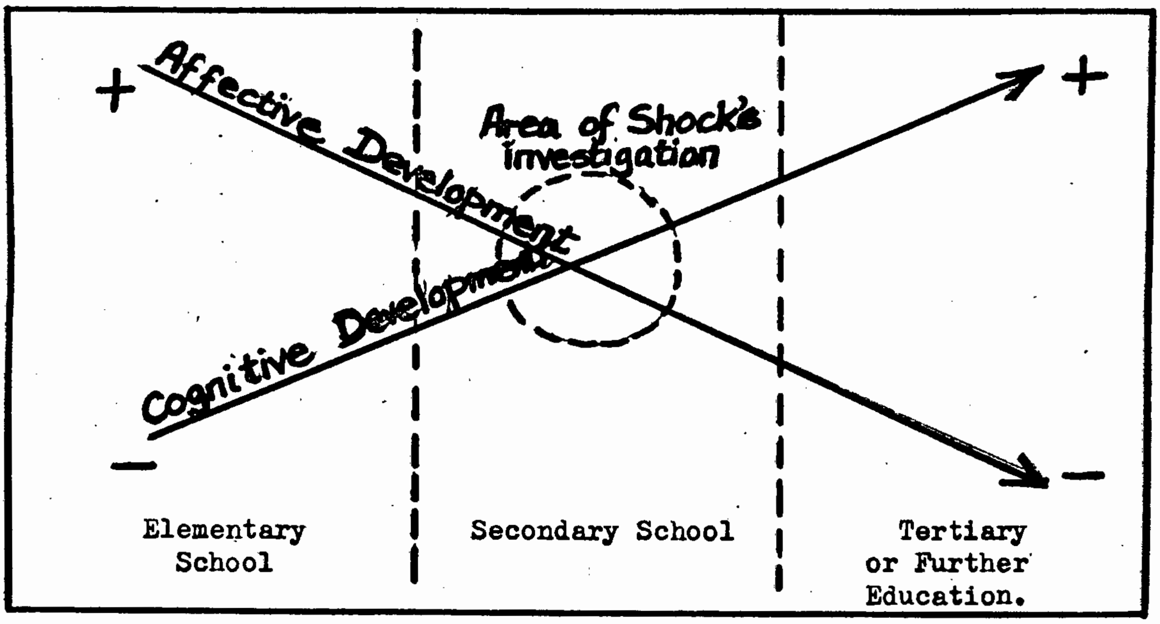

Fig. 1.1. Shock's cognitive-affective relationship model.

This model, while explaining Shock's low correlation differences at secondary school level, has some frightening implications in terms of positive attitudes, values and responsibilities at post-secondary school level.

This decline in interests and deterioration of attitudes during schooling has already been referred to by Gardner (35), Allen (36), Lucas and Broadhurst (37) and Wynn and Bledsoe (38).

Gardner/...

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(35) Gardner P.L., (1975), Op Cit.
(36) Allen E.A., (1960/61), Op Cit.
(37) Lucas, A.M. and Broadhurst, N.A., (1972), Op Cit.
(38) Wynn, D.C. and Bledsoe, J.C. (1967), Op Cit.

Gardner suggests the influence of the teacher may be more influencial than any curriculum variables.

Lowery (39), while substantiating Shock's findings regarding sex differences and cognitive development, in addition proved that socio-economic background had no significant effect on affective development. Lowery's study showed that the only meaningful variable effecting affective development was the teaching strategy employed. He compared a conventional text-book approach with an experimental approach, and found a significant increase in positive affective development resulting from the experimental approach to the biology syllabus.

Three subseqent studies have indicated that 1. Television taught classes (Welliver (40)); 2. Nuffield guided-discovery classes (Alexander (41)); and 3. Laboratory versus Demonstration versus Discussion Group methods (Yager, Engen and Snider (42)) have all failed to show a significant increase in positive affective development; on the contrary some have proved to be inferior to conventional text-book methods in their realisation of affective objectives.

On/...

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(39) Lowery L.F., "An experimental investigation into the attitudes of fifth grade students towards science", School Science and Mathematics Vol. 67. No. 6 (1967)

(40) Welliver P.W., "Television instruction and the attainment of objectives for a ninth grade physical science course", Journal of Research in Science Teaching Vol. 5 (1967/68)

(41) Alexander D., "The Nuffield Science Project", Evaluation in Curriculum Design : Twelve case studies. (1973)

(42) Yager, R.E. Engen, H.B. and Snider, B.C.F. "Effects of the laboratory and demonstration methods upon the outcomes of instruction in secondary biology". Journal of Research in Science Teaching Vol. 6 (1969)

On the other hand, there have been two promising reports that indicate significant improvements in the realisation of affective objectives. 1. Simmons and Esker (43) reported that the Process approach to biology proved to be a significantly superior method to the conventional text-book based course in realising affective objectives. 2. Fraser (44), reporting on the Australian Science Education Project (an Environmental approach), indicated that A.S.E.P. classes showed a significantly smaller deterioration in affective development than non-A.S.E.P. classes.

Perhaps it is significant that Prof. Ronneberg (45), a chemist with fifty years experience of science education, should identify a sound approach to science teaching as follows...

> ...Start with nature as it is and by using the methodology of science arrive at a body of knowledge called science ...

To date only the <u>process approach</u> which emphasizes the methodology of science and the <u>environmental approach</u> which emphasizes the methodology of science in an environmental setting have proved to be "sound approaches" to the development of positive attitudes, interests and values in science teaching.

This/...

(43) Simmons, J. and Esker, W. "Investigating the attitudes towards science fostered by the process approach programme", <u>School Science and Mathematics</u> Vol. 72. (1972)

(44) Fraser B.J., <u>The impact of A.S.E.P. on pupil learning and classroom climate</u>. (1975)

(45) Ronneberg G., (1970), <u>Op Cit</u>.

This study will attempt to demonstrate the suitability of the environmental approach in realising the aims of the pre - scribed syllabus.

(b) <u>The Environmental Approach as a method for realising affective objectives.</u>

The environmental approach has already been identified as a teaching approach well suited to value formation, but as yet there is but scant empirical evidence to substantiate this claim.

Environmental education has been clearly defined in recent years.

Bennett (46) claims that current research has shown that <u>any environmental experience</u> can be broken down into three broad cate - gories:

1. <u>Environmental discovery and inquiry</u>

   The students gather and compile data and facts about natural and man-made environmental components and their related social, political and economic aspects.

2. <u>Environmental evaluation and problem identification</u>

   To evaluate the data and give meaning to it. Answering these questions:

   How well are human and ecological needs being satisfied?

   How can the environment be maintained/ or improved?

3./...

(46) Bennett D.B., "Evaluating Environmental Education Programmes", <u>Environmental Education: strategies towards a more liveable future</u>. (1974)

3. <u>Environmental problem solving</u>

- Selecting and defining an issue
- Inquiring to become informed about the problem through investigation
- Determining alternative solutions to the problem
- Evaluating the consequences of solutions and choosing a solution
- Developing a plan of action

Strategies have been defined which encourage the learning of positive science attitudes.

<u>Klausmeier</u> (47) lists eight steps that teachers could use in order <u>to facilitate the learning of positive science attitudes</u>. This author has compared Klausmeier's eight steps to the structure of the environmental learning experience identified by Bennett.

KLAUSMEIER'S STEPS FOR THE LEARNING OF POSITIVE SCIENCE ATTITUDES.	BENNETT'S ENVIRONMENTAL LEARNING EXPERIENCE (the brackets are this author's own.)
1. Identify the attitude to be taught.	See chapter 5 of this study: The construction of affective objectives.
2. Clarify the vocabulary.	
3. Provide an informative experience consisting of:	
(a) Sensing the problem..	Selecting,....
(b) Identifying and clarifying the problem....	.. and defining an issue...
(c) Formulating hypotheses.	... determining alternative solutions to the problem..

(47) Klausmeier H.J., <u>Learning and Human Activities: Educational Psychology</u> (1961)

(d) Reasoning out the consequences of the hypotheses and designing the investigation.	.... evaluating the consequences of solutions and choosing a solution... developing a plan of action...
(e) Gathering data.	... gathering and compiling data and facts....
(f) Interpreting data.	
(g) Generalising (drawing conclusions).	.... evaluating the data and giving meaning to it....
(h) Communication of results to others.	evaluation....
4. Desirable identifying models should be provided.	(nature conservationists)
5. Pleasant emotional experiences should accompany the learning of attitudes (time to enjoy discoveries).	(field trips fulfil these requirements.
6. Appropriate contexts for practice should be provided.	(putting a conservation plan into action.)
7. Group techniques increase understanding and acceptance.	(Group decision making, planning, execution and evaluation of results. Sharing the emotional commitment.)
8. Deliberative cultivation of the desired attitude should be encouraged.	(Group is encouraged to display a positive commitment to the conservation ethic.)

Table 1.5. Comparing Klausmeier's learning steps with the Environmental Experience as defined by Bennett.

Examining the eight steps listed by Klausmeier it seems difficult to believe that they were written for science teaching in general and not the environmental approach in particular. While other approaches might realise several of these learning steps, this author doubts if any other approach could realise all of these steps.

Thus./...

This investigation will:

(a) Attempt to identify, clarify and classify the implied affective objectives in the prescribed Biology syllabus. See Chapter 5 of this report.

(b) Prepare an evaluation instrument to measure the attitudes of a selected group of standard eight pupils, using proven high-reliability and validity techniques developed by social psychologists. See Chapter 7 of this report.

(c) These attitude scales (see appendix B) will be applied to three classes, two control and one experimental group. A pretest will establish their attitudes in respect of the affective objectives of the prescribed syllabus. See Chapter 9 of this report.

(d) The experimental group will be provided with an environmental experience based on Bennett's Model. See Appendix A. The control groups will study closely matched material using the traditional lecture-demonstration methods. See Chapter 4. As far as possible all precautions will be taken to ensure that visual material and aids are matched. Both groups will be ecologically sensitised to environmental concepts and terminology at the outset of the course.

(e) The duration of the experimental programme is to be approximately one school term of 10 weeks at the conclusion of which all classes are again exposed to the attitude scales re-ordered in the form of a post test, in order that changes brought about by the experimental programme can be assessed and compared to the progress in affective development made by the two control groups. See Chapter 10 of this report.

(f) After both the experimental and control groups have been exposed to a further term of conventional lecture-demonstration approach the post test will again be repeated in order to assess the degree of deterioration or otherwise in the affective development of the two groups. See Chapter II of this report.

This then is a brief outline of the experimental method this research report will follow. Fuller details are recorded in Chapter 8 of this report.

Such/...

Such an investigation could pave the way for better curriculum development at administrative levels.

<u>This investigation could provide a starting point for:</u>

(a) A general attitude measurement test for white pupils in the Cape Province using the prescribed syllabus, to establish pupil interests and attitudes and geographical distribution as a variable in affective development in biology.

(b) An increased emphasis on high-relevance and value-rich content material to be included in new biology syllabuses. eg. Ecology, field work techniques, and an environmental approach where possible.

(c) A better understanding of "local school" environments as teachers make use of the local habitat to develop an awareness of scientific problem-solving methodology and environmental responsibility.

(d) A more natural linkage with the increasing environmental influences now working through the new proposed elementary science courses and the emphasis on field work in the elementary school.

(e) Improved tertiary level biology syllabusesfor teacher training institutions preparing future teachers to meet the challenge of value-education in science more positively.

2. /...

2. The field of this investigation

It is not this author's contention that the whole of the prescribed syllabus in Biology is suited to an environmental approach in its present form. However, perhaps as much as two - thirds of the present syllabus could be reasonably interpreted by an environmental approach. Ultimately each school would probably select its own immediate eco-system for reasons of obvious convenience. Most eco-systems offer more than one suitable habitat for close tudy, but it is the intention of this investigation to measure the impact on affective development of just one habitat study, thus making these results applicable to all schools regardless of variety of local habitats or otherwise.

Each habitat consists of a variety of ecological niches occupied by various organisms that are ecologically balanced in relation to one another. Thus one habitat would present a fair sample for the children to be able to survey, sample, identify problems, hypothesize about, test hypotheses and suggest possible courses of action; in the course of which many affective objectives could be realised.

In this investigation a shore-line habitat was selected for an environmental educational experience lasting long enough for attitudes to develop, namely one school term; the first term of 1979.

(a)/...

(a) This choice of habitat held several advantages for this investigation:

(i) It was not the "local school habitat" and as the section of the shoreline being studied lay some 25 kilometres from the school the possibility of contamination of results due to chance acquaintance and visitation of the experimental area by members of the control group was reduced.

(ii) The richness of the inter-tidal fringe flora and fauna ensured a maximum return for minimum investment of field trip time with specimens being easy to study considering their limited range of movement. The time required for the investigation was limited to one school term to minimise any disruption of the normal school programme.

(iii) The sea-shore habitat covered many of the specimens already covered in the conventional text book making a close match of cognitive material possible. (See chapter 4). This reduced the possibility of different cognitive material contributing to the affective outcomes.

(b) The choice of pupils, term and teacher held several advantages for this investigation as well:

(i) Standard eight pupils are drawn from the third year of the secondary school course. They write no external examination at the end of the year, so that any small differences in cognitive material between the experimental/

and/...

and control group could easily be compensated for in the promotion examination at the end of the year.

(ii) The first term was well suited to the investigation as the pupils had:

(a) No prior experience of the Senior Secondary Course: Biology Syllabus as regards content or method.

(b) Fewer problems in attending field trips due to the selection of a term with fewer Saturday sports fixtures, rugby or hockey practices or matches.

(c) More classroom learning time as a result of selecting a term during which there were no formal examinations.

(iii) Both the experimental and control groups were taught by the same teacher. This eliminated one of the major variables thought to influence affective development.

(c) Summary of the variables of this investigation.

Every effort was made to ensure that the maximum number of controllable variables were controlled, thus eliminating as many secondary differences as possible that might have affected the final results obtained:

(i) Socio-economic variables

A school was selected that served a fairly homogenous socio-economic area, in an upper middle-class suburb of Cape Town.

(ii) Age variables

Although it was not practical to match the ages of the control and experimental group, it was assumed that the average age and average school experience of the two groups was similar by selecting the entire standard eight biology pupil population.

(iii) Sex variables

Both groups consisted of a mixture of boys and girls. Again it was not convenient or practical to match the groups too rigidly and it was necessary to assume that any differences due to imbalance in the numbers of boys and girls was not significant.

(iv) Teacher variables

Differences due to the two groups having been taught by different teachers were eliminated by selecting groups taught by the same teacher.

(v) Time variables

Differences due to timing were eliminated by testing both groups on the same day.

(vi) Content variables

Were held to a minimum by selecting content material for each group that was as closely matched as the two different aproaches would permit.

(vii) Cognitive ability variables

It was not convenient or practical to match the groups in terms of intelligence test results.

Again it was necessary to assume that any differences due to intelligence would not be significant.

Support for assuming that sex variables and cognitive ability variables would make no significant difference to the dependant variables at the end of the investigation was provided by Lowery (49).

Thus every effort was made to ensure that any differences between the control and experimental groups were due to the experimental variables alone, namely the two teaching strategies that were being compared as to their ability to influence affective development.

It was noted earlier in this chapter that Lowery found that the only meaningful variable in attitude formation was the teaching strategy employed.

3. Application of the method employed in this investigation

The three broad categories into which any environmental experience can be subdivided have already been identified in some detail by Bennett (50) earlier in this chapter.

It now only remains to apply the scheme he provided to the experimental group studying the shore-line habitat. The scheme that follows was matched to Bennett's categories; a full and more exact sequence will be provided in chapter 6 of this report.

(49) Lowery L.F., (1967), Op cit.
(50) Bennett D.B., (1974), Op cit.

(a) <u>THE ENVIRONMENTAL EXPERIENCE:</u> THE SHORE-LINE AS HABITAT

(i) <u>ENVIRONMENTAL DISCOVERY AND INQUIRY</u>

a) The class <u>surveys</u> a shoreline.

b) The class <u>identify</u> species of animals and plants present.

c) The class <u>maps</u> their distribution.

d) The class <u>note and measure</u> the abiotic factors operating in the habitat.

e) The class <u>notes</u> the human use of the habitat and <u>maps</u> its distribution.

f) The class <u>gathers information</u> by means of library resources, films, slides, and resource people.

(ii) <u>ENVIRONMENTAL EVALUATION AND PROBLEM IDENTIFICATION</u>

The class examine:

a) How well animals and plants are adapted to their environment.

b) The role the shore plays in fulfilling human needs (i.e. physical needs, psychological needs and social needs).

c) The extent to which the present shoreline meets those needs.

They identify: i) Existing conditions to be corrected.

ii) Conditions to be improved.

iii) Conditions to be prevented.

(iii)/...

(iii) <u>ENVIRONMENTAL PROBLEM-SOLVING</u>

The class select a theoretical problem and:

a) Investigate it fully.

b) Develop solutions.

c) Choose the best solution.

d) Develop a plan of action.

e) Present a plan for evaluation.

f) Try to execute their plan in as much as lies within their power.

This was not intended to be more than a basic outline as a large degree of flexibility must be maintained in order that the class could gain experience in value-formation by participating in the decision-making process, thus guiding the course of the group study.

(b) It was envisaged that <u>the experimental group would learn by means of these methods</u>:

(i) <u>Formal persuasive communications</u> (passive) from the class teacher in the form of verbal communications, and audio-visual demonstrations <u>eg</u>. films, and slides.

(ii) <u>Formal persuasive communications</u> (active) in the form of two field trips to the habitat for the purpose of surveying, mapping, measuring, noting, and finally comparing and testing hypotheses.

(iii)/...

(iii) Peer Group discussion techniques employed while problem-solving in the laboratory and classroom.

(iv) Library research methods while gathering background information.

(v) Role play and Counter-attitudinal behaviour while participating in large class group debates.

These techniques have been shown (51 and 52) to include most of the legitimate methods of promoting positive values and attitudes and inducing desirable attitude change. All these techniques are well suited to the environmental experience already outlined.

4. Summary statement of the method of investigation

The purpose of this investigation was to establish the effectiveness or otherwise of the environmental approach to biology teaching to bring about increased positive affective development. This investigation employed the following methods:

(a) At the commencement of the first term of 1979 an entire standard eight group from a local, Cape Town, secondary, co-educational school was pretested using a specially devised and refined and validated attitude scale to establish the pupils' attitudes and values with respect to the affective objectives of the prescibed syllabus.

(b)/....

(51) Triandis H.C. (1971), Op Cit.
(52) Fishbein, M. and Ajzen, L., (1975), Op Cit.

(b) The group was equally divided into a control group and an experimental group, both of which received identical text-book teaching on Ecology prior to the programme proper.

(c) The control group received the normal educational experience (conventional text book approach) during the first term of 1979.

(d) The experimental group received an environmental educational experience during the same period.

(e) This environmental experience involved making a close study of a stretch of shore-line making use of discovery and inquiry methods implicit in the scientific method of problem-solving to investigate problems arising from the use or misuse of the natural shore-line habitat.

(f) This experience incorporated recognised techniques for producing attitude change, namely: persuasive communication, peer-group discussion, library research, role play and counter-attitudinal behaviour.

(g) The treatment of the two groups was deliberately maximally orientated to cover the same content material and to ensure as much similarity as possible in all other variables with the intentional exception of teaching strategy.

(h) At the end of the first term both groups were post-tested (same test repeated) to assess changes in attitude brought about by the respective teaching strategies.

(i) At the end of the second term after both groups had received the same normal educational experience the post-test was repeated with the intention of investigating whether there had been any deterioration in the status of the groups attitudes or otherwise.

CHAPTER 2

RELATED STUDIES INVESTIGATING THE EFFICIENCY OF SCIENCE IN PROMOTING AFFECTIVE DEVELOPMENT IN SECONDARY SCHOOL PUPILS.

CHAPTER 2: RELATED STUDIES INVESTIGATING THE EFFICIENCY OF SCIENCE IN PROMOTING AFFECTIVE DEVELOPMENT IN SECONDARY SCHOOL PUPILS.

A. THE IMPACT OF SCIENCE TEACHING METHODS ON COGNITIVE DEVELOPMENT.

It is illuminating to compare the impact of different teaching methods on cognitive and affective development. School teachers have always been more familiar with cognitive objectives and more competent at cognitive evaluation than affective evaluation. Seven investigations into the impact of different teaching methods on cognitive development were compared. The results of this comparative study are tabled below.

† This method yields significantly better cognitive results.	Cunningham (1) 1924	Downing (2) 1925	Isenbarger (3) 1925	Anibal (4) 1926	Barnard (5) 1942	Taylor (6) 1959	Oliver (7) 1965
Lecture - demonstration	●	●	● †	●	●	●	
Individual laboratory work	●	●	●	●	●		
Group discussion						●	
Lecture - discussion							●
Lecture - discussion - demonstration							●
Lecture - discussion - laboratory work.							●

Table 2.1 A chronological comparison of seven investigations into the effect of different teaching methods on cognitive development.

An analysis of table 2.1 reveals that relatively little experimentation with teaching methods took place prior to 1959, which date coincided with the period of rapid curriculum development. All researchers were unanimous in their conclusions that teaching methods made no significant impact on cognitive development. It should be noted that much of the testing was of rather low level cognitive objectives, and testing of higher order cognitive objectives might well reveal a different picture. Isenbarger's (3) results showed that conventional lecture - demonstration methods were superior to individual laboratory work at the fact-learning level only, although these findings are not supported by the results of the other investigators.
Oliver found(7) that high ability (as measured by I.Q.) pupils always achieve more in terms of cognitive objectives, this being a far more significant variable than teaching methods. These conclusions make it very difficult to justify innovative methods in terms of examination results, which notoriously emphasize lower order cognitive learning.

B/...

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(1) Cunningham H.A., "Laboratory methods in natural science teaching", School Science and Mathematics. Vol. 24. (1924)

(2) Downing E.R., "A comparison of the lecture-demonstration and the laboratory method of instruction in science", School Review Vol. 33.(1925)

(3) Isenbarger J., "Lecture-demonstration-recitation technique in biology teaching", School Science and Mathematics Vol. 25. (1925)

(4) Anibal F.G., "Comparative Effectiveness of the lecture-demonstration and individual laboratory method", Journal of Educational Research. Vol. 13. (1926)

(5) Barnard J.D., "The lecture-demonstration vs. the problem-solving method of teaching a college science course", Science Education. Vol. 26. (1942)

(6) Taylor K.O., "A comparison of the effectiveness of a lecture method and a small-group discussion method of teaching high school biology", Journal of Science Education. Vol. 43. (1959)

(7) Oliver M., "The efficiency of three methods of teaching high school biology", The Journal of Experimental Education. Vol. 33. No. 3. (1965)

B. THE IMPACT OF SCIENCE TEACHING METHODS ON AFFECTIVE DEVELOPMENT.

If teaching methods were found to make no difference to the attainment of cognitive objectives, they have been found to be the only significant variable in realising affective objectives. (8) Conversely, high ability as measured by intelligence quotient was found to make no significant difference to the results of investigations in affective development. Indeed, Shock (9) found that there was no relationship between cognitive and affective development at secondary school level.

Eleven investigations into affective development at secondary school level in relationship to science-orientated affective objectives were compared. Six of these investigations concerned the impact of different teaching methods on attitudes and values. All these investigations are considerably more recent than their cognitive counterparts reflecting the more recent awareness of the importance of affective objectives and their attainment. The/...

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(8) Lowery L.F., "An experimental investigation into the attitudes of fifth grade students towards science", School Science and Mathematics. Vol. 67. No. 6. (1967)

(9) Shock N.H., "Analysis of the relationship which exists between cognitive and affective educational objectives", Journal of Research in Science Teaching. Vol. 10. No. 4. (1973).

The results of this comparative study are tabled below:

† This method yields significantly better affective results.	Lowery (10) 1967	Welliver (11) 1967	Simmons and Esker (12) 1972	Alexander (13) 1973	Fraser (14) 1975	Fraser and Wright (15) 1975
Lecture-demonstration	●	●	●	● †	●	●
Individual laboratory work	● †	│	│	●	│	│
Television (lecture-demonstration)		●	│		│	│
Process method (scientific methodology emphasized)			● †		│	│
Environmental method (lecture-discussion-laboratory work).					● †	●

Table 2.2 A chronological comparison of six investigations into the effect of different teaching methods on affective development.

Clearly/...

(10) Lowery L.F., (1967), Op Cit.
(11) Welliver P.W., "Television instruction and the attainment of objectives for a ninth grade physical science course", Journal of Research in Science Teaching. Vol. 5. (1967/68)
(12) Simmons, J. and Esker, W., "Investigating the attitudes towards science fostered by the process approach", School Science and Mathematics. Vol. 72. (1972).
(13) Alexander D., "The Nuffield Secondary Science Project", Evaluation in Curriculum Design : Twelve case studies. (1973)

(14) Fraser B.J., The impact of A.S.E.P. on pupil learning and classroom climate. (1975)

(15) Fraser, B.J. and Wright, P. "Overcoming the Robinson Crusoe syndrome", Lab. Talk. Vol. 19. No. 2. (1975)

Clearly the newer innovative methods have much to offer in terms of affective development. A fuller analysis of these investigations is provided in table 2.3 but at this stage it is interesting to first note some aspects of table 2.2. Alexander's investigation of <u>Nuffield techniques</u> yielded almost the opposite results to Lowery's investigation although both teaching methods were <u>similar</u>. Methods that are particularly effective in producing positive attitudes with regard to science objectives <u>all</u> (with the exception of Alexander's anomalous findings) <u>involved laboratory work at some stage</u>. Unfortunately none of these investigators attempted to classify their affective objectives in terms of Blooms Taxonomy (16) thus it is not possible to establish from these results whether higher or lower order affective objectives are being realised, however it is clear that <u>some</u> affective objectives are being attained and for this reason alone experimentation with new teaching methods is justified.

C./...

(16) Bloom, B.S. Krathwohl, D.R. and Masia, B.B. <u>Taxonomy of Educational Objectives</u> : <u>Book 2. Affective Domain</u>. (1964)

C. A REVIEW OF SOME RECENT STUDIES INVESTIGATING THE EFFICIENCY OF SECONDARY SCHOOL SCIENCE TEACHING IN ACHIEVING POSITIVE ATTITUDE FORMATION.

1. Subjective Investigations.

During 1969 three subjective attempts were made by investigators to assess pupil's attitudes. No hypotheses were tested, no quantifiable data was gathered, no measuring instruments were employed and hence no statistically significant conclusions were reached.

Selmes (17) sought to assess children's opinions towards science by tape-recording group interviews and later analysing the frequencies of certain key statements. He concluded that his technique was too unreliable as there were semanic interpretation problems and children seemed to be badly mis-informed about science and scientists.

Ashton and Meredith (17) analysed the answers provided by G.C.E. candidates to a particular question dealing with attitudes towards science. Their results were no more than an opinion survey and somewhat unreliable at that, as the question was not answered by all candidates.

Newel (17) on interviewing serving teachers at a conference found that they were aware of the negative attitudes that many of their pupils had towards science but were at a loss how to rectify this situation.

2./...

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(17) Selmes, C. Ashton, B. Meredith, H. and Newel, A. "Attitudes to science and scientists", <u>School Science Review</u>. Vol. 51. No. 174 (1969)

2. Objective Investigations

Eleven objective investigations dating from 1967 to 1975 were reviewed. They were compared according to three categories:

The experimental variables;

The testing design;

The sampling technique.

All eleven investigations were conducted in secondary schools, illustrating the growing awareness of the importance of affective objectives at secondary school level.

The results of this comparative study are shown in table 2.3 - A comparison of the experimental variables, testing patterns and sampling techniques employed in eleven recent investigations into the affective development of secondary school science pupils.

(a) An analysis of the experimental variables

(i) Different teaching strategies.

The variable most frequently investigated was teaching method. Six of the eleven investigations have already been briefly compared in table 2.2 where the success of innovative teaching methods over the lecture-demonstration technique was noted, with the notable exceptions of:

Table 2.3/...

This investigation yielded a statistically significant result. †		EXPERIMENTAL VARIABLES				TESTING DESIGN		SAMPLING TECHNIQUE	
		TEACHING METHOD							
		USING CONTROL GROUP	NO CONTROL GROUP	TIME	OTHER (SEX, AGE, I.Q., COG. DEV.)	POST-TEST ONLY	PRE- AND POST-TEST	RANDOM SAMPLING	SELECTED CLASS GROUPS
1. Lowery	1967	● †			●		●		●
2. Welliver	1967	●				●			●
3. Wynn and Bledsoe (18)	1967			● †			●		●
4. Yager, Engen, Snider (19)	1969		●				●	●	
5. Mackay (20)	1970			● †			●		●
6. Lucas and Broadhurst (21)	1972			● †			●		●
7. Simons and Esker	1972	● †				●			●
8. Alexander	1973	● †					●		●
9. Shock	1973				●		●		●
10. Fraser	1975	● †					●		●
11. Fraser and Wright	1975	●				●			●
COMPARISON WITH THIS RESEARCH INVESTIGATION									
Opie	1979	●					●		●

Table 2.3 A comparison of the experimental variables, testing patterns and sampling techniques employed in eleven recent investigations into the affective development of secondary school science pupils.

a) <u>Welliver's television investigation</u> (22) We note from table 2.3 that Welliver only made use of a post test to measure for significant differences and as he did not use a randomised sample population he must have assumed that his control group was very closely matched to his experimental group. Possibly this was a source of experimental error. It is also possible that the experimental and control groups did not have a sufficiently different educational experience to show significant differences as a television class is in essence prepackaged audio-visual lecture-demonstration, and hence fairly similar to the conventional lecture-demonstration method.

Yager,/...

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(18) Wynn, D.C. and Bledsoe, J.C. "Factors related to gain and loss of scientific interests during high school", <u>Science Education</u>. Vol. 51. (1967)

(19) Yager, R.E. Engen, H.B. Snider, B.C.F. "Effects of the laboratory and demonstration methods upon the outcomes of instruction in secondary biology", <u>Journal of Research in Science Teaching</u> Vol. 6. (1969)

(20) Mackay L.D., "Changes in Victorian physics students during two years of physics study", <u>The Australian Physicist</u>. (1970)

(21) Lucas, A.M. and Broadhurst, N.A. "Changes in some content - free skills, knowledge and attitudes during two terms of grade 12 biology instruction in ten South Australian schools", <u>Australian Science Teachers' Journal</u> Vol. 18. No. 1 (1972)

(22) Welliver P.W., (1967/68), <u>Op Cit</u>.

b) <u>Yager, Engen and Snider's laboratory-demonstration-discussion technique investigation</u> (23)

These investigators were able to assign pupils randomly to each of 3 different experimental groups. One group performed the experiments, one group saw them demonstrated, one group only discussed them. The fact that no significant differences were noted may be due to the fact that there was no control group that enjoyed a combination of all three activities.

c) <u>Fraser and Wright (24) comparing the lecture-demonstration with the Intermediate Science Curriculm Study materials (involving laboratory work and discussion)</u>, found no significant differences between the control and experimental group possibly due to the assumption that the five classes involved were of equal attitude status before the investigation. Only a post-test was administered.

It was true of all the studies where two or more teaching methods were compared, that <u>only those investigations that made use of a control group for comparison purposes yielded statistically significant results.</u>

d)/...

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(23) Yager, R.E. Engen, H.B. Snider B.C.F., (1969), <u>Op. Cit</u>.

(24) Fraser, B.J. and Wright, P., (1975), <u>Op. Cit</u>.

d) <u>It has already been pointed out that Alexander's comparison of Nuffield and Non-nuffield classes</u> (25) yielded a disappointing result. He found that the attitudes of the Non-Nuffield classes declined more slowly than those classes being taught by Nuffield Project methods. Gardner (26) suggests possibly Nuffield Project Methods represent a harmful innovation as far as affective development is concerned, but more research is needed to establish the factors involved.

As pointed out in Table 2.2 the investigations of Lowery (27), Simmons and Esker (28), and Fraser (29) identify the most promising teaching methods to effect maximum positive affective development.

Fraser (30) in a similar investigation, not shown on Table 2.3 because of it's similarity to his earlier investigation (Fraser 29) concluded that while both A.S.E.P. and Non-A.S.E.P. pupils underwent an attitudinal deterioration between the pre and post tests, the A.S.E.P. pupils underwent a smaller decline in enjoyment than the control group. Furthermore he found that if the experimental group was divided into high and low socio-economic status sub-groups, the high socio-economic status group actually showed a <u>slight increase</u> in enjoyment of science lessons during the year. See fig. 2.1 below:

(25) Alexander D., (1973), <u>Op Cit</u>.
(26) Gardner. P.L., "Science curricula and attitudes to science", <u>The Australian Science Teachers' Journal</u>. Vol. 21. No. 2. (1975)
(27) Lowery L.F., (1967), <u>Op Cit</u>.

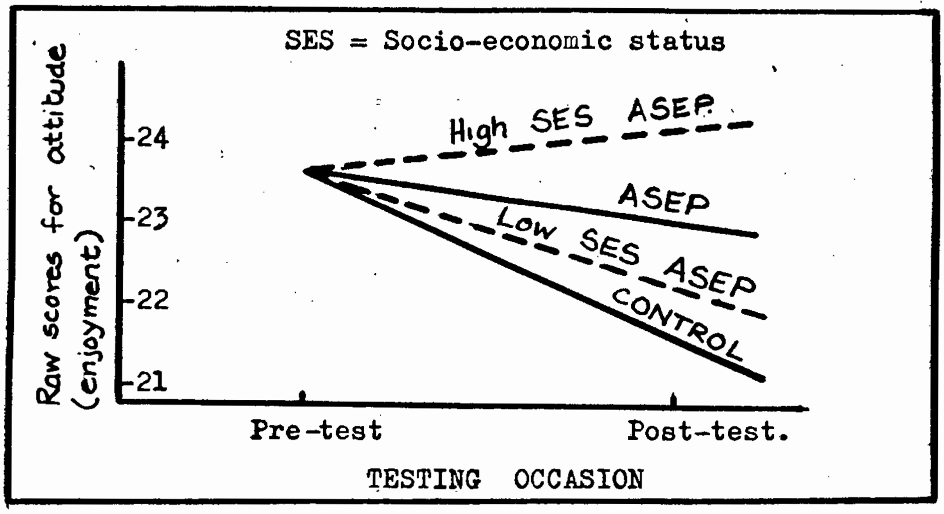

Figure 2.1 Comparison of attitude change in ASEP and Non-ASEP pupils (Fraser 30)

(ii) Time as an experimental variable.

All three investigations concerned with the measurement of attitude change over a period of time, usually not less than one year, showed that there was a significant decline in secondary school pupils attitudes towards science.

a) Wynn and Bledsoe (31) tested the attitudes of the same group of boys and girls for five successive years. Their results indicated that the attitudes of the boys showed a small but steady decline over the period. Girl's attitudes were more variable and too inconsistent to indicate statistical significance.

b)/...

(28) Simmons, J. and Esker, W., (1972), Op Cit.
(29) Fraser B.J., (1975), Op Cit.
(30) Fraser B.J., "Are A.S.E.P. pupils achieving the aims?", The Australian Science Teachers Journal, Vol. 22. No. 3. (1976)
(31) Wynn, D.C. and Bledsoe, J.C., (1967), Op.Cit.

b) Mackay (32), testing the attitudes of the same class of senior physics students for a two year period, also reported a significant decline in interest and enjoyment of physics.

c) Lucas and Broadhurst (33)performed a similar investigation using senior biology students and likewise reported a significant decline in interest and enjoyment of biology over the course of a year.

All three investigations made use of a pre-test and one or more post-tests. They all emphasize the urgent need to identify the factors responsible for deteriorating affective development and to establish an efficient means of counteracting it.

(iii) Other experimental variables

No other experimental variables have been found that significantly influence affective development.

(a) Lowery's investigation (34) showed that sex differences, I.Q. differences and socio-economic differences did not influence affective development.

b)/....

(32) Mackay L.D., (1970), Op Cit.
(33) Lucas, A.M. and Broadhurst, N.A., (1972), Op Cit.
(34) Lowery L.F., (1967), Op Cit.

b) Shock (35) reported similar findings that age, sex, academic level, cognitive development and motivational differences did not significantly influence affective development.

These investigations have served to focus investigators attention on teaching method as the experimental variable with the most promise of influencing positive affective development.

(b) An analysis of the test designs employed.

Ten of the eleven investigations employed a pre-test and post-test(s) design . Of the eight investigations yielding significant results, seven employed pre- and post-test designs.

The notable exception to this rule is the investigation of Simmons and Esker (36) whose results would certainly have been even more meaningful if it could have been ascertained that their control and experimental group were reasonably evenly matched with regard to attitudes on a pre-test.

The other two investigations making use of a post-test only, namely Welliver (37) and Fraser and Wright (38), did not yield significant results, probably in part due to the poor design of the test. This is in part supported by the significant results of Fraser's (39) very similar investigation when using a pre- and post-test design.

(c)/....

(35) Shock N.H., (1973), Op.Cit.
(36) Simmons, J. and Esker, W., (1972), Op. Cit.
(37) Welliver P.W., (1967/68), Op. Cit.
(38) Fraser, B.J. and Wright, P., (1975), Op. Cit.

(c) An analysis of sampling methods employed.

All but one of the eleven investigations showed a distinct preference for working with class groups. This is not interpreted as being more desirable than randomized sampling methods but rather as being a great deal less inconvenient to the administration of the host school. Few truely scientific attitude investigations have been conducted to date due to this problem of the nigh impossibility of obtaining randomized samples to work with at secondary school level. School administrators tend to subdivide classes into groups based on subject preferences and academic (cognitive) ability; and the inflexibility of most timetables makes it impossible to alter the existing pupil distribution patterns.

3. Summary of the significant findings relating to affective development in science pupils.

(a) Three investigations revealed a steady decline in interest and enjoyment in physical and natural science. This is particularly true for boys.

(b) Teaching method has been identified as the only variable investigated that encouraged more positive attitudes towards science.

(c)/...

(39) Fraser B.J., (1975), Op. Cit.

(c) The process approach and the environmental approach are both significantly <u>more successful at reducing the rate of affective deterioration</u> with regard to the affective objectives of science than the lecture-demonstration method.

(d) The environmental approach may even result in substantially <u>more positive attitudes</u> towards science in pupils with higher socio-economic status values.

D. THE IMPLICATIONS OF THESE RECENT INVESTIGATIONS FOR THIS STUDY.

1. <u>The implications for future study</u>.

These pioneer studies collectively provide meaningful pointers for futher research, namely;

(a) There needs to be <u>more experimentation with innovative methods</u>, particularly those that offer some laboratory experience and group discussion.

(b) Separate investigations relating to the impact of different teaching methods on high and low socio-economic status groups ought to be conducted in order to establish <u>what factors account for the more positive affective development of the high socio-economic status experimental group</u>.

(c)/...

(c) Meaningful investigations aimed at demonstrating significant differences in the teaching strategies being compared, should employ control and experimental groups; pre- and post-test designs and, if possible, random-sampling methods.

2. How the present study applies some of these implications in practice.

(a) The environmental approach being used has already revealed promise in terms of affective development, and is rich in discussion opportunities and laboratory work.

(b) The school selected for this investigation is in a upper-middle class suburb of Cape Town where the children can be reasonably expected to have high socio-economic aspirations.

(c) The research programme incorporates a control group and pre-and post-testing designs.

3. In what respect this study goes beyond the earlier studies.

This investigation is a more rigidly designed study than most of its predecessors, in that : ....

(a) It is based on a particular theory of attitude formation namely: Fishbein's conceptual model for belief, attitude, intentions and behavior. (40) This theory is employed to achieve maximum attitude change within the framework of the environmental experience.

(b)/...

(40) Fishbein, M. and Ajzen, I., Belief, Attitude and Intention : An Introduction to Theory and Research. (1975)

(b) It is based on a particular environmental education model developed by Bennett (41). The experience of the experimental group follows this pattern closely.

(c) The aims of the prescribed syllabus being investigated are first clarified and expanded into intermediate objectives using Bloom's affective Taxonomy (42). They are then classified for ease of comparison and ranking purposes.

(d) Separate attitude scales were developed for each of the six aims in order that all items could be related to a single common construct (the broad aim) so that it would be valid to sum the raw scores obtained on each scale.

(e) A second post-test was administered one term after the first post-test to investigate the permanence of attitudes fostered by the environmental approach or otherwise.

In these five respects this study is a pioneer study to the best of this author's knowledge. Earlier investigators have generally failed to make use of any theory of attitude change, or give explicit details of the theoretical constructs underlying their teaching method.

This/...

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(41) Bennett D.B., "Evaluating Environmental Education Programmes", Environmental Education : strategies towards a more liveable future. (1974)

(42) Bloom, B.S. Krathwohl, D.R. and Masia, B.B., (1964) Op.Cit.

This author could find no comparable work in the field of intermediate affective objective classification and identification, and too often no clear indication that items were all related to a single common construct (43). No study has been made of the permanence of attitudes formed by any innovative teaching method.

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(43) Gardner P.L., "Attitude measurement. A critique of some recent research", Educational Research Vol. 17. No. 2 (1975)

CHAPTER 3

THE THEORETICAL CONSTRUCTS FORMING THE BASIS OF THE PRESENT INVESTIGATION

4/....

CHAPTER 3: THE THEORETICAL CONSTRUCTS FORMING THE BASIS OF THE PRESENT INVESTIGATION.

A. THE RELATIONSHIPS BETWEEN THE THEORETICAL CONSTRUCTS.

There are four basic theoretical constructs which form the foundation upon which this investigation rests : viz.

1. The Theory of Intermediate Objectives.

   The theory of the presence of intermediate objectives is not new; however as no statement giving specific details of these objectives could be located the hypotheses proposed in this chapter are the author's own. Masia's (1) guide to the classification of affective objectives was of significant assistance in preparing a detailed list of objectives on which to base a series of meaningful attitude measuring scales.

2. The Environmental Education Model (2)

   Bennett's model shows the relationship between an environmental education experience, attitudes and behaviours. This author has interpreted the model in terms of the findings of social psychologists pertaining to attitude and values.

3./...

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(1) Bloom, B.S. Krathwohl, D.R. and Masia, B.B., Taxonomy of Educational Objectives : Book 2. Affective Domain. (1964)

(2) Bennett D.B., "Evaluating Environmental Education Programmes", Environmental Education : Strategies towards a more liveable future.(1974)

3. <u>The General Conceptual Framework of theories of attitude formation and change</u>.

Fishbein and Ajzen (3) have synthesized the more promising findings of several recent attitude theorists into one general conceptual framework upon which this research investigation is based.

4. <u>The Summated Ratings method of Attitude scale construction</u>.

This well-known method developed by Likert (4) is described and evaluated in this section.

The relationships between these four theoretical constructs are illustrated in Fig. 3.1 (overleaf).

The nature of <u>society</u>, it's structure, values, beliefs and traditions, combine with the available <u>knowledge</u> and <u>learning processes</u> to provide the source material which is filtered through the <u>South African Value System</u> as interpreted by official administrators responsible for curriculum development.

Prescribed/...

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(3) Fishbein, M. and Ajzen I., <u>Belief, Attitude, Intention and Behaviour: An introduction to theory and research</u>. (1975)

(4) Likert R., "A technique for the measurement of attitudes", <u>Archives of Psychology</u>, No. 140. (1932)

Prescribed syllabii emerge from this stage which have their aims relatively broadly defined. These aims can be catagorised after clarification into cognitive (knowledge) objectives, affective (feelings or attitude) objectives, psychomotor (skills) objectives. It is possible to differentiate these aims into intermediate objectives that are neither as vague as the broad aims nor as rigidly specific as behavioural objectives.
The investigation proper consists of applying an environmental educational experience to an experimental group. Attitude change can be maximised by an understanding of the relationships that exist between beliefs, attitudes, behavioural intentions and behaviour. Attitude change can be measured by means of a pre-test - post-test design using group responses to attitude scales based on items constructed with the intermediate affective objectives in mind. The method of summated ratings is widely believed to be the most convenient attitude scale technique of high reliability suited to secondary school pupils.

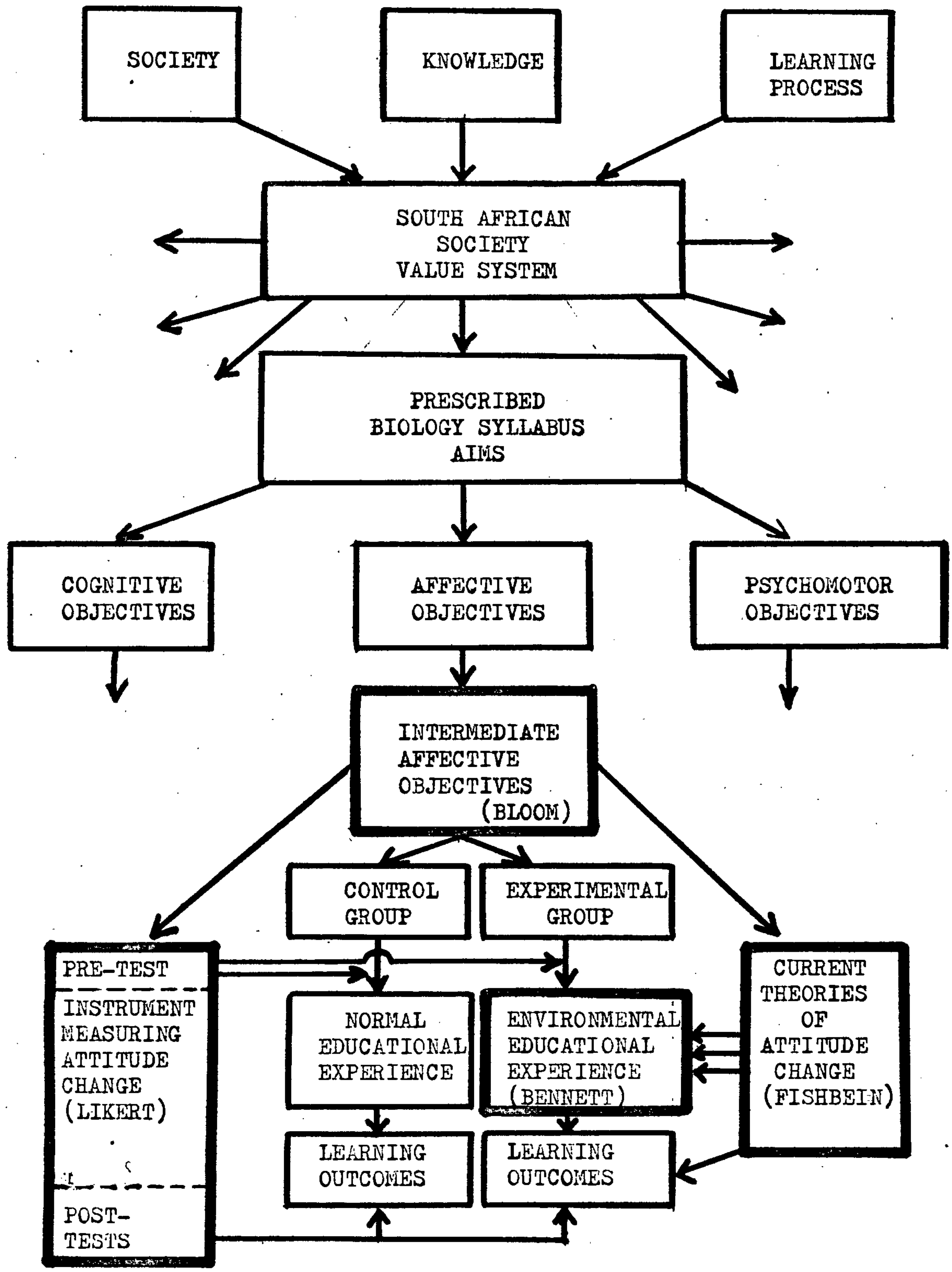

Fig. 3.1 The relationship between the theoretical contructs.

B. THE FOUR THEORETICAL CONSTRUCTS EXPLAINED

1. The Theory of Intermediate Objectives.

While the justification for this theory is further developed in Chapter 5 of this study, a brief introduction is given at this stage for the sake of completeness of this chapter.

Broadly speaking, educational goals tend to be either too generalised, in which case we refer to them as goals or aims, or too specific such as the rigidly defined behavioural objectives that identify each task in terms of objectives to be achieved.

Educators can be found to support both view points, but very little attempt has been made to bridge the gap between the two types of objectives. That aims and behavioural objectives represent two extremes of the objective continuum seems fairly certain. Nisbet (5) comments on the missing objectives as follows; we...

> ... must find intermediate practical objectives which will avoid generality and will also avoid over specificity ...

Until very recently no attempt had been made to unify the two extreme viewpoints. Now educators are showing signs of a growing dissatisfaction with the strait-jacket of behavioural objectives and are seeking objectives that are both practical and sufficiently flexible to accomodate both schools of thought. Dressel/...

(5) Nisbet S., Purpose in the Curriculum. (1957).

Dressel (6) has proposed a set of competency objectives that are certainly intermediate by nature, as they do not fit the definitions supplied by Zahorick (7) of aims or behavioural objectives.

Recently the Scottish Centre for Mathematics, Science and Technical Education have provided a list of twenty-two objectives for their biology course. They have been differentiated in terms of cognitive, affective and psychomotor domains.(8) Although Hughes does not mention the term intermediate objectives, his objectives are far too many and too detailed to be classed as broad aims and far too flexible and general to be classified as behavioural objectives.

As yet, to the best of this author's knowledge, no investigator or curriculum planner has presented a fully differentiated list of specific intermediate affective objectives in any detail to compare to the lists offered in Chapter 5 of this study.

Fig. 3.2 illustrates/...

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(6) Dressel P.L., "The nature and role of objectives in instruction", Educational Technology Vol. 17. No. 5. (1977)

(7) Zahorick J.A., "The virtue of vagueness in instructional objectives", Elementary School Journal. Vol. 76. (1976)

(8) Hughes J.A.R., The New Biology Syllabus. Memorandum No. 7 (1973)

Fig. 3.2 illustrates the relationships between educational objectives and the possible location of the objectives mentioned thus far in this study.

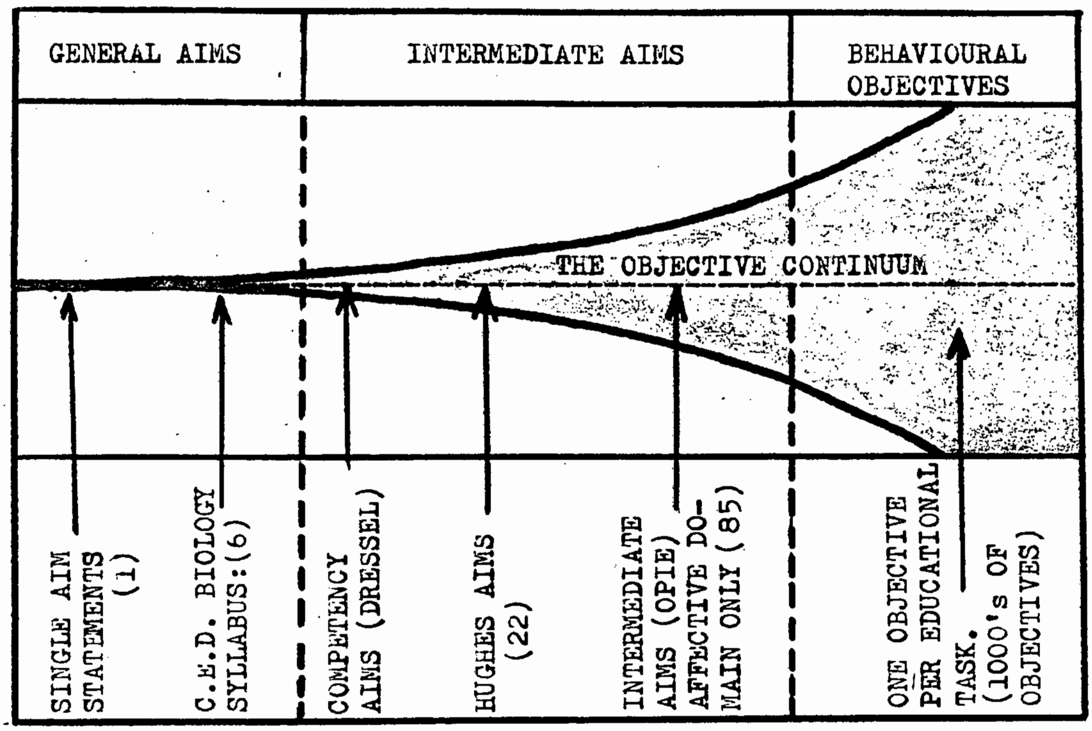

Fig. 3.2 The relationships between educational objectives.

It will be noted that the boundaries between intermediate objectives and other objectives are not rigidly determined and as the range of intermediate objectives is not fully known the locations of particular studies on the continuum are only relative to each other.

The number of objectives increases rapidly from general aims to behavioural objectives; thus lists of intermediate objectives will differ in number depending on the location of any objective statement on the continuum.

Thus/...

Thus while Hughes (9) identified ten affective objectives in his list of twenty-two intermediate objectives; this author identified eighty-five affective objectives that were also of intermediate status.

While some authors (10) feel that educational objectives are so completely dependent on each other as to make any differentiation into separate domains (viz. cognitive, affective and psychomotor) meaningless; others (11,12) while recognising the interdependence of objectives still insist on the necessity of formulating meaningful objectives in terms of the three domains.

> ....learning is never purely affective, cognitive or psychomotor...the student may develop on all three areas simultaneously....the educator must choose which of these three areas is of primary concern at any particular time when formulating objectives... (Harrow 1972)

For the purposes of this investigation, this author, faced with the present trend towards increased emphasis on value education, selected the affective domain as being the chief determinant of attitude formation. In/...

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(9) Hughes J.A.R., (1973), Op. Cit.

(10) Ormell C.P., "Bloom's taxonomy and the objectives of education", Educational Research Vol. 17. (1974)

(11) Mc Ashan H.H., "Behavioural Objectives : The history and the promise", Educational Technology Vol. 17. No. 5 (1977)

(12) Harrow A.J., Taxonomy of the Psychomotor Domain (1972)

In order that the intermediate affective objectives could be constructed in a systematic manner they were hierarchically classified according to the definitions of affective objectives supplied by Masia. (13) An attempt was made to supply an example for each stage of the taxonomy provided that the original framework of the aims of the prescribed Biology syllabus permitted the interpretation (See Chapter 5).

2. The Environmental Education Model.

(a) The Importance of Values.

Stapp (14) defines three areas around which secondary school administrators could develop a series of objectives, namely the ....

(1) Affective subgoal - to help individuals acquire strong feelings fundamental to developing a concern for the environment and a motivation to participate in activities for maintaining and improving the quality of the environment.

(2) Cognitive subgoal - to help individuals acquire basic understanding of the total environment and associated environmental problems.

(3) Behavioural-skill subgoal- to help individuals develop thinking and action skills for the prevention of environmental degradation, and correction of environmental abuses."

This/...

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(13) Bloom, B.S. Krathwohl, D.R. and Masia, B.B., (1964), Op.Cit.

(14) Stapp W.B., "An instructional programme approach to environmental education (K-12)-based on an action model", Environmental Education : Strategies towards a more liveable future. (1974)

This study is primarily concerned with the first category of sub-goals. To achieve these sub-goals it is necessary to arrange a series of "environmental encounters" based on community problem-solving and value building. It will be necessary to expose the children to ecological principles before attempting to solve any problems.

The seashore habitat was selected for an environmental encounter upon which to base this investigation.

The key to understanding Bennett's Environmental Education Evaluation Model (in section (b)) is an appreciation of how values are formed. (15^1)

Stapp (15^2) identifies the process of value clarification as follows:

> ... (1) Students are presented with an issue.
>
> (2) Students suggest alternative solutions.
>
> (3) Students consider the consequences of each alternative.
>
> (4) Students express their feelings about each alternative.
>
> (5) Students make a free choice. ...

This approach ensures that students become aware of their personal beliefs, attitudes, values and behaviours. The alternative to this approach is inculcating, instilling and fostering desirable values. In/...

(15^1) Bennett D.B., (1974), Op. Cit.

(15^2) Stapp W.B., (1974), Op. Cit.

In Chapter one we saw the need for science educators to promote right attitudes and moral responsibility towards society, within the framework of Western democratic ideals. Stapp rejects inculcation, instillation and fostering as indoctrination which has been shown to lack durability with the passage of time.

(b) Bennett's Environmental Education Model.

Bennett sees the components of environment, values and behaviour interacting with each other.

Fig. 3.3 /...

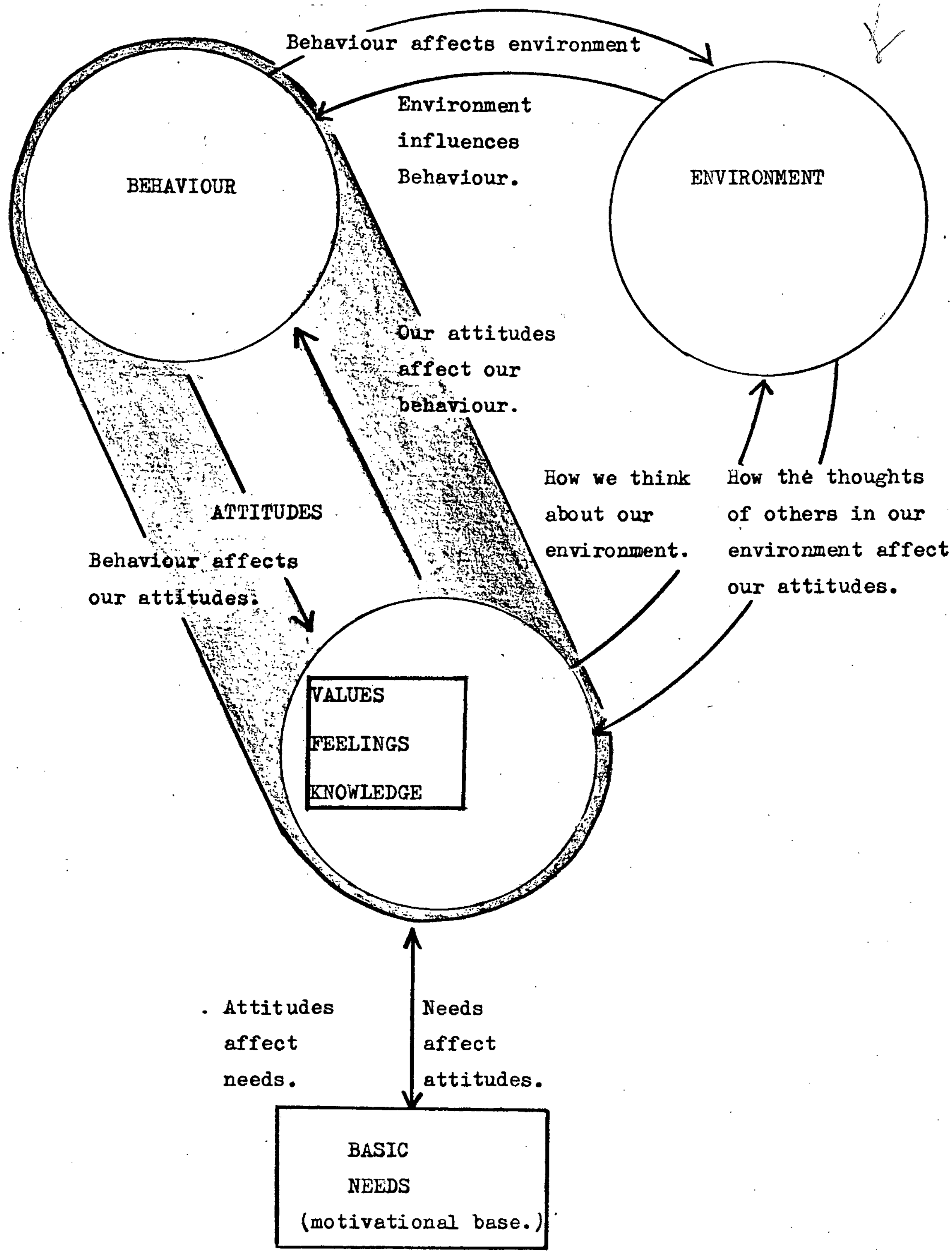

Fig. 3.3 <u>An Environmental Education Model</u>
Adapted from: Bennett D.B., (1974)

This model is valuable in that it shows the motivational base from which values develop. All components are linked with two-way arrows indicating a relationship where any single component can affect all other components.

His model has been adapted to show that attitudes incorporate a behavioural component.

Most social psychologists and investigators (16,17,18,19) recognise that attitudes consist of three components:

ATTITUDES ← COGNITIVE COMPONENT (Knowledge)
ATTITUDES ← AFFECTIVE COMPONENT (Feelings)
ATTITUDES ← BEHAVIOURAL COMPONENT (Action)

Knowledge affects beliefs, beliefs affect feelings, feelings are related to behavioural outcomes, although the relationship is not the simple direct relationship that Bennett's model suggests, according to Fishbein and Ajzen's (20) study.

Bennett's/...

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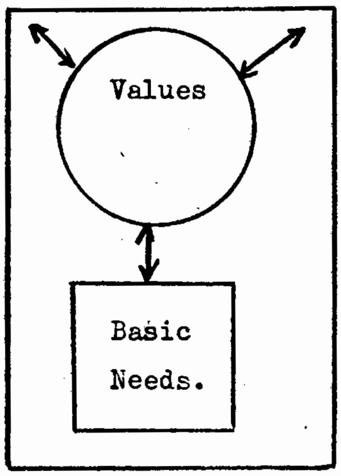
(16) Brown S., Attitude Goals in Secondary School Science. (1976)
(17) Evans K.M., Attitudes and Interests in Education. (1965)
(18) Triandis H.C., Attitude and Attitude Change. (1971)
(19) Swan, J.A. and Stapp, W.B., Environmental Education : Strategies towards a more liveable future. (1974)
(20) Fishbein, M and Ajzen, I., (1975), Op. Cit.

Bennett's model contains all three components of attitude and relates them individually to the total environment. He significantly separates behaviour from the other two components realising that what people do in their environment is more potent than what they feel or believe.

(c) The implications of this model for creating an effective environmental encounter.

The teacher must realise that ....

Fig. 3.3(a)



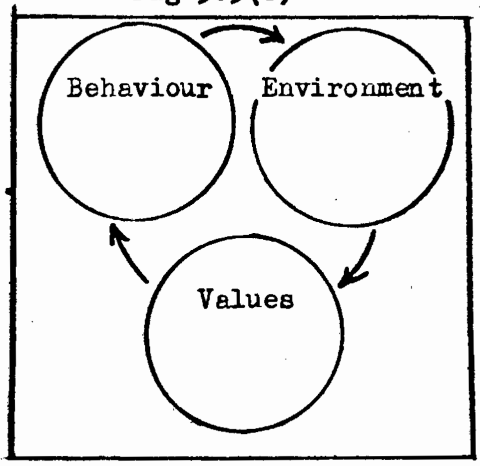
(i) Each pupil has a set of basic needs that affect their values. This in turn affects attitudes and subsequent behaviour, and ideas concerning the role of the environment.

In turn, the consequences of behaviour can influence feelings and beliefs (values) as can the social moves of others in the pupil's environment. This may cause a re-evaluation of personal basic needs.

(ii)/...

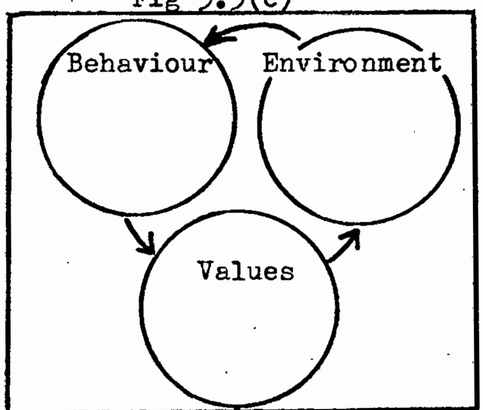
(ii) The pupils' values, affect their attitudes and behaviour. Behaviour always affects the environment. This will in turn elicit approval or disapproval from those who share the environment with us.

Fig 3.3(b)



(iii) The pupils' beliefs concerning the environment influence behaviour, the consequences of which in turn affect attitudes and values.

Fig 3.3(c)



(iv) He/She is a component of each pupil's environment and can present the environment to the pupil most effectively. (discovery)

(v) The pupil should be encouraged to evaluate the consequences of behaviour towards the environment, in terms of himself and others, (inquiry/evaluation/problem identification).

(vi)/...

(vi) The pupil should be encouraged to examine the beliefs which form part of each alternative response and consequence (problem-solving/value-clarification).

(vii) The pupil should be allowed to make a free choice in order that the values formed may be "their own" and have enduring value.

Thus Bennett's components of the environmental encounter have been integrated with Stapp's process of value-clarification. This is <u>the basic teaching-learning model</u> that has it's expression in the environmental approach as detailed in Chapter One under the categories:

a) Discovery and inquiry

b) Evaluation and problem identification

c) Problem solving.

It is assumed that to these explicit categories further implicit categories could be added: viz.

d) Value-clarification

e) Attitude formation

f) Moral responsibility.

3. <u>The General Conceptual Framework of theories of attitude formation and change</u>.

(a) Some definitions of attitude ;

We/...

We have already referred to the multicomponent definition of attitude as being a generally accepted definition of attitudes, namely, that attitudes contain affective, cognitive and behavioural components. Attitude scale measurements invariably seem to yield a single score that fails to reflect these three different components in any precise fashion. For all practical purposes research workers consider a measurement of the affective component to be a measurement of the essence of attitude. Thus whether the definition includes a multi-component statement or a simple unidimensional concept makes very little difference to the final result, as measuring instruments are not sufficiently refined to reflect more than one component efficiently.

Virtually every theorist seems to agree that attitudes are learned, but the importance of this assumption is not always recognised by teachers.

Allport (21) defines attitude as ...

> ...a learned predisposition to respond in a consistently favourable or unfavourable manner with respect to a given object .

Thurstone (22) refers to attitude as "the amount of affect for or against a psychological object".

Fishbein (23) considers attitude to be a "general predisposition that leads to a set of behavioural intentions, each intention is linked to a specific behaviour."

It/...

(21) Allport G.W., The Nature of Prejudice. (1954)
(22) Thurstone L., The Measurement of Values. (1963)
(23) Fishbein, M. and Ajzen, I., (1975), Op. Cit.

It would appear that attitudes contain not three but <u>four discrete components</u>:

Attitudes
- Beliefs, knowledge.
- Predispositions, feelings.
- Behavioural intentions.
- Action component.

(b) Some contemporary theories of Attitude Change.

Since the early 1950's there have been several pioneer theories in the field of attitude change. Not all of them are of relevance to the school learning situation. Most attitude theories have their origins in two major schools of thought, namely:

(i) <u>The Learning Theories of Attitude</u>.

This school bases its theories on the stimulus-response approach of behaviour theory.

(ii) <u>The Consistency Theories of Attitude</u>.

This school bases it's theories on the cognitive approach of field theory.

This author has selected four contemporary theories for more detailed investigation:

(i) The Reinforcement Theory of Attitude Change.

a) A brief statement of the basic theory.

This is a learning theory of attitude changes intended by it's promoters, Hovland, Janis and Kelly (24) to be no more than a basic framework for future attitude research. As such it was a most useful starting point, of special relevance in formal teaching situations.

This theory proposes that for an attitude to change a discrete sequence of psychological events must take place. Fig. 3.4 illustrates this sequence.

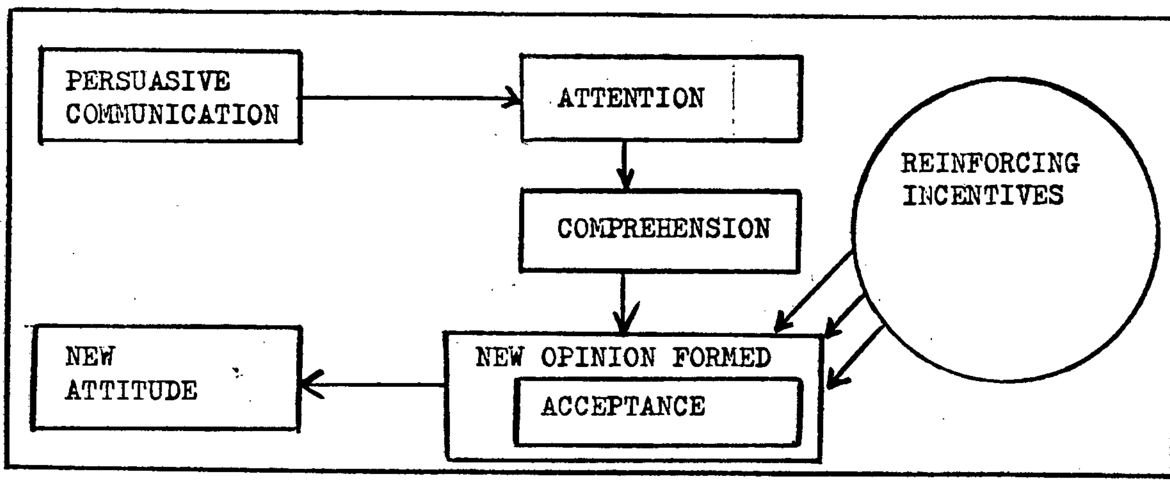


Fig 3.4 The Reinforcement Theory of Attitude Change.

First there must be a persuasive communication that is heard and understood. Incentives must be offered in the form of arguments, reasons, rewards or punishments before the new ideas are accepted, and a new opinion forms. These learned new opinions may result in a change of attitude.

b)/...

(24) Hovland, C. Janis, I. and Kelly, H., Communication and Persuasion. (1953)

(25) Insko C.A., Theories of Attitude Change. (1967)

b) The limitations of the theory

According to Insko (25) this theory suffers from several weaknesses. The exact nature of the reinforcing incentive is not understood; the degree of comprehension needed to assure acceptance has not been clarified; the theory makes no provision for learning that results in attitude change without concious attention to a persuasive communication. There is in addition a rather gross assumption that a new opinion (cognitive belief) results in a changed attitude.

c) Implications for teaching

The three cognitive steps involved in forming a new opinion are part and parcel of basic teaching technique but the reinforcing incentives need to be more clearly understood especially in a world of rapidly changing values. It is important not to be beguiled by the apparent simplicity of the relationship between new opinions and new attitudes. Clearly this theory deals mainly with the formation of a belief and has very little to say about attitude change as such.

(ii) The Congruity Theory of Attitude Change.

a) A brief statement of the basic theory

Osgood and Tannenbaum (26) based their theory on the basic cognitive consistency of attitudes and beliefs. Belief/...

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(26) Osgood, C. and Tannenbaum, P., "The Principle of congruity in the prediction of attitude change," Psychological Review Vol. 62. (1955)

Belief objects could be associated together on bi-polar attitude dimensions. The question of attitude change arises when two attitudes held are thrown into disequilibrium by new information of one sort or another. Fig. 3.5 illustrates the problem.

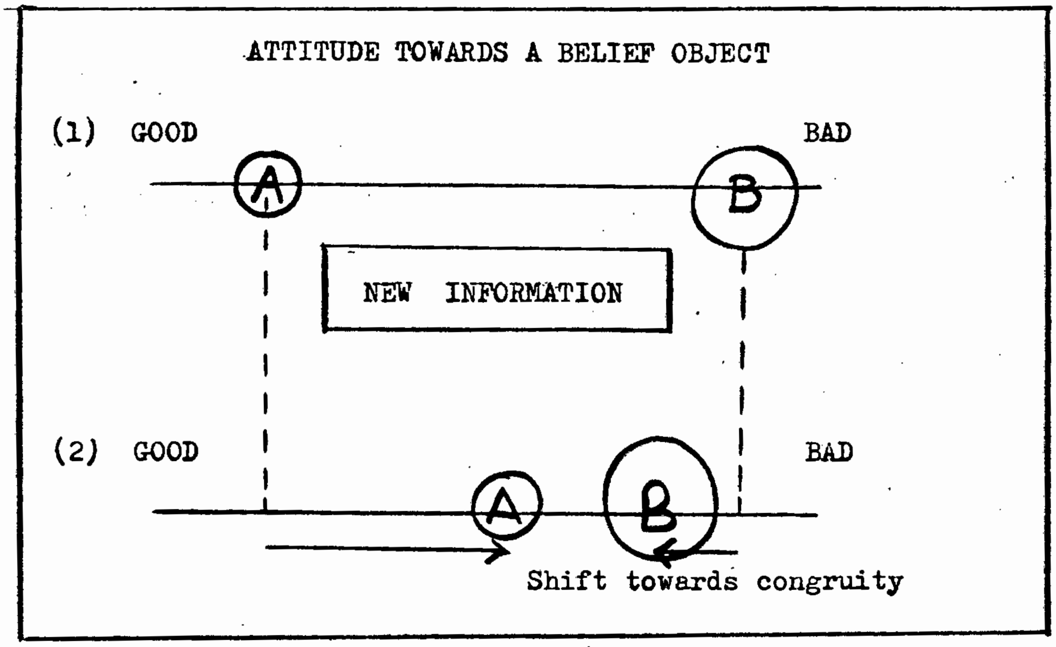

Fig. 3.5 An example illustrating congruity theory.

For example if a person holds attitudes towards two political leaders in relation to their stated commitment to democratic ideals (A having a positive attitude and B having a negative attitude); and now receives new information concerning politician A's praise of politician B, there will be a pressure towards congruity or equilibrium of these two linked belief objects. Probably the person will think a lot less of politician A and a bit more of politician B. This is clearly a change of attitude.

b)/...

b) The limitations of the theory.

The fact that the attitudes towards the two belief objects do not shift equally in the direction of equilibrium is one of the problems of congruity theory. Ad hoc corrections are hard to make for incredulity and assertions that do not fit the existing cognitive belief pattern. Insko (27) also notes that there are signs of summation effects when complex stimulus-objects are considered. Clearly this theory does not fit all the facts and is limited to a consideration of the relationship between beliefs and two attitudes.

c) Implications for teaching.

It is important to realise that there is a tendency to congruity or cognitive consistency when presenting new information that is intended to be assimilated by the pupils. Several existing attitudes may shift in the direction of equilibrium especially when it becomes difficult to assimilate the new information without incredulity. This makes it very difficult to predict attitude changes towards individual belief-objects because of this pressure towards congruity between linked belief-objects.

(iii)/...

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(27) Insko C.A., (1967), <u>Op. Cit</u>.

(iii) The Balance Theory of Attitude Change

a) A brief statement of the basic theory.

Balance Theory is also a cognitive consistency theory seeking to explain the relationship between beliefs and attitudes. Heider (28) visualised this cognitive balance in terms of triads.

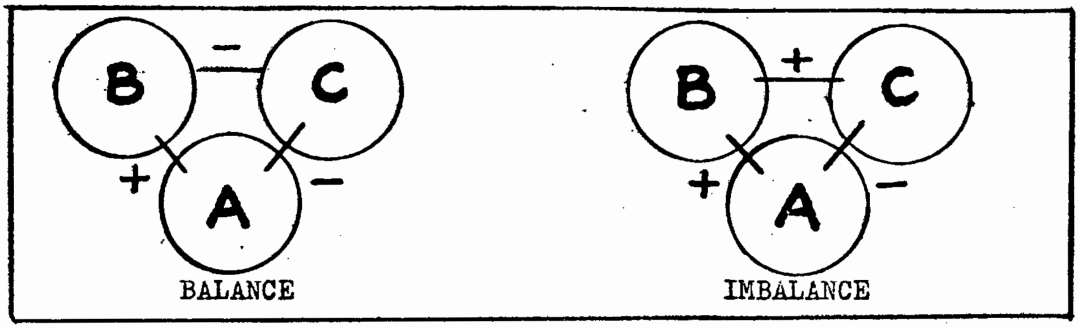

Fig 3.6(a) An example illustrating Balance theory.

This theory also seeks to relate two attitudes to belief objects to beliefs about self. In Fig 3.6 there are two triangular relationships between 3 persons. If A likes B and dislikes C it is to be expected (from A's point of view) that B and C will dislike each other. There is no imbalance in this situation and hence no pressure for attitude change.

Conversely if A likes B and dislikes C yet B and C like each other, this creates tension and stress in A.

The/...

(28) Heider F., "Attitudes and cognitive organisation", Journal of Psychology Vol. 21. (1946)

The relationships are imbalanced and there is pressure towards attitude change.

This change may take the form of altered opinions and attitudes towards B or C (i.e. they are not the persons A originally thought they were) or A may be forced to alter his opinion of himself in relation to B or C.

b) The limitations of the theory

Insko (29) points out that the definitions offered in Heider's theory are a bit vague and are too general to be of much use.

c) Implications for teaching

Heider emphasises the perspective of the attitude holder in this model. It is important to realise that altering the pupil's beliefs about some belief object can result in a change of attitudes to the belief-object, or to linked belief-objects or beliefs concerning himself. Clearly this theory aims at explaining attitudes in terms of more complex relationships and beliefs.

(iv) The Dissonance Theory of Attitude Change.

a) A brief statement of the basic theory.

This important theory has more active supporters than any other theory. It is also a cognitive consistency theory. Essentially/...

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(29) Insko C.A., (1967), Op. Cit.

Essentially Festinger (30) said that cognitive elements (beliefs) may be relevant or irrelevant to each other. Relevant beliefs can be dissonant (they do not follow logically from each other) or consonant (they do follow from each other).

If two dissonant beliefs are of great importance in their relevance to each other there is great pressure to reduce dissonance. Thus dissonance creates cognitive tension, stress and a desire for change that reduces dissonance. This is further complicated by recognising that all beliefs have a certain innate resistance to change that has to be overcome before attitude changes can take place. Decisions are examples of situations that may create dissonance, the unchosen alternative may be most attractive in terms of beliefs relating to it. In such a case dissonance can be reduced by:

i) Changing your mind

ii) Increasing the attractiveness of the chosen alternative

iii) Decreasing the attractiveness of the unchosen alternative

iv) Increasing the similarity of the two choices.

Dissonance/...

(30) Festinger L., A theory of cognitive dissonance. (1957)

Dissonance theory is popular because of its ability to provide non-obvious predictions which are often empirically supported, due to its emphasis on decisions in conflict situations.

b) The limitations of the theory

Insko (31) believes that the term dissonance is vaguely defined; this makes it necessary to interpret it somewhat intuitively. It is thus generally thought to be somewhat over simplified. In addition it deals only with the relationships between cognitive elements (beliefs) and does not provide much guidance towards a clear theory of attitude change.

c) Implications for teaching

The teacher has to recognise the value of personal decision making in clarifying the pupil's beliefs and creating dissonance which results in new opinions through the various dissonance reducing strategies outlined above.

d) A summary of the implications of these learning and cognitive consistency theories.

The purpose of the brief outlines provided thus far, is to indicate the as yet embryonic stage of development of theories of attitude change. No/...

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(31) Insko C.A., (1967), Op. Cit.

No one single adequate theory has been proposed which accounts for all four components of attitude.

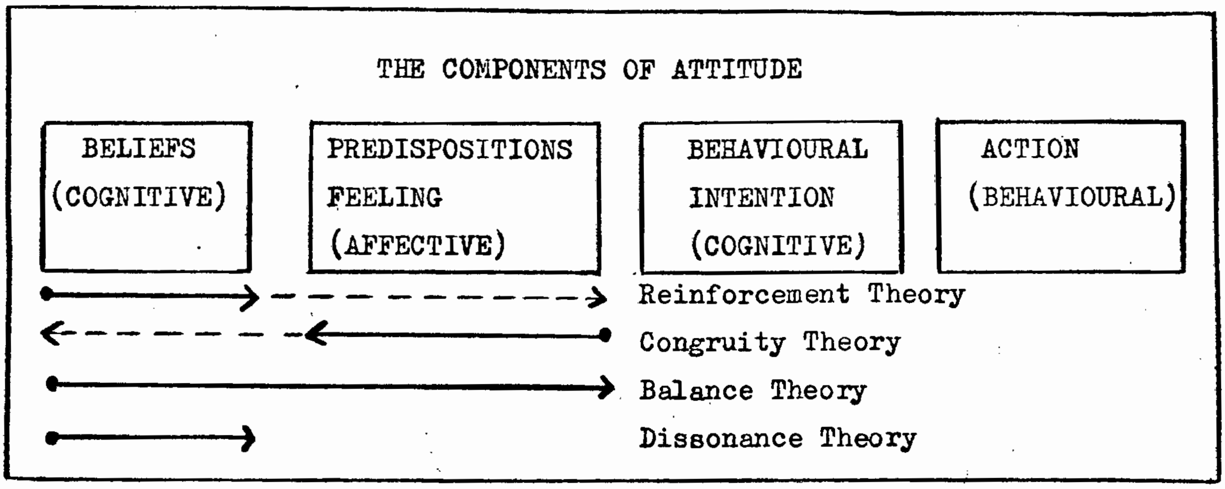

Fig 3.6(b) The conceptual range of the four attitude theories.

Most theories deal with beliefs and attitudes at the conceptual level, while dissonance theory deals with beliefs alone. The relationship between attitude/behavioural intention / behaviour remains to be clarified.

The theories all seem to indicate the importance of reinforcement whether as tangible rewards or punishments, a seeking for cognitive equilibrium through congruity, a pressure towards balance or an effort to reduce dissonance. It would appear as if attitude change is a result of a response to new information that creates stress and tensions in the cognitive structure resulting in attitude shifts in order to reduce tension and regain balance. This in turn emphasises the importance of cognitive consistency in creating stable attitudes and inconsistency in inducing attitude change.

What/...

What was not particularly apparent from these four studies was the huge diversity of attitude change theories, each research worker operating within the narrow framework of his own pet theory. It is only recently that Fishbein and Ajzen have sought to unite the main attitude change theories within one general conceptual framework. (32)

(e) The General Conceptual Framework of Attitude Theory explained.

In recognition of the four main components of attitude theory, Fishbein and Ajzen prepared this basic framework in 1975.

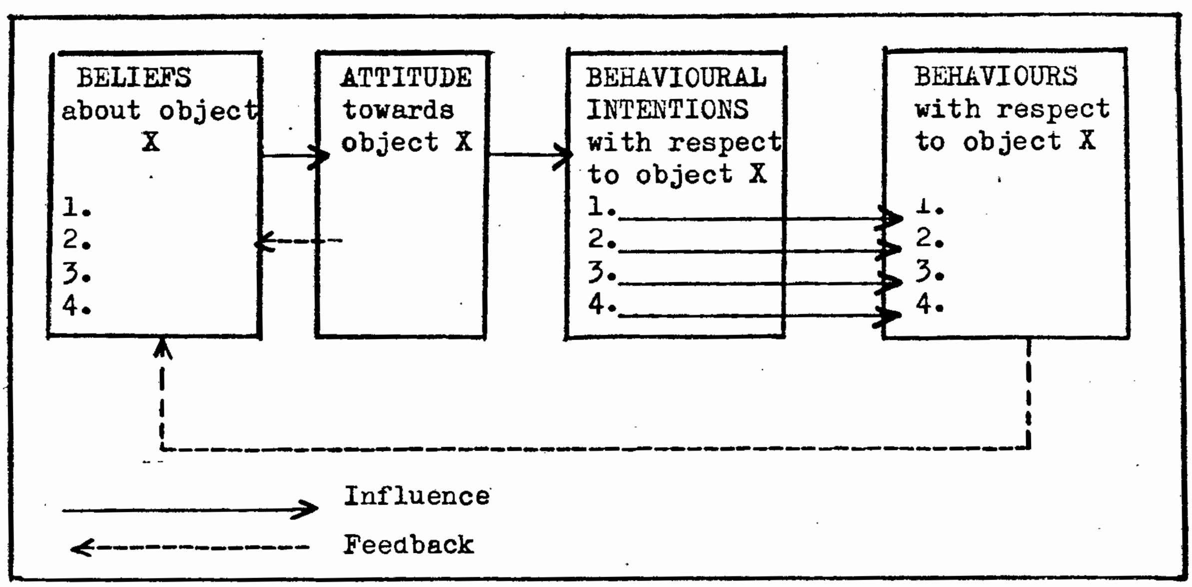

Fig 3.7 The General Conceptual Framework of Attitude Theory (Fishbein and Ajzen)

Beliefs are the fundamental cognitive elements of attitude, all theories stress the importance of cognitive information (Persuasive communications). These/...

(32) Fishbein, M. and Ajzen, I., (1975), Op. Cit.

These beliefs are affected by direct observations, information received, and inference processes. All beliefs are related to belief objects.

> The totality of .... beliefs serves as the informational base .... that determines attitudes, intentions and behaviours . (33)

This model rests on the assumption that man is a rational organism who uses the information at hand (beliefs) to make judgements and arrive at decisions.

Our attitudes consist of the totality of our positive and negative beliefs with regard to an object.

These attitudes lead to a set of intentions. They do not predispose a person to perform any specific behaviour. Individual intentions within the set of intentions are related to specific behaviours.

If two persons hold the same attitude it does not mean that they will perform the same behaviour. That will depend on the consequences of the behaviour alternatives as each person interprets them, and they will respond differently out of their set of behavioural intentions.

Edwards (34) hypothesized that when faced with a choice of behaviours a person will select the alternative that is likely to lead to the most favourable outcome. Empirical findings support this hypothesis. It/...

(33) Fishbein, M. and Ajzen, I., (1975), Op. cit.
(34) Edwards W, "The theory of decision making", Psychological Bulletin Vol. 51. (1954)

It is this possibility that two persons with the same attitude can behave in different ways that has made behavioural objectives for affective education impossible apart from the theory of a set of behavioural intentions.

Thus it becomes important to know what influences the formation of behavioural intentions in order that behaviour can be more meaningfully predicted.

Fishbein and Ajzen (35) claim that behavioural intentions are a function of beliefs concerning the consequences of performing certain specific behaviours, and the expectations of others (i.e. the normative beliefs).

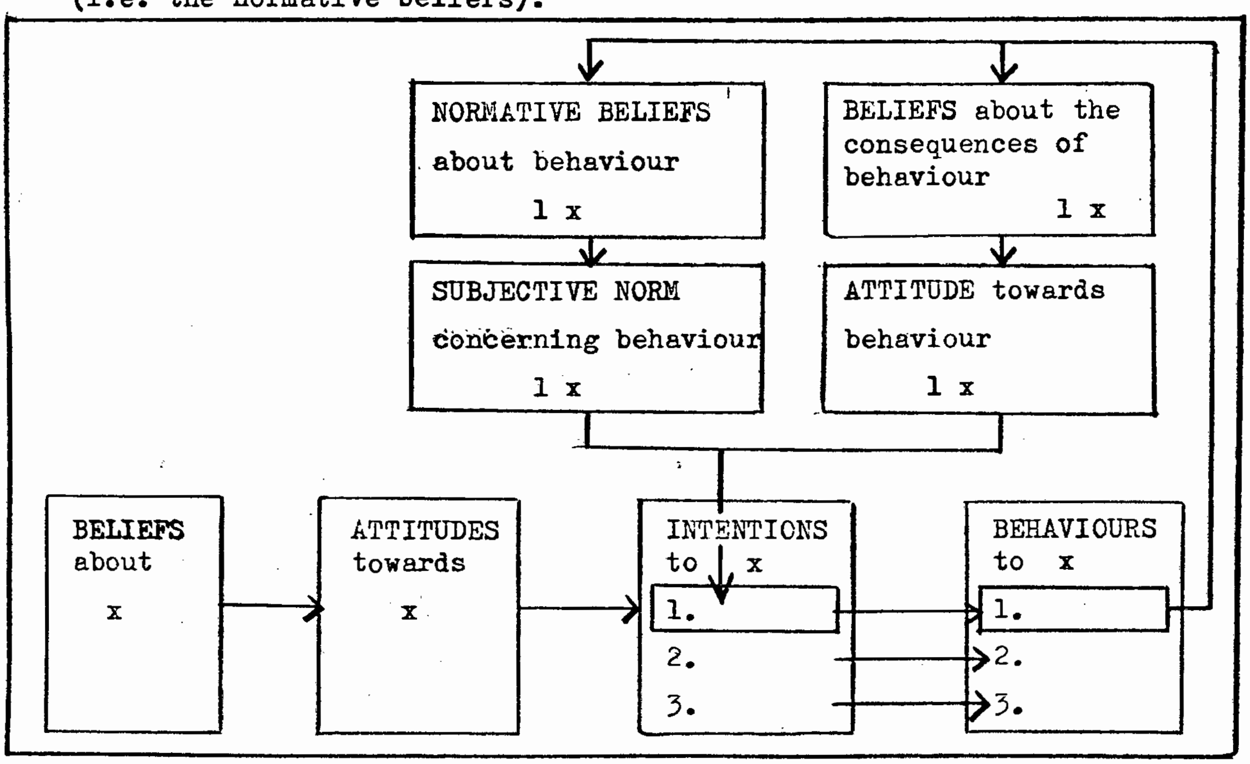

Fig 3.8 The specific predisposition for a particular behaviour (adapted from Fishbein and Ajzen)

These/...

(35) Fishbein, M. and Ajzen, I., (1975) Op. Cit.

These beliefs about the behaviour and its consequences lead to i) certain attitudes concerning the behaviour and its consequences, ii) a tendency to react to the pressure of what others expect of us (subjective norm). These two factors form the major determinant of the intention to behave in a particular way.

(e) The Implications of the General Conceptual Framework of Attitude Theory for this investigation.

Each of the four components of this Theory serve as guide lines in constructing an educational experience that maximises attitude-formation and value-clarification. It must be stressed that the environmental educational experience conforms closely to the last theory of attitude development as proposed by Fishbein and Ajzen; as has been anticipated in the much earlier work of Klausmeier reviewed in Chapter 1. (36)

The Components of the General Conceptual Framework. (Fishbein and Ajzen)	Application to this Environmental Educational Experience.
1. Beliefs	
The informational base.	Data gathering
Persuasive Communication	Formal lecturing
Direct Observation	Laboratory and field work.
Inference Processes	Group discussions.

(36) Klausmeier H.J., Learning and Human Activities: Educational Psychology (1961)

<table>
<tr><td>2. <u>Attitudes</u>
Our positive and negative predispositions which can be altered by our beliefs.</td><td>Role play and counter -attitudinal behaviour through large group discussion and debate in an effort to help each student clarify his/her own values and attitudes.</td></tr>
<tr><td>3. <u>Behavioural Intention</u>.
The function of the beliefs concerning the consequences of a choice of action and the expectations of others, leading to certain attitudes and a tendency to react to the pressure of group opinion.</td><td>The environmental encounter involves evaluation of possible alternative solutions to problems and the consequences of action. This results in personal value-clarification and an awareness of peer group pressure, and social pressures as a whole.</td></tr>
<tr><td colspan="2">No effort will be made to evaluate the behavioural intentions of individual pupils as the point of this investigation is to evaluate the teaching strategy and it's effect on the group as a whole.</td></tr>
<tr><td colspan="2">4. <u>Behaviour</u>
No close correlation is anticipated between attitude formation and behavioural outcome for the group as a whole either, as there are so many unknown variables operating in the system. Hence any significant correlation could well be the result of meaningless <u>summation effects</u>.</td></tr>
</table>

4. <u>The Summated Ratings Method of Attitude Scale Construction</u>.

(a) What an attitude scale measures.

Attitude scales are blunt instruments that are used to divide people into broad groups with regard to particular attitudes or attitude clusters.

The/...

The commonest, most researched, most widely used and most convenient scale in common usage where attitude change resulting from introducing an experimental variable is measured, (such as the environmental educational approach) is without doubt the Likert Scale (37).

This method is commonly referred to as the method of summated ratings because a total score is found for each subject by summating his scores (ratings) for the individual items making up the scale (38). This method cannot be used to assign individual pupils into "favourable" and "unfavourable" classes with respect to any measured attitude, as the neutral point on the favourable-unfavourable continuum is not known and it's does not necessarily correspond to the midpoint of the range of scores.

If, however, the investigation is concerned with mean changes resulting from introducing an experimental variable or comparing the mean attitude scores of two groups the method of summated ratings is most suitable (39).

This/...

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(37) Likert R., (1932), Op. Cit.

(38) Bird C., Social Psychology. (1940)

(39) Edwards A.L., Techniques of Attitude Scale Construction. (1957)

This method is as good as any other more sophisticated method for the purpose of comparing (i) mean attitude differences between the control and experimental groups in this investigation; (ii) and for measuring the mean attitude change resulting from the experimental teaching strategy and the normal teaching strategy. (iii) It will also be completely applicable to a later (second post-test) comparison of mean attitude difference between the two groups to measure the stability of attitudes learned from either method. It will also be much more simple to use and hence more convenient.

(b) The attitudes that are measured.

The first step in the construction of an attitude scale is to decide what attitude objectives are to be measured.

All investigators agree that attitudes tend to be linked together in certain vague groupings or attitude clusters. For example, Allport (40) has argued for a cluster of traits, chiefly intellectual, which make for radicalism on political, economic and other social issues. Likert (41) worked with five major attitude clusters, namely, international relations, race relations, economic conflict, political conflict, and religion.

Agreement, however, on the importance of these clusterings is by no means unanimous. However/...

(40) Allport, G.W. and Vernon, P.E., "The field of personality", "Psychological Bulletin. Vol. 27 (1930)

(41) Murphy, G. and Likert, R., Public Opinion and the individual. (1937)

However Gardner (42) when debunking several recent research papers dealing with attitude measurement points out that <u>the items in the attitude scale must stem from a single theoretical construct</u>, that clearly shows them all to have something in common. Measurements obtained by summing scores obtained from different scales to produce a general attitude score are meaningless and useless.

In order to avoid falling into this trap this author has constructed a <u>series</u> of separate attitude scales corresponding to the six aims of the prescribed Biology Syllabus. The attitude changes will thus be related to each of the six aims. This will ensure that each attitude cluster, based on the responses related to the affective objectives of the syllabus, are directly linked to the aim with which each objective was initially identified. This will enable the author to determine to what extent each aim is responsible for promoting affective development and how sensitive each aim is to the environmental approach.

These affective objective clusters are detailed in Chapter 5 of this study.

(c) Construction of the item pool

The items are <u>statements intended to elicit an affective response</u> from each pupil.

They/...

(42) Gardner P.L., "Attitude Measurement. A critique of some recent research," <u>Educational Research</u>. Vol. 17. No. 2. (1975)

They are asked to rate their response on a five point scale beneath each verbal statement. The scale ranges from:

Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree

Scores are assigned to each response in such a way that the most favourable response is worth 4 and the most unfavourable response is worth 0.

By preparing statements carefully in accordance with certain basic criteria listed below ambiguous and vaguely worded statements are kept to the minimum:

Rules governing the preparation of items.

(Adapted from Likert. (43)
Triandis (44) and Oppenheim. (45).)

1. Items must express desired behaviour rather than fact, (eg. words like "should")
2. Items must refer to present activities or future activities.
3. Items must be clear, simple, concise statements.
4. Items must not include double negatives.
5. Items must not be capable of several interpretations.
6. Items must cover all objectives in the scale.
7. Items must be briefly worded.
8. Items must avoid universals eg. all, every, never.
9. Items must have the favourable response on different ends of the scale in random arrangements.

(43) Likert R., (1932), Op. Cit.
(44) Triandis H.C., Attitude and Attitude Change (1971).
(45) Oppenheim A.N., Questionnaire Design and Attitude Measurement. (1966)

(d) The Pilot Test

The purpose of the pilot trial is two-fold:

(1) To establish the content validity of the item pool by making use of a criterion group of judges.

(2) To establish construct validity based on the purification of the scales using the top and bottom 25% of the pupils as internal criterion groups. This is known as the method of internal consistency. Once validity has been established, the reliabilty of the scales can be computed.

It is essential that the second pilot trial be conducted with a group as similar as possible to the experimental group.

In this investigation the 1978 Standard Eight class was used prior to the purified attitude scale being used with the 1979 Standard Eight class. Pupils having to repeat the same Standard in 1979 were excluded from the investigation, to eliminate possible pre-test contamination of results.

It was decided to supply the pupils with a frame of reference in the form of an explanation of the purpose of the test to avoid possible contamination resulting from pupils trying to guess the purpose for themselves, and possibly causing their ratings to diverge more than they might have done otherwise. There is no research evidence to indicate that an accurate understanding of the purpose of an anonymous attitude scale significantly affects the dependant variables of the investigation.

As the scores of individual pupils are unimportant to the method of summated ratings and no research questions were based on an interpretation of any single individual's progress, anonymous questionaires were used. This had the advantage of reducing the "guinea-pig effect" where pupils seek to assume ideal postures to please or annoy the teacher.

All tests were conducted by the regular class teacher as it has been shown by Webb (46) that the threat of subjects' awareness of being tested is far less of an issue in educational research especially when being tested by their regular teacher.

(e) The item analysis

The attitude scale is purified by selecting the "best items". The "best items" are deemed to be those that differentiate best between the high scoring group (top 25%) and the low scoring group (bottom 25%) which groups are assumed to be criterion groups.

There are various methods of selecting these "best items":

(i) Correlation

The correlation co-efficient between each pupil's score on each item and his total score for all the items is computed. Those items with the highest score form the purified scale.

(ii)/...

---

(46) Webb, E.J. Campbell, D.T. Swartz, R.D. Sechrest, L. Unobtrusive Measures (1966).

(ii) The t test

If the same number of pupils are selected for each criterion group, as they will be if we select 25% in each group, then according to Edwards (47) the following formula can be used to assess the value of t for each item on the pilot test:

$$t = \frac{\bar{X}_H - \bar{X}_L}{\sqrt{\frac{\sum(X_H - \bar{X}_H)^2 + \sum(X_L - \bar{X}_L)^2}{n(n-1)}}}$$

where $\sum(X_H - \bar{X}_H)^2 = \sum X_H^2 - \frac{(X_H)^2}{n}$

and $\sum(X_L - \bar{X}_L)^2 = \sum X_L^2 - \frac{(X_L)^2}{n}$

where $\bar{X}_H$ = the mean score on a given item for the high group.

$\bar{X}_L$ = the mean score on a given item for the low group.

n = the total number of subjects in the high and low groups.

Significant differences between the two criterion groups are indicated by those items with the highest t values of <u>significant difference</u>, which are then arranged in rank order and a suitable number selected to form the attitude scale in question. This <u>final selection</u> is based on the need to balance favourable responses (strongly agree) with favourable responses (strongly disagree) in order to minimise possible response sets that might be generated if only favourable statements were included in the scale.

(iii)/...

(47) Edwards A.L., (1957), <u>Op. Cit.</u>

(iii) Short-cut Method

Murphy and Likert (48) found that the best items could be identified by using the difference between the means of the high and low groups. By ranking these differences the best item could be selected.

Edwards believes that it.....

> is doubtful.... whether any of the methods of item analysis in current use would result in an ordering of the statements that is essentially different from the ordering we obtain in terms of t values.

As there were too few candidates to obtain reliable t test results this last described method was used; with most encouraging results.

(f) The Reliability of the Attitude Scale.

The reliability of the method of summated ratings has been established several times when comparing it with other more sophisticated methods. Edwards and Kenney (49) gained much support for Likert Scales when they proved that....

> Scales constructed by the Likert method will yield higher reliability co-efficients with fewer items than scales constructed by the Thurstone method.

Poppleton and Pilkington (50) more recently confirmed this finding and found Likert Scales and scoring methods to be more reliable and valid than Thurstone, Guilford or Castle Scales.

No/...

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(48) Murphy, G. and Likert, R., (1937), Op. Cit.
(49) Edwards, A.L. and Kenney, K.C., " A comparison of the Thurstone and Likert techniques of attitude scale construction," Journal of Applied Psychology. Vol. 30. (1946)
(50) Poppleton, P.K. and Pilkington, G.W., " A comparison of four methods of scoring an attitude scale in relation to it's reliability and validity", British Journal of Social and Clinical Psychology Vol. 3. (1964)

No attempts to "sophisticate" this technique have ever yielded more satisfactory results. (51)

There are two methods of establishing the reliability of the purified attitude scale:

(i) By repeating the pilot test using the same pilot sample to assess the reliability of the scale over time, although this method introduces the variable of pupil stability and lower reliability co-efficients should be expected.

(ii) By using a split-half (odd and even number) correlation co-efficient without having to repeat the pilot test.

This method involves summing the odd and even scores seperately for each scale and computing to find Pearson's correlation co-efficient using the following formula:

$$r = \frac{\sum XY - \frac{\sum X \sum Y}{N}}{\sqrt{\left(\sum X^2 - \frac{(\sum X)^2}{N}\right)\left(\sum Y^2 - \frac{(\sum Y)^2}{N}\right)}}$$

Where X is the individual odd score
and Y is the individual even score
and N is the number of odd or even scores.
This gives the reliability for half the test.

By/...

(51) Edwards, A.L. and Kilpatrick, F.P., "A technique for the construction of attitude scales," Journal of Applied Psychology. Vol. 32. (1948).

By reducing the investigations measuring instruments to a series of attitude scales, it will be possible using these techniques, to establish a part-score reliability, as opposed to a total reliability co-efficient for the scales. By applying the formula:

$$r_{(1+2)} = \frac{2r}{1+r}$$

the part-score co-efficient is corrected.

It is a distinct advantage for this investigation that the individual scales do not need to consist of many items to establish the reliability of the test. Hall (52) established that the fewer the items the higher the reliability co-efficients could be expected to be. He used ten items in his Attitude-towards-Religion Scale.
None of the purified scales used in this investigation numbered fewer than ten items.

(g) The validity of the Attitude Scale.

The chief difficulty in assessing the validity of this attitude scale is the lack of fixed criteria. Criterion groups are needed with known attitudes to see if the scale can discriminate between them. But as we have seen, in the last section of this chapter, it is not possible to predict behaviour from attitudes, nor are attitudes easily inferred from behaviour. So members of criterion groups may not have common attitudes which could validate this scale.

Other/...

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(52) Hall.O.M., " Attitudes and unemployment", Archives of Psychology. No. 165. (1934)

Other techniques employed by Thurstone in his equal-interval scale involved the use of judges to establish content validity of the items, but it is just this lengthy and difficult technique that has inspired the development of the summated ratings method.

This difficult situation has led to the concept of construct validity whereby the user of Likert Scales assumes that the best available measure of the attitude concerned is the total purified item pool. These items are consistent and homogenous and may possibly be valid as well. We thus assume that the high and low scoring groups are criterion groups.

By means of correlation, establishing ranked t values or ranking differences between item means for each criterion group, the need for an external criterion group is diminished and construct validity is established.

Notwithstanding the above argument commonly encountered in the literature, this author approached five independent Biology teachers and assessed their responses to the items in the unpurified item pool. It was assumed that a high degree of common agreement as to the correct response for each item would indicate that the item had content validity. Their results were used to sift out unsuitable items prior to the pilot testing in a local school.

Items/...

This first pilot test (using five judges) revealed that there was uncertainty or disagreement about what constituted the correct response for several items. These ambiguous or misleading items were immediately discarded.

(h) The implications of the method of summated ratings for this investigation.

(i) This method is statistically acceptable to answer the following research questions:

a) What mean attitude differences exist between the control and experimental groups before and after the experiment ?

b) Which teaching strategy achieves the most positive mean attitude change ?

c) Which group learned the more stable attitudes during the investigation ?

(ii) A series of attitude scales was used to differentiate between the different attitude clusters, so that the sensitivity of each aim to the experimental approach could be measured.

(iii) A first pilot test was used to establish content validity of the six scales.

(iv) A second pilot test was administered to the standard 8 class who were one year ahead of the research programme. This test was truthfully motivated, anonymous and administered by the regular teacher. The method of ranked-differences was used to purify the scales. Their reliabilty was established using corrected split-half correlation techniques.

PART TWO:

DEVELOPMENT AND FINAL DESIGN OF THE INVESTIGATION

CHAPTER 4

CONTENT ANALYSIS OF THE SELECTED AREA OF THE PRESCRIBED SYLLABUS

CHAPTER 4 - CONTENT ANALYSIS OF THE SELECTED AREA OF THE PRESCRIBED SYLLABUS

A. CONTENT ANALYSIS IN THE LIGHT OF THE SYLLABUS AND IT'S OBJECTIVES

1. Teaching Method and the realisation of objectives.

The purpose of this investigation is to consider the effectiveness of the environmental approach as outlined in Chapter One, with the conventional lecture-demonstration approach (referred to in this investigation as the "normal educational experience") in achieving affective objectives.

In terms of the realisation of cognitive objectives different teaching methods have been shown to make little difference in realising the syllabus aims. This has encouraged the widespread use of the lecture-demonstration method as it makes least demands on the cognitive abilities of the pupils and hence results in less confusion for the less-able pupils in the class. In this respect it may even result in significantly better examination means for the group as a whole. (1)

If cognitive objectives are the only consideration in the prescribed syllabus then there is little doubt about the obvious suitability in terms of official evaluation (the Senior Certificate Biology Examination) of the lecture-demonstration method.

It/...

(1) Isenbarger J., "Lecture-demonstration-recitation technique in biology teaching", School Science and Mathematics. Vol. 25. (1925)

It has already been pointed out in Chapter One that the emphasis for promotion purposes is on the cognitive objectives of the prescribed syllabus alone. In the light of this obvious inducement the lecture-demonstration method has for many years been the "normal educational experience" in many biology teacher's classrooms.

On the other hand when the lecture-demonstration method is evaluated in terms of affective objectives it has often been shown to be less suitable than innovative methods involving group discussion-laboratory work- and lectures (2),(3) especially when these techniques are employed within an environmental framework (4).

In short it is unlikely that the full scope of the affective objectives of the prescribed syllabus can be realised by the "normal educational experience" while cognitive objectives are so heavily emphasized.

2./...

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(2) Lowery L.F., "An experimental investigation into the attitudes of fifth grade students towards science", School Science and Mathematics. Vol. 67. No. 6. (1967).

(3) Simons, J. and Esker, W., "Investigating the attitudes towards science fostered by the process approach", School Science and Mathematics . Vol. 72. (1972)

(4) Fraser B.J. The impact of A.S.E.P. on pupil learning and classroom climate. (1975).

2. The Paradox of the syllabus.

When the recommended study approach published in the amended syllabus for biology is analysized (5) it can be shown that the curriculum developers are aware of the value of the environmental approach, but the syllabus has been constructed in such a manner as to make the realisation an environmental approach exceedingly difficult:

> STUDY APPROACH AND GENERAL AIMS.
>
> The approach should be such as to stimulate the pupils' awareness and appreciation of the wonder of creation, the riches of our .....flora and fauna.... the mutual inter-dependance of living things. This should lead to an understanding of theecosystem.......the emphasis should be on organisms in relation to their environment. Instruction should.....be based on pupils' own observations within their environment.
>
> GENERAL REMARKS
>
> ....The arrangement of the components of the subject-matter must be such that provision is made for the integration of plant and animal studies in order that the pupils may become aware of the phenomena of life.
>
> The Amended Biology Syllabus.

The above quotations clearly demonstrate the environmental emphasis in the prescribed syllabus. The following quotation from the same Amended Biology Syllabus emphasizes the scientific method.

STUDY/...

(5) Cape Education Department. "Senior Secondary Course Amended Syllabus for Biology", The Education Gazette, Part 76, No. 3, (1977)

STUDY APPROACH AND GENERAL AIMS.

> ...As part of their training in the scientific methods of study, pupils should be given constant practice in critical observation and accurate recording....in handling material and apparatus....in applying their knowledge and understanding to new problems in order that they may cultivate habits of logical and systematic thinking. Pupils should.... realise that all scientific work is based on the questioning and revision of previously accepted and currently held theories.
>
> Pupils should examine fresh and/or preserved material and keep a record of their own observations. Candidates must be acquainted with the use of the microscope.
>
> The Amended Biology Syllabus.

Clearly this envisages <u>an operational knowledge of scientific methodology</u> which should be realised, when linked with the previous quotation, through the <u>environmental approach</u>.

This being the case it would be a fair assumption that:

(a) The subject-matter of the prescribed syllabus would be arranged within an environmental framework.

(b) Environmental methods (eg. sampling and survey techniques) would form an introduction to the course.

(c) Provision would be made for practical examinations and student projects.

(d) Field trips would be compulsory.

In/...

In reality this is not the case:

(a) The framework of the syllabus.

The subject matter in Standard Eight is set out after a topical approach, namely:

THE SYLLABUS : STANDARD EIGHT.

1. ENERGY AND BIOLOGICAL ENERGY PATHWAYS.
   (Definitions and sources of energy.)
2. STRUCTURE AND PROPERTIES OF MATTER.
   (Atomic, Molecular and Ionic structure of matter. Covalent bonding. Sources of ions in aqueous solutions. Kinetic energy of molecules.)
3. THE CELL.
   (Comparison of the basic structures of plant and animals cells.)
4. GENERAL BODY PLANS OF ANIMALS, THEIR SKELETONS AND THEIR LOCOMOTION; ASPECTS OF THEIR TRANSPORT SYSTEMS.
   (Structural arrangement and support, locomotion and transport systems of at least one example from: Protozoa, Coelenterata, Platyhelminthes, Annelida, Arthropoda (Crustacea, Arachnida, Insecta) Mollusca, Chordata (Osteichthyes, Amphibian, Reptilia, Aves, Mammalia.) Special emphasis on the skeleton, blood and muscle of a mammal.)
5. PLANT ORGANISATION : ANATOMY AND PHYSIOLOGY OF ANGIOSPERMS.
   (The structure and function of plant organs and tissues, in relation to water and food movement.)

The Amended Biology Syllabus.
(Summaries in brackets are this author's own.)

While this approach is undeniably logical in it's progression it is <u>not</u> an approach suited to <u>an environmental emphasis</u>. The C.E.D. has this to say when commenting on this particular study approach:

No/...

> No attempt has been made to prescribe too closely the general approach, nor to advocate a specific method of study for any particular part of the syllabus... subject matter should be arranged to suit local conditions....it is recommended that the work be planned on a seasonal basis.
>
> The Amended Biology Syllabus. (6)

In view of the <u>implicit</u> method analysed on pages 103 to 105 , <u>a general approach has most definitely been prescribed</u> although no details of how to achieve this <u>environmental approach</u> have been supplied to teachers. The Cape Education Department wants the work to be handled within the context of environmental and scientific methodology. The study approach and general aims prescribed make this patently obvious.

Although the prescribed syllabus hesitates to name the method directly, it is difficult to imagine how the present Standard 8 syllabus with it's closely reasoned sequence of development from simple to complex organisms could be "planned on a seasonal basis" without seriously interfering with the logical progression of the subject matter.

Any attempt to change the order of the subject matter will result in some introductory concepts being taught after the content matter for which they form a basis. Alternatively, if the recommended sequence is followed many of the animal specimens will be difficult to find in the Autumn and Winter school terms.

In/...

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(6) Cape Education Department. (1977). <u>Op. Cit</u>.

In summary <u>the official approach recommended is very close to an environmental approach but the syllabus content is arranged in such a fashion as to favour a lecture-demonstration approach</u>.

(b) The introduction to the syllabus.

Although an environmental approach is implicitly recommended, no provision has been made for an introduction suited to an environmental approach. On the contrary the ecological material in the three year course <u>almost</u> forms an optional appendix, and is often omitted by teachers pressed for time who realise the general lack of relevant connection between this section and the rest of what is essentially a systematic interpretation of the discipline inadequately structured to an environmental approach.

(c) Practical examinations and student projects.

> Although practical work is an integral and compulsory part of the course, there will be no formal practical examination... at the end of the year.
>
> The Amended Biology Syllabus (7)

While/...

---

(7) Cape Education Department (1977). <u>Op. Cit</u>.

While, every effort is made to ensure that practical work is properly recorded and some 35 areas of the Standard Eight syllabus suited to practical work are identified by asterisks with the injunction that practical work in the indicated area is compulsory, no provision is made for a formal practical examination at the end of the year, unless by special request of the school in consultation with the Inspector of Education. The marks allocated to this recording of practical work throughout the year are only 12½% of the total promotion mark. Whether the practical work is always properly executed in terms of scientific methodology or even conducted by the pupils themselves is open to question. Many of the "practicals" are little more than completing a questionaire based on a teacher demonstration which "proved" the validity of some classical experiment long since enshrined in the text book, with no element of uncertainty as to the anticipated outcome. It is doubtful whether the scientific methodology can be properly communicated to pupils under these conditions. Similarly no provision is made for individual or group project work in the form of term assignments to be conducted in the pupils' own leisure time. That they would form a valuable source of practical work for assessing the individual's grasp of scientific procedures and field observations is too often overlooked by biology teachers. A list of some sixteen suitable proven assignments for field work is listed in Opie's (8) paper presented to the Cape Biology teachers at their 1976 Refresher Course.

Perhaps/...

(8) Opie F.W.J., "Some aspects of field work in ecology." Refresher Course in Biology. (1976).

Perhaps the reason why most biology teachers fail to employ these methods is a reflection of the inability of their students to handle practical investigations by themselves although following a course whose whole study approach strongly recommends the scientific methodology within the environmental framework.

(d) Field trips.

Although there is a growing awareness of the need for field work as yet no regular provision has been made for biology teachers' to take their class out of the school premises for a field trip. Until field work is made mandatory there is little hope of realising the recommended study approach.

In the light of all this it is clear that a paradox exists. On the one hand the importance of the environmental approach is realised in the aims, study approach and general remarks that preface the syllabus content but the content itself and the nature of the emphasis on practical work makes this very approach all but impossible.

Professor R.F. Fuggle of the University of Cape Town's School of Environmental Studies commented on the impossibility of doing more than lip-service to the aims of the syllabus while the present structure and interpretation is maintained.

3. Content and the Affective Objectives.

It has already been pointed out in Chapter 3, that every attitude has a belief or cognitive component; and that affective objectives are realised from an informational base. The pupils must know facts before they can cultivate feelings, attitudes and values towards life.

It has also been pointed out that by neglecting to teach for affective objectives we fail completely to realise positive attitude formation unless it occurs by chance. (9)

A.D. Luckhoff (10) in stating the official viewpoint of the Cape Education Department in 1971, had this to say with regard to the realisation of affective objectives....

> ... It's importance (the Affective Domain) is, nevertheless, of such a nature that the attitude of the pupil should never be allowed to become negative. Fortunately teachers are...highly competent to observe interests and to apply oral tests in such a way that pupil's attitudes can be gauged.

That/...

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(9) Shock N.H., "Analysis of the relationship that exists between cognitive and affective educational objectives," Journal of Research in Science Teaching. Vol. 10. No. 4. (1973)

(10) Luckhoff A.D., "Evaluation in the Sciences", Refresher Course in Physical Science, Biology and Physiology. (1971)

That this statement contains two unsubstantiated assumptions (a) that pupils' attitudes are consistently positive and that (b) teachers are competent to assess attitudes; need not be contested at this stage. These assumptions were dealt with in Chapter 2.

More important is the underlying belief that affective objectives are being automatically achieved by realising cognitive objectives and hence there is no need to evaluate affective development.

The possible truth of this statement is investigated in Section C of this Chapter.

B. SELECTION OF CONTENT AREAS FOR THIS INVESTIGATION.

In Chapter 1, when identifying the controlled variables of this investigation, it was established that content differences between the study material of the experimental and control group would be <u>minimised</u> as much as the two different approaches permitted it.

By carefully selecting a range of animal species from section 4 of the Std. 8 syllabus (viz. General Body Plans of Animals, their skeletons and their locomotion; aspects of their transport system) it was possible to compile a list of a variety of life forms very similar in diversity to those animals that inhabit the <u>inter-tidal zone</u>:

CONTROL GROUP (Section 4 of Std. 8 syllabus)	EXPERIMENTAL GROUP (Environmental Selection based on shore-line habitat)
1. Ecological Sensitization Programme.	
2. Protozoa-Amoeba	2. Plankton
3. Hydra	3. Sea Anemone
4. Earthworm	4. Bristle worm
5. Crab/Crayfish	5. Pool Crustacea
6. Snail	6. Pool Molluscs
7. Fish	7. Pool Fish
8. Bird	8. Sea Gull

Table 4.1 The content of the control and experimental programme.

It can be seen from Table 4.1 that the content of the two programmes, while not being identical, has nevertheless been closely matched in selection of animal specimens. Essentially the difference in terms of content is the fact that in the experimental programme animals all form part of one ecosystem, interacting with each other and forming part of the same food chain. The abiotic and biotic factors are thus linked for all the animals mentioned. They will all show adaptations that enable them to occupy one niche of the habitat successfully. The habitat will be considered in it's totality including the influence of human beings and other organisms (plants) not specifically mentioned in the Table of Contents (4.1)

It/...

It is assumed that the control group also see their selection of animals as being part of an environment as recommended in the syllabus, but the relationships between the animals will be far less obvious to the class as many of the animals come from completely different habitats and their sensitivity to human influence should also be far less obvious.

The method of teaching the two programmes will differ substantially, and while the control group are likely to follow the sequence suggested in Table 4.1 on the basis of increasing complexity. The environmental group are more likely to work on all aspects simultaneously in accordance with problem-solving techniques.

In Table 4.2 the contents of the two courses have again been compared in full detail to bring out some of the differences in interpretation of content.

Table 4.2/...

Table 4.2 The content of the two programmes

<table>
<tr><th>TIME
in periods</th><th>CONTROL GROUP</th><th>EXPERIMENTAL GROUP</th><th>TIME</th></tr>
<tr><td>10</td><td colspan="2">ECOLOGICAL SENSITIZATION
(Common to both groups)</td><td>10</td></tr>
<tr><td></td><td>General Examples</td><td>Rocky Shore examples</td><td></td></tr>
<tr><td></td><td colspan="2">Abiotic Components</td><td></td></tr>
<tr><td></td><td>Temperature
Light
Water
Oxygen</td><td>Light
Water
Surface
Temperature
Salinity
Acidity</td><td></td></tr>
<tr><td></td><td colspan="2">Biotic Components</td><td></td></tr>
<tr><td></td><td>Food Supply -Producers
Living Space
Consumers
Decomposers
Food Chains</td><td>Food Supply - Producers
Living Space
Consumers
Decomposers
Food Chains</td><td></td></tr>
<tr><td>1</td><td>INTRODUCTION TO TAXONOMY
Binomial nomenclature
Principles involved</td><td>FIELD-TRIP
To a rocky shore to survey the abiotic and biotic factors and collect materials and data for lab. work.</td><td>1 day</td></tr>
<tr><td>2</td><td>PHYLUM PROTOZOA
Amoeba - Habitat
Structure
Locomotion</td><td rowspan="3">LABORATORY FOLLOW-UP
Groups investigate:
PHYLUM PROTOZOA et al.
Nature of plankton
Locomotion
Role in Food Chains
PHYLUM COELENTERATA
Sea Anemone - Habitat
Structure
Locomotion
Feeding
Role in Food Chain</td><td rowspan="3">17</td></tr>
<tr><td>3</td><td>PHYLUM COELENTERATA
Hydra - Habitat
Structure
General body plan
Hydrostatic Skeleton
Locomotion</td></tr>
<tr><td>3</td><td>PHYLUM PLATYHELMINTHES
Planaria - Habitat
Structure T/S
General body plan
Cephalisation
Hydrostatic Skeleton
Locomotion</td></tr>
</table>

PHYLUM ANNELIDA/...

TIME	PHYLUM ANNELIDA
5	Earthworm – Habitat Structure Bilateral Coelomate body plan Hydrostatic Skeleton Locomotion Blood system Practical Work
	PHYLUM ARTHROPODA
2	General introduction Common Characteristics Exoskeleton
	CRUSTACEA
3	Crab – Habitat Sructure Specialisations Locomotion Blood Systems Practical Work
	ARACHNIDA
1	Spider – Habitat Structure Specialisations
	INSECTA
	Locust – Special Project done by pupils
	PHYLUM MOLLUSCA
3	Garden Snail – Habitat Structure General body plan Hydrostatic Skeleton Locomotion Practical Work
	PHYLUM CHORDATA **VERTEBRATA**
1	General introduction Endoskeleton
3	**OSTEICHTHYES**
	Any fish – Structure Locomotion Practical Work

PHYLUM ANNELIDA	TIME
Bristle Worm – Habitat Structure Role in Food Chain	
PHYLUM ARTHROPODA	
CRUSTACEA	
Shore crab – Structure Role in Food Chain Locomotion	
Barnacles – Structure Feeding Colonisation	
Quay Louse – Habitat selection	
PHYLUM MOLLUSCA	
Limpet – Structure Mode of Feeding Role in Food Chain Response to abiotic conditions	
PHYLUM CHORDATA **VERTEBRATA** **OSTEICHTHYES**	
Klipfish – Structure Feeding Locomotion	
AVES	
Sea Gull – Structure Feeding Role in Food Chain .	
SPECIAL COMMUNITIES	
Zonation of the Shore Microfauna of Holdfasts Sea Weeds on the Shore	
FIELD TRIP TWO	½ day
To the same site to study human uses of the shore.	
Topics covered during **LABORATORY FOLLOW-UP:**	17
The litter problem	

	AVES	The effect of the Railway line on the shore Sewage disposal Environmental Marring Casual Shore Use Oil Pollution. Conservation and Exploitation of Marine Resources.
4	Pigeon - Structure Locomotion	
	AMPHIBIA	
3	Frog - Structure Locomotion Practical Work	
	REPTILIA	
2	Lizard - Structure Locomotion Practical Work	
	MAMMALIA	
1	Rabbit - Structure Locomotion	

The sequence of the experimental programme outlined above bears no relation to the intended sequence during the programme. Full details of the sequence are found in Appendix A, where a short summary is provided on pages A5 to A7. The purpose of listing the content as in Table 4.2 is purely to facilitate comparisons.

No attempt has been made at this stage to outline the different skills learned by individual groups as there is no favourable comparison in the control programme. Full details are listed in Appendix A.

The control programme is centred on a systematic approach to which the content is made to conform and hence appears very well structured by comparison with the experimental programme. The experimental programme is essentially the study of a habitat and subject matter is limited to those species found in the habitat. However this is not seen as a disadvantage as the species are more naturally related to each other in terms of biotic factors. In short it is a "real life" situation that promotes relevance and the challenges that provoke positive attitude formation if correctly channelled.

It/...

It is envisaged that these two programmes will occupy the classes for the whole of the first term.

Both groups will be provided with adequate opportunity for practical work, project work and voluntary extra reading. Extra films will be shown to the control group to balance up for the lack of field work they will not receive,

A careful examination of Table 4.2 reveals that while the content has been closely matched it is not possible for it to be identical for both groups because of the nature of the environmental approach and the attendant importance of viewing each component as part of a larger whole.

C. AN ANALYSIS OF CONTENT AREAS IN TERMS OF THE AFFECTIVE OBJECTIVES OF THE PRESCRIBED SYLLABUS.

1. Assessing the "affective potential" of the study programmes.

   It is only possible to speculate at this stage as to the variety and depth of the affective objectives that these study programmes could promote.

   Each affective objective is in reality a stage in the formation of a total attitude or attitude cluster as defined by the six main aims of the syllabus.

   Each is hierarchically related to objectives describing the same attitude cluster. (See Chapter 5.)

Each/...

Each affective objective is <u>based on beliefs or knowledge</u> of the attitude object.

In this sense the seven content areas all possess "<u>affective potential</u>" for realising affective development to a certain level in the hierarchy of affective objectives.

These affective objectives range from simple interest in phenomena to complex qualities of character and conscience.

<u>Awareness</u>, elicits an increasing <u>response</u>, which leads to <u>value formation</u>, <u>organisation</u> and <u>characterisation</u> as the phenomena are increasingly absorbed into the structure of the pupil's personality. Bloom (11) refers to this process as <u>internalisation.</u>

The stages of increasing internalisation were classified according to Bloom, Krathwohl and Masia's affective taxonomy, a portion of which is shown in Table 4.3.

Table 4.3/...

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(11) Bloom, B.S. Krathwohl, D.R. and Masia B.B. <u>Taxonomy of Educational Objectives</u>. Book 2. Affective Domain. (1964)

CLASSIFICATION	SUMMARY
1.3	The pupil watches out for particular information
2.2	A voluntary response from choice.
2.3	An emotional response of pleasure or enjoyment.
3.1	"A belief about" the attitude object.
3.2	An acceptance of a value to the point of seeking it.
3.3	A conviction involving commitment.
4.1	Relating the value to other values.
4.2	Organisation of values into a priority ranked system.

Table 4.3 <u>Bloom's Hierarchy of Affective Objectives simplified for the secondary school</u>. (Adapted from: Bloom, Krathwohl and Masia.)

This hierarchy of affective objectives has been used to classify the possible affective potential of the two programmes as illustrated in Table 4.4. below:

THE CONTROL GROUP										THE EXPERIMENTAL GROUP							
4·2	4·1	3·3	3·2	3·1	2·3	2·2	1·3			1·3	2·2	2·3	3·1	3·2	3·3	4·1	4·2
					●	●	●	AMOEBA	PLANKTON	●	●	●	●	●	●		
					●	●	●	HYDRA	SEA ANEM-ONE	●	●	●	●	●	●		
					●	●	●	EARTHWORM	BRISTLE WORM	●	●	●	●	●	●		
					●	●	●	CRAB/CRAY FISH	POOL CRUS-TACEA	●	●	●	●	●	●		
					●	●	●	SNAIL	POOL MOLL-USCS	●	●	●	●	●	●		
					●	●	●	FISH	POOL FISH	●	●	●	●	●	●	●	●
					●	●	●	BIRD	SEA GULL	●	●	●	●	●	●	●	●

Table 4.4 An analysis of the two content programmes in terms of their "affective potential" for realising affective objectives.

Main range of educational objectives at secondary school level.

(These objectives are classified in terms of the lists supplied in Chapter 5.)

An analysis of Table 4.4. reveals several interesting differences between the possible achievement of affective objectives in the two programmes (experimental and control).

It would be unrealistic to expect all pupils to reach the same levels of affective development after just one term, or to ignore the fact that they have all already experienced some considerable affective development at secondary school level which may contribute substantially to the achievement of the prescribed syllabus affective objectives before they even start working through the course. It would also be facile to expect full affective development on such a restricted portion of the course after one brief term.

Notwithstanding these limitations Table 4.4. does indicate some differences in "affective potential" that are worth consideration.

The environmental approach to content matter as opposed to the systematic approach (as set forth in the prescribed syllabus) would appear to have more potential for affective development to higher-order, affective objectives resulting in greater internalisation of values, even to the extent of realising objectives not normally considered to be within the range of secondary school educational objectives.

Most/...

Most of the pupils in the control group should be able to potentially realise level 2.3 in their affective development as a result of their study programme; finding pleasure and enjoyment in the work they are involved in. This interest is closely linked to the fact that practical work and demonstration of specimens encourages them to notice as much as possible when examining specimens. It is unlikely that they would reach this level (2.3) by a lecture method alone.

This author does not believe that the study programme followed by the control group and generally referred to as the normal educational experience will be able to elicit affective development at the valuing (3.0) level of the hierarchy, for the average pupil.

2. <u>The additional "affective" potential of the experimental programme.</u>

In Table 4.4 it is clear that the experimental programme has greater potential for affective development than the control group programme.

This extra "affective potential" should provide more opportunities for value formation as the bulk of the extra objectives fall into the "valuing" category.

In/...

In Table 4.5, the extra "affective potential" is analysed in terms of the different aims or attitude clusters of the prescribed syllabus.

AFFECTIVE CLASSIFICATION	3.1	3.2	3.3	4.1	4.2	5.1	5.2
ECOLOGICAL AIM	●	●	●	●	●		
ROLE OF BIOLOGY AIM	●	●					
LOOKING AND THINKING AIM	●	●	●				
SCIENTIFIC METHOD AIM	●	●	●				
READING AIM	●						
CONSERVATION AIM	●	●	●	●	●		

Table 4.5 - <u>The additional "affective potential" of the experimental programme analysed in terms of the six aims.</u>

——— This line indicates the maximum level attained in terms of internalisation by the affective objectives of the syllabus as listed in Chapter 5.

(a) Level 3.1 - Acceptance of a value.

This is the only level of objectives that is achieved uniformly across all six aims by the content material of the experimental programme.

As such the importance of the content cannot be underestimated. Objectives realised at this level affect the pupils' <u>beliefs</u> related to the six aims. Beliefs are the first essential components of attitude formation and change.

(b)/...

(b) Level 3.2 - Preference for a value.

Likewise almost all syllabus aims are realised at level 3.2 by the content of the experimental programme. The notable exception is in the reading aim, where level 3.2 represents the very highest limit of the affective objectives. It was felt it would be a little premature to expect this study programme to realise so much affective development in the pupils, namely; "The pupil prefers to read authoritative, accurate accounts rather than popular biased accounts". (12)

While this might prove to be true of one or two pupils, it is more likely to be the result of exceptional personal maturity rather than the effectiveness of this programme. The fact that level 3.2 can potentially be realised by the content of the study programme in so many areas holds much promise of positive attitude formation over a wide spectrum of biological values.

(c) Level 3.3 - Commitment to a value.

Most syllabus aims realise their affective objectives at level 3.3 in this experimental programme, particularly the ecological aim and the conservation aim. The looking and thinking aim and the scientific method aim reach their "potential" limit at this level and thus it is unlikely that more than a few of the more affectively mature pupils will realise their full potential in this direction. The/...

(12) See Chapter 5.

The other two aims however are more far reaching in their potential for affective development within the framework of this experimental programme.

As each aim reaches it s limit of "affective potential" this author would anticipate fewer and fewer pupils reaching that level during the study programme. Theoretically it should, using more sensitive measuring instruments, be possible to draw an affective development profile for each pupil at the time of testing across the six aims of the syllabus, but this is beyond the scope of this investigation.

(d) Level 4.1 - Conceptualisation of a value
and 4.2 - Organisation of a value system.

Affective objectives at this level are not commonly constructed as part of the range of educational objectives normally realised at school. However, this author believes that the experimental programme outlined in this chapter has the "affective potential" to promote affective development to these levels in some of the more developed pupils. It is not surprising to find that a syllabus so implicitly environmental in it's aims should, when employing an environmental approach, realise it's full "affective potential" in those aims that are specifically environmentally orientated, namely; the ecological aim and the conservation aim. Level 4.1 and 4.2 constitute very high levels of internalisation and the attitudes learned at level 3.0 are by this stage completely integrated and related to other attitudes in the personal value system.

Once/...

Once again perhaps only one or two pupils will have had the prior affective development necessary to reach these levels.

There is no research substantiation for the common belief that attitudes form only slowly over many years. It may prove to be the case that pupils develop rapidly to their maximum affective potential, but more research work remains to be done in this area.

The purpose of this investigation is to establish whether or not more of these affective objectives are realised by the experimental group as a whole than by the control group as a whole.

This analysis has shown that while the two programmes are very similar in terms of cognitive development they have very different "affective potential" in terms of the aims of the syllabus.

CHAPTER 5

CLARIFICATION OF OBJECTIVES IN TERMS OF THE AFFECTIVE DOMAIN

CHAPTER 5 - CLARIFICATION OF OBJECTIVES IN TERMS OF THE AFFECTIVE DOMAIN.

A. THE OBJECTIVES CONTROVERSY

Since the early 1960's there has been a "curriculum explosion" which has included the increased proliferation of new science and biology courses. Much research has been devoted to structuring these curricula and setting up educational objectives.

At present there appear to be two distinct schools of thought on the setting up of objectives and a third less well-defined school that seems to be seeking a compromise position.

1. General Objectives

This group shows a preference for broad aims, goals or directions, intentionally stating it's objectives in broad, vaguely worded statements of a multi-dimensional nature. When these aims are examined they are usually found to be "objective-clusters" that can be very widely interpreted.

Zahorick (1) points out that he believes this practice to be more moral than the stating of specific objectives because:

(1)/...

(1) Zahorick J.A., "The virtue of vagueness in instructional objectives", Elementary School Journal Vol. 76. (1976).

(1) there is less manipulation of pupils to predetermined ends; (2) there is less chance of ultimate indoctrination and more personal freedom. He also points out that general objectives provide greater student freedom to set their own goals and so provides for better motivated learning. Finally he discounts the possibility of being able to predict learning outcomes in advance with any certainty. X

Many of the older science courses are still based on these assumptions voiced by Zahorick. Often there are no detailed instructions as to how these aims are to be achieved as it is usually thought that provided the content learning tasks are properly assigned and tested, the general objectives will be achieved automatically.

The Cape Education Department's Senior Biology Course provides a set of six aims that illustrate an example of general objectives:

... SENIOR SECONDARY COURSE : BIOLOGY (Higher Grade)

1. To guide pupils to an understanding and an appreciation of the interdependance of living things (especially man) and their relationship to the physical environment;
2. To teach pupils to appreciate how the development and application of scientific knowledge affects the progress of civilisation;
3. To excite pupils' interest in biological phenomena, to promote their powers of observation and to stimulate imaginative thinking;
4. To enable pupils to grasp the scientific method of approach and to cultivate habits of logical and systematic thinking in them;
5. To cultivate a desire in pupils to read more widely and more deeply on biological matters;
6. To foster in pupils a love for the South African fauna and flora and to stress the vital importance of nature conservation. ...

Cape Education Department (2)

While these goals in themselves are somewhat vague, closer examination of them later in this Chapter will reveal them to be very all-inclusive in their potential interpretation. However, as with many other science courses the reality of the evaluation procedure severely limits their broader interpretation to the lower levels of the cognitive domain:

> The methods of evaluation of pupils' progress should reflect an emphasis on facts being understood, interpreted and applied rather than on the mere memorisation of the bare facts . (C.E.D. 1973)

There is no testing of any of the many affective objectives that are mentioned or are implicit in these aims.

Too/...

(2) Cape Education Department., Senior Secondary Course: Syllabus for Biology (1973).

Too often they are assumed to be unevaluated by-products of cognitive objectives. So these aims can be likened to Dressel's (3) academic discipline goals. Teachers present a discipline to their class who in turn have to master the skills, principles and terminology of the subject. There are several current Biology courses that are based in reality on this rather narrow orientation, amongst others:

The Scottish Integrated Science Course and

Nuffield O-level Biology Course

Teachers who are involved in teaching these courses are usually surprised at the need for stating more specific educational objectives as being self-evident and irrelevant to the classroom realities. The Nichol s (4) point out that general objectives will always be more popular and so receive wide-spread support because they leave each teacher free to give his or her own meaning to them. Zahorick (5) defines the general objective as differing from the more specific behavioural objective with respect to three dimensions:

Table 5.1/...

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(3) Dressel P.L., "The nature and role of objectives in instruction", Educational Technology. Vol. 17. No. 5 (1977)

(4) Nichols, H. and Nichols, A., Creative Teaching. (1975)

(5) Zahorick J.A., (1976) Op. Cit.

DIMENSION	GENERAL OBJECTIVES	BEHAVIOURAL OBJECTIVES
FOCUS	Broad	Narrow
FORM	Topical	Behavioural
TIME	Remote	Immediate

Table 5.1 The nature of instructional objectives.
Adapted from Zahorick (1976).

According to the definitions above the C.E.D's aims are typical general objectives.

2. Specific Behavioural Objectives.

As part of the rapid curriculum development of the past twenty years, there has been a definite move towards more specific objectives, particularly in America. The supporters of this movement insist that educational objectives be stated in behavioural form in order that the rate of growth, change or development taking place can be measured. That these behavioural objectives are narrower, immediate and behavioural in form as Zahorick claims can be seen when considering Kibler's (6) identification of the elements of a behavioural objective:

Behavioural objectives state-

1. Who performs the desired behaviour.
2. The actual behaviour to be employed.
3. The results which will be evaluated.
4. The relevant conditions under which the behaviour is to be performed.
5. The standard that will be used to evaluate it s success.

This/...

(6) Kibler, R.J. Barker, L.L. and Miles, D.T., Behavioural Objectives and Instruction. (1970).

This definition is widely accepted, Dressel (7) supplying a similar definition. These precise statements of intention have earned widespread support and condemnation alike.

Dressel claims that traditional education has failed to state effective operational objectives; a shortcoming that Mc Ashan (8) points out could be made good by stating more precise objectives. The question as to exactly how precise these improved objectives are to be is not considered by these authors, it being implied that the only alternative to broad aims are behavioural objectives.

Mc Ashan claims that behavioural objectives help to:

1. Avoid duplication in content of course objectives.
2. Prevent course content proliferation caused by uncertainty of objective limits.
3. Make students aware of what is expected in terms of achievement.
4. Improve assessment of achievement.
5. Increases student motivation.
6. Assure students of the relevance of the study to life situations.
7. Improve the competency of teachers.

Even/...

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(7) Dressel P.L., (1977), Op. Cit.

(8) Mc Ashan H.H., "Behavioural objectives : The history and the promise," Educational Technology. Vol. 17. No. 5. (1977).

Even if all these assumptions could be shown to be true and most of them can be, the problem still remains of the classroom teacher faced with thousands of precise, specific objectives that the majority of their class must succeed in achieving. Where this very literal approach is being implemented there is much evidence of teacher frustration.

Not all supporters of the behavioural movement share this literal interpretation. Mc Ashan and the Nichol s agree that most behavioural objectives need redefining in more practical terms. While they do embody the promise of improved courses, better evaluation, increased motivation and higher levels of teacher competency, in their present form they are of little use in selecting syllabus content or organising it in a meaningful way. Mc Ashan sees them as constituting a necessary stage in the process towards more effective educational objectives.

The negative side of the behavioural objectives argument is brought into focus by the comments of Dressel (9); Mc Ashan (10); Nichol and Nichol (11); Ojemann (12) and Zahorick (13).

The/...

(9) Dressel P.L., (1977), Op. Cit.

(10) Mc Ashan H.H., (1977), Op. Cit.

(11) Nichols, H. and Nichols, A., (1975). Op. Cit.

(12) Ojemann R.H., "Should educational objectives be stated in behavioural terms?," Elementary School Journal. Vol. 74. (1974).

(13) Zahorick J.A., (1976). Op. Cit.

The shortcomings are summarised as follows:

(a) They are limited in form to behavioural outcomes.

(i) They only measure observable behaviour. (e.g. Lower order cognitive and psychomotor learnings that are usually of a trivial nature.)

(ii) They do not measure affective learnings as overt behavioural outcomes may not necessarily be duplicating real learning outcomes.

(iii) Broad integrative objectives are ignored.

(b) They are difficult if not impossible to use.

In fairness it should be noted some of these criticisms could also be applied to general objectives:

eg. (a) Note the emphasis on lower order cognitive learning in the C.E.D. evaluation guide.

(b) Note the lack of measurement of affective learnings in the C.E.D. evaluation guide.

3. Intermediate Objectives.

Commenting on the gulf between general and behavioural objectives, Nisbet (14) stressed the need to find intermediate objectives in 1957, but there is little evidence in the literature to show that this suggestion was widely accepted.

More/...

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(14) Nisbet S., Purpose in the Curriculum. (1957)

More recently Dressel (15) has suggested that it is possible to state objectives more precisely without going as far as the rigorous behavioural definition of an educational objective. He lists six competency objectives which he elaborates into families of educational objectives:

1. The student should know how to acquire knowledge and know how to use it.
2. The student should have a high level of mastery of the skills of communication.
3. The student should have a consciousness of his or her values and value commitments and an understanding of the values of others.
4. The student should be able to co-operate and collaborate with others in problem-solving and plans of action.
5. The student should be aware of / concerned about / feel responsible for contemporary events, issues and problems.
6. The student should have a concern for the ability to organise or integrate knowledge, abilities and values.

It will be noted that these objectives do not fit into Zahorick's (16) neat definitions of general or behavioural objectives. While they are in some senses remote in time, in other senses they are immediate. They may not be strictly behavioural in form but they do affect behaviour that can be observed. They contain cognitive and affective learnings. Their usefulness will depend on the detail provided in each objective family.

4/...

(15) Dressel P.L., (1977). Op. Cit.

(16) Zahorick J.A., (1976). Op. Cit.

4. The implications for this investigation.

Much good has come out of the behavioural objectives movement. It has made us aware of the need for more precise objectives in order that the traditionally assumed and non-observable learning outcomes stated in our vague, broad aims may be tangibly seen to be achieved in related behavioural outcomes.

However, much more attention needs to be devoted to the clarification of intermediate rather than immediate objectives so that classroom teachers can link their immediate objectives (behavioural or otherwise) with the broad aims of the syllabus. Dressel's competency objectives are a positive move in this direction. Without these gap-bridging intermediate objectives classroom teachers will continue to wonder if their immediate objectives are really satisfying the thrust of the broad aims of the course in any effective or balanced sense of the word.

In this Chapter an attempt has been made to supply the missing intermediate objectives relating to the affective learning outcomes as implied by the main aims of the C.E.D. Senior Biology Course.

B./...

B. THE CLASSIFICATION OF EDUCATIONAL OBJECTIVES.

There have been three major attempts to bring order to the development of educational objectives in the last twenty years. All three attempts have assumed that learning outcomes can be ranked hierarchically thus making it possible to classify any educational objective in it s appropriate level in the cognitive, affective or psychomotor domain.

1. The Cognitive Domain

Bloom's[17] cognitive taxonomy is perhaps the classification system that has the most universal applicability, although not all of it s assumptions, particularly it's hierarchical nature, are accepted by all.

Bloom classified cognitive learning outcomes from simple recall through a range of increasing complexity to highly original and creative combination and synthesis of new ideas and materials.

This domain was certainly the most easy to classify as educators have much expertise in evaluating cognitive learnings. While this taxonomy is widely used at it's lowest levels i.e. I.0 Knowledge; 2.0 Comprehension; 3.0 Application - research has shown that the hierarchy of increasing complexity is not as powerful in it s three upper levels as in it s three lower levels. (18)

There/...

(17) Bloom B.S., Taxonomy of Educational Objectives : Handbook 1 : Cognitive Domain. (1956).

(18) Transvaal Education Department, Information Sheet : Biology (1975).

There is much difference of opinion as to the exact classification of cognitive objectives at the levels of 4.0 Analysis; 5.0 Synthesis; and 6.0 Evaluation.

2. The Affective Domain.

The affective domain taxonomy (19) was much more hesitantly proposed as a far greater degree of uncertainty prevailed amongst educators concerning the measurement of affective behaviour. However, it's originators felt that a continuum of affective components did exist ranging from simple awareness of phenomena to a sophisticated philosophy of life. As a person's level of affective response moves to higher levels in the continuum, the given phenomena or values are increasingly absorbed into the structure of personality, modifying and refining it. Bloom himself was far from satisfied with the taxonomy, comparing it to "folklore" in comparison with the exact definitions of the cognitive domain. While it is possible to classify objectives in all 5 levels of the taxonomy, in practice most affective objectives fall into categories 2.0 Responding; 3.0 Valuing and 4.0 Organisation. Much of level 5.0 is widely considered to be beyond the range of formal education.

Some/...

(19) Bloom, B.S., Krathwohl, D.R. and Masia, B.B., Taxonomy of Educational Objectives : Handbook 2 : Affective Domain. (1964).

Some research workers reject these two taxonomies completely. For example, Ormell (20) rejects all facets of Bloom's two taxonomies as being a limited and inadequate interpretation of reality for many subject disciplines including Biology. Ormell does not recognise separate distinctions between the taxonomies and believes that they are so completely dependent on each other as to make classification impossible.

Others (Mc Ashan (21) and Harrow (22)) accept the truth of this statement but insist that it is still necessary to formulate meaningful objectives in terms of the three domains.

3. The Psychomotor Domain.
Harrow's psychomotor domain (23) consists of the recognition of all six major levels of increasing sophistication of body movement. They are further subdivided into 64 subsections thus effectively ensuring the more precise classification of psychomotor objectives, but in so doing making the classification less flexible to wider interpretation.

This/...

(20) Ormell C.P., "Bloom's Taxonomy and the objectives of education", Educational Research. Vol. 17. (1974).

(21) Mc Ashan H.H., (1977), Op. Cit.

(22) Harrow A.J., Taxonomy of the Psychomotor Domain. (1972).

(23) Harrow A.J., (1972). Op. Cit.

This author found great difficulty in applying this taxonomy to Biology. The taxonomy of the psychomotor domain proposed by Harrow is based on the chronological psychomotor development of a normal child from earliest years and it is doubtful whether this taxonomy will find much use outside the field of physical education.

It is however possible to write psychomotor objectives for Biology from a selection of some of the sublevels, namely 3.0 Perceptual Abilities; and 5.0 Skilled Movements - but the inability of the taxonomy to accomodate any Biology objectives in level 4.0 Physical Abilities causes this author to have reservations concerning the validity of the hierarchical nature of this taxonomy.

This author also found that a biologist and a physical educator would not be able to write psychomotor objectives of the same degree of difficulty at the same levels e.g. 3.21 Visual Acuity.

This also raises doubts as to the universal usefulness of this taxonomy. Notwithstanding the above reservations, Harrow's taxonomy does serve to illustrate a variety of different psychomotor learnings and this facilitates the writing of psychomotor objectives.

Table 5.2/...

✓

COGNITIVE	AFFECTIVE	PSYCHOMOTOR
6.0 Evaluation		6.0 Non-discursive
5.0 Synthesis	5.0 Characterisation	5.0 Skilled Movement
4.0 Analysis	4.0 Organisation	4.0 Physical Abilities
3.0 Application	3.0 Valuing	3.0 Perceptual Abilities
2.0 Comprehension	2.0 Responding	2.0 Basic Fundamental Movement
1.0 Knowledge	1.0 Receiving	1.0 Reflex Movement

Table 5.2 The main categories into which instructional objectives can be classified. (From: Bloom (1956); Bloom, Krathwohl and Masia(1964); Harrow (1972).

It should be noted that while a high level of cognitive attainment may be reached in one domain there is no certainty that a similar level may be reached in another domain, yet many learnings are achievements that can be measured in all three domains.
The doubts expressed in this report are summed up in the following table.

COGNITIVE	AFFECTIVE	PSYCHOMOTOR
6.0 ?		6.0 ?
5.0 ?	5.0 ?	5.0 Skilled Movement
4.0 ?	4.0 Organisation	4.0 ?
3.0 Application	3.0 Valuing	3.0 Perceptual Ability
2.0 Comprehension	2.0 Responding	2.0 ?
1.0 Knowledge	1.0 Receiving	1.0 ?

Table 5.3 Areas of uncertainty regarding the classification of instructional objectives.

This author felt that used with caution these three domains could serve as a model for illustrating the variety of educational objectives needed to contruct a balanced Biology course.

4. The Implications for this investigation.

Bearing in mind the reservations expressed concerning the Affective Domain Taxonomy proposed by Bloom et al., this author has made use of the major categories outlined above to help identify affective objectives at increasing levels of internalisation and grade them according to Bloom's definitive categories. The decision to concentrate on the affective domain was justified by the fact that using two different teaching strategies it is impossible to ensure that cognitive and psychomotor experiences would be identical for both groups although every effort would be made to match the cognitive experiences as closely as possible.

Thus/...

Thus in an effort to ensure unidimensional testing of affective learning outcomes, no cognitive or psychomotor objectives were identified for the purpose of investigation.

C. THE CONSTRUCTION OF INTERMEDIATE AFFECTIVE OBJECTIVES FOR THE CAPE EDUCATION DEPARTMENT'S SENIOR BIOLOGY COURSE.

In Chapter One (Section 3(b)) it has been pointed out that classroom teachers are unable to relate their daily tasks to the general objectives listed in the prescribed syllabus. This is in no small measure due to the lack of practical intermediate objectives. In this section the six aims of the prescribed syllabus are expanded until they are reduced to the level of intermediate objectives. Due to the nature of this investigation only the affective objectives are listed.

1. Clusters of Objectives.

The original biology course was published in 1973 (24), but in 1974 (25) it was found necessary to list a further 11 aims by way of amplification of the original 6 aims.

This author compared the two sets of aims with each other to assess the extent of overlap between them.

Table 5.4/...

(24) Cape Education Department, (1973), Op. Cit.

(25) Cape Education Department, Guide for the teaching of Biology : Higher Grade and Standard Grade in Std. 8,9 and 10. (1974)

THE AIMS LISTED IN THE 1973 SYLLABUS

THE AIMS LISTED IN THE DIFFERENTIATED GUIDE (1974)

THE AIMS LISTED IN THE DIFFERENTIATED GUIDE (1974)	1. The Ecological Aim	2. The Role of Biology Aim	3. The Looking and Thinking Aim	4. The Scientific Method Aim	5. The Reading Aim	6. The Conservation Aim
A. To understand the nature and aims of Biology as science and develop a favourable attitude.		●		●		●
B. To understand the role of Biology in everyday life.	●	●		●	●	●
C. To accumulate principles and generalisations and to arrange these in an orderly manner.				●		
D. To foster a love of the S.A. fauna and flora.						●
E. To understand Biology as a continuing historical process.		●				
F. To develop skill in experimental work.			●	●		
G. To develop skill in the application of biological principles.		●		●		
H. To develop skill in critical thinking.				●		
I. To develop skill in recognition & formulation of biological problems.	●		●	●		
J. To understand research processes & procedures in Biology.				●	●	
K. To develop skill in hypothesis formation.			●	●		

Table 5.4 A comparison of the 1973 and 1974 aims of the prescribed syllabus.

It/...

It is clear from this comparison that 5 of the 6 1973 Aims are multidimensional objective clusters. This overlap is more clearly shown if symbols are substituted for the aims as follows:

1973 Aims	1974 Aims
1.	B,I.
2.	A,B,E.G.
3.	F,I,K.
4.	A,B,C,F,G,H,I,J,K.
5.	B,J.
6.	A.B.D.

Table 5.5 The multidimensional nature of the 1973 Aims.

It was found that the degree of overlap was considerable. Many of the new aims amplified several of the older aims, and almost all of the new aims are contained in aim 4. This was taken to be a clear indication of the multidimensional nature of the six original aims.

Each aim is in reality a cluster of more specific objectives that can be expanded and clarified repeatedly into cognitive, affective and psychomotor objectives. In Table 1.4 of Chapter 1, it was shown that of the sixteen major categories of affective objectives developed in recent curriculum projects all but one of them are implicitly present in the general aims of the prescribed syllabus. Many of them apply to more than one aim.

Furthermore/...

Furthermore the aims can easily be restated at other levels of increasing specificity, as is illustrated by Figure 3.2 in Chapter 3. Clearly then all general instructional objectives contain within their broad verbal statements the potential for expansion into hundreds if not thousands of sub-objectives. As such these broad aims are referred to in this study as objective clusters and their affective sub-objectives are hence attitude or value - formative clusters.

2. Expanding the Objective Clusters.

In expanding the objective clusters to reveal their implicit intermediate objectives careful attention was paid to the exact wording of the syllabus aims. The aims were expanded by means of the hierarchical classification of the affective domain proposed by Bloom, Krathwohl and Masia. (25)

When considering these intermediate affective objectives the following points should be born in mind:

(a) No objectives were written for the 1.1 level (Awareness) because of its close similarity to the 1.1 level in the cognitive domain (Knowledge of specifics).

(b)/...

(25) Bloom, B.S. Krathwohl, D.R. and Masia, B.B., (1964), Op. Cit.

(b) Only one objective was written for the 1.2 level (Willingness to receive) as pupils in school situations have very little option not to pay attention for any length of time. In any event paying attention is hardly a suitable educational objective at secondary school level.

(c) No objectives were written for the 2.1 level (Acquiescence in responding) as this very lowest level of responding is defined as a pupil passively doing what he is told to do. As obedience is not a goal of education (Masia 1964) it was decided not to make use of this category.

(d) Two of the objetive clusters (No. 3 The Looking and Thinking Aim and No. 5 the Reading Aim) do not range beyond level 3.3 (Commitment to a value). This is due to the limited nature of these two aims.

(e) The Scientific Method Aim (No. 4) was found to contain the widest range of affective objectives. This was the only objective cluster found to contain Level 5.0 objectives. This is because it is felt that the personality of an individual can be characterised by these scientific values, so affecting the individual's approach to life.

THE INTERMEDIATE AFFECTIVE OBJECTIVES

(a) Table 5.6 The Ecological Intermediate Objectives.
(To guide pupils to an understanding and an appreciation of the interdependance of living things (especially man) and their relationship to the physical environment.)

CLASSIFICATION LEVEL		INTERMEDIATE OBJECTIVE
1.0 RECEIVING	1.3	The pupil is sensitive to the relationships between all living things and their environment.
	1.3	The pupil is aware of man's influence on living things and their environment.
2.0 RESPONDING	2.2	The pupil acquires an interest in all living things and how they relate to himself.
	2.3	The pupil enjoys learning about the interrelationships between all living things and their environment.
	2.3	The pupil develops a keen interest in discovering the habitats that living creatures occupy.
3.0 VALUING	3.1	The pupil believes that it is important to preserve the total environment of all animals and plants where possible.

3.2/...

CLASSIFICATION LEVEL		INTERMEDIATE OBJECTIVE
	3.2	The pupil assumes an active role in helping to preserve a threatened habitat.
	3.3	The pupil is convinced of the worth of trying to preserve a threatened ecological habitat.
4.0 ORGANISATION	4.1	The pupil forms judgments about society's responsibilities towards nature conservation.
	4.2	The pupil accepts the fact that often human needs must take priority over maintainance of natural habitats.

(b) Table 5.7 The Role of Biology Intermediate Objectives.

(To teach pupils to appreciate how the development and application of scientific knowledge affects the progress of civilisation.)

CLASSIFICATION LEVEL		INTERMEDIATE OBJECTIVE
1.0 RECEIVING	1.2	The pupils show an awareness of the contributions that scientists make to society.
	1.2	The pupil is aware of the inter-dependence of all branches of knowledge.
	1.3	The pupil shows an appreciation of the contributions of scientists to society.
2.0 RESPONDING	2.2	The pupil takes an interest in scientific discoveries and how they relate to society.

CLASSIFICATION LEVEL		INTERMEDIATE OBJECTIVE
	2.3	The pupil enjoys learning about new scientific discoveries that could possibly advance the progress of civilisation.
3.0 VALUING	3.1	The pupil acquires a respect for scientists working for man's improvement.
	3.1	The pupil acquires a respect for research work and it s methods.
	3.2	The pupil assumes an active role in a voluntary class research project that has obvious relevance for him/her.
	3.3	The pupil is convinced of the worth of scientific endeavour as a means of solving particular social problems.
4.0 ORGANISATION	4.1	The pupil has a balanced view of the possible contributions and limitations of science to solve society's problems.

(c) Table 5.8./...

(c) Table 5.8. The Looking and Thinking Intermediate Objectives.
(To excite pupil's interest in biological phenomena, to promote their powers of observation and to stimulate imaginative thinking.)

CLASSIFICATION LEVEL		INTERMEDIATE OBJECTIVE
1.0 RECEIVING	1.3	The pupil pays attention to biological phenomena.
	1.3	The pupil shows a willingness to speculate and consider the hypotheses of others.
2.0 RESPONDING	2.2	The pupil takes an interest in animals and plants.
	2.2	The pupil shows critical interest in hypotheses that propose creative solutions to biological problems.
	2.3	The pupil takes pleasure in debating solutions to biological problems and in imaginative solutions.
	2.3	The pupil enjoys examing specimens carefully and in fine detail, noticing as much as possible.
	2.3	The pupil keeps his own pets or plant collection or similar biological interest (shells etc.)
3.0 VALUING	3.1	The pupil acquires a respect for creative, imaginative thinking.
	3.1	The pupil acquires a respect for accurate observation.

3.2/...

CLASSIFICATION LEVEL		INTERMEDIATE OBJECTIVE
	3.2	The pupil is prepared to invest his/her own time in making detailed observations of biological phenomena.
	3.3	The pupil is devoted to the ideal of accurate observation.
	3.3	The pupil feels a sense of creative frustration over unsolved problems, that drives him to further investigation.

(d) <u>Table 5.9.</u> <u>The Scientific Method Intermediate Objectives.</u>
(To enable pupils to grasp the scientific method of approach and to cultivate habits of logical and systematic thinking.)

CLASSIFICATION LEVEL		INTERMEDIATE OBJECTIVE
1.0 RECEIVING	1.3	The pupil shows a willingness to consider rational answers (cause and effect) in the face of traditional superstition.
	1.3	The pupil shows a willingness to subject his opinions to critical judgment and hypothesis testing.
2.0 RESPONDING	2.2	The pupil shows an interest in the results of experimental work.
	2.2	The pupil shows an interest in the hypotheses and criticisms of others.
	2.2	The pupil shows an interest in logical arguments as an approach to problem solving.

2.2/...

CLASSIFICATION LEVEL		INTERMEDIATE OBJECTIVE.
	2.2	The pupil shows an interest in the ways in which scientists work.
	2.3	The pupil shows an interest in formulating and testing his own hypotheses.
	2.3	The pupil debates for pleasure the solutions to problems demanding logical and systematic thinking.
	2.3	The pupil shows obvious pleasure in the logical and systematic organisation of his work.
3.0 VALUING	3.1	The pupil does his own experimental work at school on an unsolicited voluntary basis for interest's sake alone.
	3.1	The pupil rejects dogmatism in favour of retaining an open-mind.
	3.1	The pupil shows respect for the results of the experimental work of others.
	3.1	The pupil tolerates and accepts objective criticism of his own hypotheses and work. He is aware of his limitations and is prepared to suspend judgment in humility and caution.
	3.1	The pupil respects accurate scientific reporting and recording.

CLASSIFICATION LEVEL	INTERMEDIATE OBJECTIVE
3.2	The pupil is prepared to spend some of his holiday time investigating biological phenomena for interest's sake alone.
3.2	The pupil rejects biased scientific reporting with contempt.
3.2	The pupil is prepared to accept responsibility for scientific investigation of obvious relevance.
3.3	The pupil is convinced of the value of the scientific approach to problem solving.
3.3.	The pupil shows scepticism in the face of facile solutions.
4.0 ORGANISATION	
4.1	The pupil tries to apply the scientific method of problem solving to problems in areas other than science.
4.2	The pupil has a realistic acceptance and understanding of the assumptions and limitations of the scientific method.
4.2	The pupil appreciates the dynamic nature of science and that there is always the possibility of new discoveries invalidating old hypotheses.

CLASSIFICATION LEVEL		INTERMEDIATE OBJECTIVE
5.0 CHARACTERISATION	5.1	The pupil shows a willingness to reconsider and if necessary change his/her mind when confronted with new factual evidence that negates his/her previously held theories.

(e) Table 5.10. The Reading Intermediate Objectives.
(To cultivate a desire to read widely and deeply on biological matters.)

CLASSIFICATION LEVEL		INTERMEDIATE OBJECTIVE
1.0 RECEIVING	1.3	The pupil is alert to biological news.
2.0 RESPONDING	2.2	The pupil is interested in articles of a biological nature in popular form - T.V.; radio; newspapers; paperback science books; well illustrated magazines.
	2.3	The pupil develops a keen interest in reading up a particular aspect of biology.
	2.3	The pupil is prepared to use scientific periodicals to follow up his interest.
3.0 VALUING	3.1	The pupil believes that scientific writing is more truthful than most other sources.

3.1/...

CLASSIFICATION LEVEL		INTERMEDIATE OBJECTIVE
	3.1	The pupil is aware of and compensates for media bias.
	3.2	The pupil chooses to read biological works in preference to many others in his spare time and on holiday.
	3.2	The pupil prefers to read authoritative, accurate accounts rather than popular biased accounts.

(f) <u>Table 5.11</u>. <u>The Conservation Intermediate Objectives</u>.
(To foster in pupils a love for the South African flora and fauna and to stress the vital importance of nature conservation.)

CLASSIFICATION LEVEL		INTERMEDIATE OBJECTIVE
1.0 RECEIVING	1.3	The pupil is sensitive to the beauty of our fauna and flora.
	1.3	The pupil is sensitive to the presence of alien plants.
	1.3	The pupil is sensitive to pollution and environmental marring.
2.0 RESPONDING	2.2	The pupil wants to know more about conservation topics (alien plants/the effects of pollution).
	2.2	The pupil is interested in the variety of South African plants and animals.
	2.2	The pupil wants to know more about methods of conservation.

2.2/...

CLASSIFICATION LEVEL		INTERMEDIATE OBJECTIVE
	2.2	The pupil shows a respect for all living things.
	2.3	The pupil enjoys walking in natural and unspoiled surroundings.
	2.3	The pupil takes a pleasure in South African wild plants and animals.
3.0 VALUING	3.1	The pupil shows concern for and resentment over all forms of pollution.
	3.1	The pupil obeys the conservation laws even when by himself, and appreciates the need for them.
	3.1	The pupil takes a pride in South African wild plants and flowers.
	3.2	The pupil considers it his duty to do whatever is practical concerning pollution wherever he finds it.
	3.2	The pupil is prepared to assume an active role in nature conservation (i.e. control of alien vegetation).
	3.2	The pupil visits game reserves on his own initiative.
	3.2	Watches T.V. programmes on nature conservation and wild life whenever he can.

3.2/...

CLASSIFICATION LEVEL		INTERMEDIATE OBJECTIVE
	3.2	Attends lectures relating to nature conservation whenever possible.
	3.2	Would like to join a conservation society.
	3.2	The pupil would like to grow some wild flowers in his/her garden.
	3.2	The pupil has developed a love of South African fauna and flora.
	3.3	The pupil is incensed by acts of vandalism that result in damage to the natural environment.
	3.3	The pupil is committed to the conservation ethic and law.
4.0 ORGANISATION	4.1	The pupil appreciates and understands the distinction between conservation and preservation.
	4.2	The pupil appreciates that human needs and the conservation ideal may sometimes be in conflict and is prepared to place human priorities ahead of other ideals.

3. The implications/...

3. The implications for this investigation.

The intermediate objectives listed above are not definitive in any way. They represent this author's interpretation of the intentions of general aims of the prescribed syllabus. The method of clarification of these intermediate objectives assumes a hierarchical progression of increasing internalisation, and hence value clarification is assured. It is assumed that pupils will develop in terms of the lower order affective objectives before they reach the higher order objectives.

The affective component of the prescribed syllabus aims has been expanded above into 88 intermediate objectives as follows:

AIM	Range of Affective Objectives at intermediate level 1.0 2.0 3.0 ¦ 4.0 5.0	Total number of objectives.
1	1.3 → 4.2	10
2	1.2 → 4.2	10
3	1.3 → 3.3	12
4	1.3 → 5.1	24
5	1.3 → 3.2	8
6	1.3 → 4.2	24
		88

Table 5.12. The range of the Intermediate Affective Objectives in each objective cluster and their total numbers.

It /...

It will be noted from this table that some objectives exceed level 3.0, which is normally accepted as the upper range for affective development at school. Certainly level 5.0 is thought to be beyond the range of formal education. It has already been shown that the affective potential of these objectives is limited by the nature of the content material and the teaching strategy employed (See Table 4.4 and 4.5 in Chapter 4). In this investigation it is not anticipated that intermediate affective objectives beyond level 4.2 will be realised.

These intermediate affective objectives formed the basis of the pool of items constructed for the purpose of forming attitude scales to measure the anticipated attitude change with respect to each objective cluster. See Appendix B. The formation, testing and refinement of these scales is described in full in Chapter 7.

CHAPTER 6

THE CONSTRUCTION OF THE UNITS OF WORK FOR THE EXPERIMENTAL AND CONTROL GROUPS.

CHAPTER 6 : THE CONSTRUCTION OF THE UNITS OF WORK FOR THE EXPERIMENTAL AND CONTROL GROUPS.

A. THE PRINCIPLES OF DEVELOPMENT

1. What is Environmental Education?

The term "environmental education" is a rather vague description of the nature of this approach as it is applied to Biology teaching to say the least. It is readily confused by some as another form of nature study or outdoor education. Fieldwork and outdoor methods are generally considered to be the characteristic essential of environmental education. In this section we will see that this is not the fundamental essence at all.

Fieldwork and outdoor methods are nothing new to Biology teachers. Outdoor education is primarily concerned in interesting pupils in nature, in the "outdoor laboratory." One of the aims of nature study is to make pupils into amateur naturalists.

Environmental education goes beyond this and focusses on solving environmental problems. In the process certain basic facts have to be communicated and undoubtedly an enduring interest in nature is awakened within many pupils; but this is a fringe benefit rather than the primary aim of Environmental Education.

What then is the primary aim of Environmental Education?

Hinton and May (1) suggest this useful definition:

> Environmental education is the process of recognising values and clarifying concepts in order to develop skills and attitudes necessary to understand and appreciate the inter-relationships between man, his culture and his bio-physical surroundings. Environmental education also entails practice in decision-making and formulation of a code of behaviour about issues concerning environmental quality.

Swan (2) sums up this definition more directly:

> Environmental Education is concerned with developing informed attitudes of concern for environmental quality.

Colton (3), director of Project Environment, points out that in the past teachers sought to:

> ... discover the nature of the area under study ... through investigatory and discovery approaches; the objectives (being) chiefly cognitive ones in that the aim (was) to amass information.

That/...

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(1) Hinton, K. and May, J., The Place of Science in Environmental Education (1973)

(2) Swan J.A., "The challenge of environmental education." Phi Delta Kappan Vol. 51. No.1 (1969)

(3) Colton R.W., Education for the Environment. (1974)

That this approach, which could be described as <u>education about the environment</u> and which embraces nature study, outdoor education, field work and discovery learning, is widely practised in the Cape Province with the express approval of the Cape Education Department is indisputable.

Coupled to the above approach is the implicit belief that educating people about the environment will result in progress of an ethical nature or, in the words of this study, achievement of affective objectives. It has already been established by Shock (4) that this is an unjustifiable assumption.

Colton (5) further recognises that the formation of sound attitudes has not in the past been regarded as being within the province of academic subjects however.

> ... Rural studies teachers have been conspicuous here in their insistence (on) ... <u>educating for the environment</u> ... with an emphasis on developing an informed concern for the environment. The objectives go beyond the acquisition of skills and knowledge and require the development of involvement (as)... values are formed which affect behaviour.

Clearly/...

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(4) Shock N.H., "Analysis of the relationship which exists between cognitive and affective educational objectives", <u>Journal of Research in Science Teaching</u>. Vol. 10. No. 4. (1973)

(5) Colton R.W., <u>Op. Cit</u>. (1974)

Clearly this approach goes beyond general hoping for progress of an ethical nature and sets out positively to develop environmental awareness and concern.

From the preceding three definitions certain fundamental issues emerge:

Environmental Education .

1. Includes the amassing of factual knowledge, skills and concepts.
2. Goes beyond these cognitive objectives of education to focus primarily on the attainment of the affective objectives of education.
3. It is a definite process consisting of three discrete, sequential components namely:
   (a) Value-Clarification
   At this stage an awareness of the facts in the context of problems demanding solutions promotes the formation of beliefs about the environment.
   (b) Positive Attitude Development
   These beliefs form the basis for attitudes which are the immediate goal of environmental education.
   (c) Personal Involvement and Commitment.
   Hopefully the attitudes form the motivational bases for positive social behaviour and assumption of environmental responsibility.

It is clear from the above synopsis that the formative process outlined above matches Fishbein's(6) general theory of attitude formation fairly closely, with this reservation, that in this synoptic state it would appear as if behavioural outcomes are a direct consequence of attitudes formed.

This/...

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(6) Fishbein, M. and Ajzen, I., Belief, Attitude, Intention and Behaviour : An introduction to theory and research. (1975).

This is however an over simplification of reality and has been dealt with in Chapter Four.

It is also clear that this programme will quickly break with sterile facts and casual interests and proceed to highly relevant involvement in the learning process.
The nature of environmental education as outlined above dictates a fairly closely defined pattern of procedure as regards teaching methods.

B. THE CONSTRUCTION OF THE EXPERIMENTAL AND CONTROL PROGRAMMES.

1. The Objective Base of this Environmental Programme.
Earlier in this report Fishbein's Model of Attitude Formation was matched to the Environmental Model (See Chapter 3 , pages 87 and 88) and hence what follows is constructed on the dual bases of a psychological and the environmental model.
The three-phase process as outlined in the preceding section assumes that what constitutes sound, positive attitudes of environmental concern are clearly defined before proceeding with the programme.
On this report a full list of intermediate affective objectives has been identified in Chapter 5 as based on the existing (1973) Biology Syllabus of the Cape Education Department. The success or failure of the Environmental Programme outlined in Appendix A of this report was judged solely on the measure in which this programme succeeded in achieving these

affective/...

affective objectives, through the medium of the six attitude scales included in Appendix B.

2. <u>The Method of presenting this Environmental Programme and the Control Programme</u>.

Of the 3 components listed in the previous section this author believes that the classroom programme makes it's greatest impact at the Value-Clarification level.

The method of presentation of the programme can be readily divided into two discrete components.

(a) The Informational Base.

All beliefs are based on facts. All educational programmes share this common starting point. This essential knowledge and skill component is disseminated by means of lectures, films, slides, fieldwork and laboratory work.

Every effort has been made to balance the Control and Experimental programmes in this respect.

Table 6.1 illustrates how <u>the film materials</u> shown to the two groups was carefully matched.

CONTROL GROUP	EXPERIMENTAL GROUP
What is Ecology? (PS 762)	What is Ecology? (PS 762)
Interdependence of Pond Life (PS 294)	Animals of the Rocky Shore (PS 130)
The Community (PS 773)	The Community (PS 773)
Molluscs (PS 461 B)	Sea Shell Animals (PS 183)
The Gannets of S.A. Malagas Islands (PS 528)	Our vanishing Wilderness (PS 951c)
Baboon Ecology (PS 88B)	The Fur Seal (PS 353) or Seal Island (PS 521)

Table 6.1 <u>The films shown to the Control and Experimental Groups</u>.

All the films shown to the experimental group related to the rocky shore habitat being studied. Wherever possible a similar animal film was shown to the control group although there was not the same strong theme running through these substitute films. It was felt that the study of selected animals and plants from a single habitat in the environment was a definite characteristic of the environmental approach and hence the distinctions made in the two sets of films screened.

<u>Practical Work</u> was a feature of both programmes although the practical work done in the small groups of the environmental programme was more varied in keeping with its more highly differentiated approach.

Table 6.2/...

CONTROL GROUP	EXPERIMENTAL GROUP
Practical work relating to body structure and locomotion in: Earthworms Crabs Garden snails Fish Frogs Lizards A special (individualised) project on: Locusts	Practical work relating to adaptations to environment (in groups) in: Barnacles Limpets Sea Urchin Periwinkle Quay Louse Related to Hypothesis testing. Special skills mastered by certain groups: Survey - Animals Plants Pollution Litter Collecting Preserving Identifying Graphing Leveling Quantitative Measuring Library Research Wave mechanics Reporting

Table 6.2 The Practical Work covered by each programme.

Superficially the experimental group appears to cover more practical work, but it should be borne in mind that ability-differentiated group-work is a feature of this programme. And while more time is devoted to group work no group covers more than a small fraction of all the practical work - but all are brought up to date by report back sessions and summaries provided by the class teacher. (Full details of the practical work for the Environmental Programme are listed in Appendix A on Task sheets 1 to 9 of Unit Two and Task Sheets 1 to 7 of Unit Four.)

The/...

The acquistion of basic information is further promoted by means of <u>lectures</u> by the teacher or the group reports as indicated above.
It is intentionally dealt with last as it plays a distinctly minor role in the Environmental Programme which is pupil-centred in essence, as opposed to the Control Programme where the programme is teacher-or text-book orientated.

Both programmes commenced with an introduction to ecological relationships in order that the essential differences in the two programmes might not be contaminated by a knowledge or lack of knowledge of ecology. The only difference in this introductory course of lectures was the drawing of all the experimental group's examples from the rocky shore habitat.

The time devoted to disseminating information was roughly as follows:

CONTROL GROUP	EXPERIMENTAL GROUP
Ecological Sensitisation Programme 10 periods (Unit One)	
Systematic Lecture Series covering main animal phyla with respect to body structure and loco-motion including time allocated for practical work. (approx. 10 periods.)	<u>Unit Two</u> The First Field-Trip 1 day. <u>Unit Three</u> Follow-up to First Field-trip. 8 periods investigation 9 periods report back

<u>Unit Four</u>/...

	Unit Four The Second Field trip ½ day **Unit Five** Follow-up to Second Field Trip. 5 periods investigation 12 periods report-back.
47 periods TOTAL	46 periods

Table 6.3 The distribution of time for the dissemination of material for the experimental and control groups.

An analysis of Table 6.3 reveals that there was a basic difference of significant proportions as regards the amount of time devoted by the teacher to disseminating information.

	CONTROL GROUP	EXPERIMENTAL GROUP
Teacher disseminating information	78,7	39,1
Pupils working in groups by themselves	21,3	60,9

Table 6.4 Percentage time spent by teacher in disseminating information to experimental and control groups.

The different amounts of time spent on listening to the teacher do not necessarily indicate that a proportionate amount of learning takes place during these "teaching" sessions.

In both programmes knowledge is communication in traditional ways in the classroom and laboratory. At this point the control programme has achieved it s cognitive objectives with forthright simplicity and purpose, but whether we are hence justified in assuming that the traditional way of teaching has enjoyed an equal measure of success in achieving the all important affective objectives remains to be seen. (b)/...

(b) The value-clarification base

The process of value-clarification as identified by Stapp (7) has already been presented in Chapter 3 of this report.

In summarising Stapp's conclusions it appears there are five major sequential steps to be incorporated in any successful value-clarifying educational process.

1. Pupils are presented with an issue.
2. Pupils suggest alternative solutions.
3. Pupils consider the consequences of each alternative.
4. Pupils express their feelings about each alternative.
5. Pupils make a free choice.

This provides us with a model on which to base our methodology.

Hence the first aim of the initial establishment of a sound factual base is always to present issues as soon as possible.

Units 1, 2 and 3 in Appendix A are largely concerned with gathering and disseminating the basic information, while Units 4 and 5 are concerned with present-day real-life environmental problems or issues that can be used to provoke value-clarification.

The/...

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(7) Swan, J.A. and Stapp, W.B., Environmental Education; Strategies towards a more liveable future. (1976).

The teacher strives to stimulate debate and make sure that the class considers all the "angles" and consequences of proposed action. Each pupil must be mentally and emotionally involved in each issue. The democratic process is stressed and the role and responsibility of citizens in local government and business-life is illuminated. (Further details of handling these debates are listed on page A 125 of Appendix A).

Hinton and May (8) suggest the following list of productive questions to stimulate discussion of environmental problems:

1. Who benefits?
2. Who suffers?
3. What are the alternatives?
4. Have we enough information to make a valid judgment?
5. Do we approve of what is happening?
6. What course of action could we take in order to participate?

The groups report in turn on each issue (see Table 6.8 Unit 5 for a full list of the issues debated in the programme.) By democratic processes and group pressure solutions are proposed and evaluated. Beliefs and attitudes are formed.

Idealistically, this should lead to appropriate behavioural outcomes, but in reality the situation is somewhat more complex.

Fishbein/...

(8) Hinton K.and May. J., Op. Cit. 1973.

Fishbein (9) points out that attitudes and behaviours are not directly linked together. Attitudes lead at best to behavioural intentions that are affected by a variety of different variables.

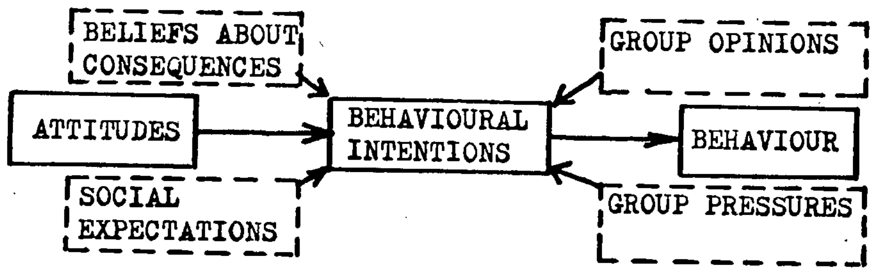

Fig. 6.1 Fishbein's Attitude Model Simplified.

Seeing that the school's contribution is thus effectively limited to value-clarification, attitude formation and behavioural intention being beyond it s scope of activities, the teacher's task is to allow values to be formed in an atmosphere of democracy and toleration.

Perhaps the role of the teacher is best summed by Swan (10) as:

> .... a midwife who allows the process of value formation to develop at it's own pace....(making) sure that the pupils learn the correct process of value clarification....

In conclusion the basic methodological differences between the control and experimental programmes could be summed up as follows:

Table 6.5/...

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(9) Fishbein M. and Ajzen, I., Op. Cit. (1975)
(10) Swan J.A., and Stapp, W.B., Op. Cit. (1976)

CONTROL GROUP	EXPERIMENTAL GROUP
The teacher is the source of learning.	The teacher is a guide to learning.
Little, if any group work.	Much emphasis on group work.
Some diversity but little differentiation.	Greater diversity and wide differentiation.
Aims at cognitive objectives only.	Aims at cognitive and affective objectives.
Assumes that affective objectives will be automatically.	Actively promotes and employs techniques that foster affective development.
Learning materials do not form a unit.	Learning material forms a unit.
Pupils do not gain experience in decision making.	Pupils gain experience in decision making.
No issues are presented.	Situations are created which demand value choices.
It is likely to leave pupils emotionally unmoved.	Opinions and attitudes are formed.

Table 6.5 Summary of methodological differences between experimental and control groups.

3. The Content presented in this Environmental Programme.

The content of the control programme and experimental programme has already been presented in this report. (See Chapter 4 pages 111 to 115a.)

Now that the methodology of the Environmental Approach has been detailed in the last section it is perhaps appropriate at this stage to elaborate on the content of the experimental programme in greater detail.

As pointed out, there is a special emphasis on the increased role of ability-differentiated groups.

The task allocated to each group demands special abilities, and there is a definite gradient of increasing difficulty from Task 1 allotted to Group 1 and Task 9 allotted to Group 9.

Before/...

Before the pupils were assigned to groups according to ability natural leaders or spokesmen were assigned to each group.

Time allocated for completing the tasks was appropriate therefore to the group's task and abilities.

Table 6.6 /...

Table 6.6 The group assignments for units 2 and 3. (Information gathering phases).

GROUP	ABILITY DIFFERENTIATION	FIRST FIELD -TRIP TASKS	LABORATORY INVESTIGATION	REPORT-BACK
1	Routine Collection	Mapping the Zonation of shore.	Experiment with limpets and wave exposure.	Zonation, Exposure and limpets.
2	Routine Survey and Microscope work.	1. Shore Bird survey. 2. Plankton collection.	Microscopic identification of plankton.	Shore birds and plankton; their role in the food chain.
3	Routine counting.	1. Recolonisation 2. Pyramid of numbers.	Whelk radula studies.	Adaptation and feeding of pool fish.
4	Collecting and use of keys.	Animal collection.	Identification and display of collection.	Adaptation and structure of the Sea Anemone.
5	"	Seaweed collection.	"	Adaptation and structure of the Bristle Worm.
6	Collecting microfauna.	1. Pool and Gully collection. 2. Drift line survey.	Identification. Mapping. Habitat selection experiment.	Secondary communities. Habitat selection. Crabs: Their structure and role in food chain.
7	Accuracy and notation.	1. Belt transect. 2. Barnacle exposure.	Graphing, Quantitative Distributions.	Barnacle structure and feeding.
8	Artistic and photographic skill.	1. Photographic record. 2. Wave Action Study.	Display of photographs. Construction of Coastal Erosion Model.	The effect of wind and waves on the shore.
9	Accuracy and careful observation.	1. Levelling transect. 2. Seaweed microfauna.	Transect Profile, Identify microfauna.	Report on microfauna of the Kelp holdfast.

Table 6.7/...

Table 6.7 The group assignments for units 4 and 5.
(Value-clarification phase).

GROUP	SECOND FIELD-TRIP TASKS	LABORATORY INVESTIGATIONS	REPORT-BACK	ISSUE DEBATED
1 2	Litter Survey	Map of litter distribution Wall chart of litter distribution. Display of litter.	Coastal litter and it s effects.	Measures to control litter-bugs and construction of a code of conduct.
3 4	Impact of the Railway Line.	Map of impact of railway line on area.	The impact of the S.A.R. on the life of the coastal strip.	The desirability of the rail link with Simonstown.
5	The sewage disposal plant.	Map of drainage and sewers.	Effects of sewerage system on public health and leisure facilities in area.	Action to be taken re: sewage disposal and it's consequences.
6	The sewage pollution.	Sensitivity of indicator species to sewage pollution.	Effects of sewage pollution on shore life in area.	Film screened. Effects of poisons and vested interests.
7	Environmental marring.	Map of objects marring the environment. Illustrated with photos.	Environmental marring in the area.	Improving the coastal strip.
8	Casual uses and photography.	Assisting another group.	Casual uses of the coastal belt. The arguments for culling seals.	Film screened. Vote on seal-culling - proposed action.
9	The industrial pollution threat.	Sensitivity of indicator species to industrial pollution.	The threat of pollution to our coasts.	Conservation in the sea. Oil pollution and whale extermination.

An examination/...

An examination of Table 6.6 will reveal how the combined efforts of the nine groups collectively covered the main marine phyla resident in the habitat, in the process establishing a sound, factual base which could be examined cognitively at a later stage.

The last two and a half weeks of the experimental programme were devoted to value clarification. The groups were again assigned a task (see Table 6.7) which covered the major environmental issues represented in the study area, while the debates ranged over a much wider spectrum of environmental concern.

Table 6.8 summarises the sequence of activities by Units of work and thus forms a rough table of contents for Appendix A which was designed as a teacher's manual for this experimental programme.

Table 6.8/...

Table 6.8 Detailing the Units of Work.

UNIT 1:	-THE ECOLOGY OF THE INTER-TIDAL ZONE OF THE ROCKY SHORE. An introduction to ecological relationships.
UNIT 2:	-FIELD-TRIP ONE : TO INVESTIGATE THE ECOLOGICAL RELATIONSHIPS ON THE ROCKY SHORE. A survey of the abiotic and biotic factors operating on the rocky shore.
UNIT 3:	-THE LABORATORY FOLLOW-UP OF THE FIRST FIELD-TRIP. Small group investigations of: - Zonation on the Rocky shore. - Correlations of shell thickness and exposure. - Molluscan body structure. - Shore-bird life. - Plankton, it's role in the food chain. - Adaptation in Klipfish. - Identification of animals and plants. - Adaptation in the Sea Anemone. - Adaptation in the Bristle Worm. - Mounting and preserving methods. - Mapping secondary communities. - Habitat selection in crustacea. - Structure of the Shore Crab. - Adaptation in Barnacles. - Distribution graphs. - Wave-action studies. - Wind effect studies. - Leveling and profile drawing. - Micro fauna of Kelp holdfasts. - Life in the drift line.
UNIT 4:	- FIELD-TRIP TWO : TO INVESTIGATE THE EFFECTS OF HUMAN USE OF THE SHORELINE. The site will be revisited to study the human uses of the shore line with special reference to:

The/...

- The litter problem.
- The impact of the railway line on the environment.
- The implications of the sewerage disposal system for the environment as a whole.
- Environmental marring.
- Casual users of the shore and their influence on shore life.
- The oil pollution threat to the rocky shore.

UNIT 5: THE FOLLOW-UP OF THE SECOND FIELD-TRIP.

- Reports are presented on all the data collected in Unit 4.
- Teacher sums up after each report. The class make decisions on the following issues:
- Measures to control littering.
- A code of conduct for beach users.
- The desirability of maintaining a rail link with Simonstown.
- Public action to be taken as regards the disposal of sewage in the area.
- The effects of poisons and the role of vested interests.
- The cost and desirability of environmental improvement.
- Conservation and the proper use of marine resources.

4. The Format adopted for the presentation of this Environmental Programme.

Apart from the sequence of this programme which was obviously closely linked to the environmental experience identified by Bennett (11) in Chapter 1 in order that it should conform to Klausmeier's (12) series of eight steps for the learning of positive science attitudes; there were several other reasons for adopting this format as outlined in Table 6.8 (The full programme forms Appendix A of this report.)

1. A desire to provide material in living form rather than as digested from a single text book.
2. To provide the teacher's manual in loose leaf binding to allow the teacher freedom to extract pages for duplicating, editing, adding up-to-date material and, in short, providing the nucleus of a dynamic resource collection based on the rocky shore.
3. To encourage the teacher to make full use of the small group method by providing full details of tasks and advance warning of laboratory work and reports expected.
4. To present a highly differentiated sequence of tasks suited to a range of abilities.
5. To incorporate skills learned in other subjects and promote transfer of training.
6. To expose pupils to newspaper materials written for the general public.
7. To use government publications where appropriate to show the role of the Government acting on behalf of the public in these issues.
8. To permit a variety of viewpoints to help pupils assess the validity of the evidence.
9. To provide a high, personally relevant approach to the teaching of biology and so stimulate latent interest and awaken dormant attitudes.

10/...

(11) Bennett D.B., "Evaluating Environmental Education Programmes," Environmental Education : Strategies towards a more liveable future. (1974)

(12) Klausmeier H.J., Learning and Human Activities : Educational Psychology. (1961).

10. To provide a wider range of educational experience than could be successfully handled in the traditional approach.

Thus this relatively new approach to biology teaching was found to be wide enough to cope with the man-made environment, water pollution, environmental marring, irresponsible use of pesticides, waste disposal and other environmental issues within the framework of the existing examination system, while making significant positive efforts to actively achieve the affective objectives of the syllabus as well.

CHAPTER 7

THE REPORT ON THE PILOT TRIALS OF THE ATTITUDE SCALES

CHAPTER 7 : THE REPORT ON THE PILOT TRIALS OF THE ATTITUDE SCALES

A. THE CONSTRUCTION OF THE SCALES.

1. The Background to the construction of the scales.

Much has already been documented in this report relating to the construction of the scales found in Appendix B. At this point it would perhaps be appropriate to trace the stages in their development to obtain a clear overall picture.

Since 1954 there has been an increasing swing towards the construction of affective-rich syllabus objectives at the expense of cognitive objectives.

This has undoubtedly been motivated by the awareness of increasing negative attitudes as pupils mature in cognitive behaviours.

Certain "mile stone" research papers have done much to focus our attention on attitude formation and successful teaching strategies.

Shock (1) has shown that it is a mistake to assume that sound affective development is taking place automatically as we persue cognitive objectives.

Lowery/...

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(1) Shock N.H., "Analysis of the relationship which exists between cognitive and affective educational objectives." Journal of Research in Science Teaching Vol. 10. No. 4 (1973)

Lowery (2) found that the only way of achieving affective objectives was to adopt a successful attitude-teaching strategy.

Fraser (3) and Simmons and Esker (4) identified these successful strategies as the environmental approach and the process approach to science teaching.

Simon and Harmin (5) claim that the teaching of values is the "new science" of the 1970's.

This sudden interest in attitudes and values has created a demand for measuring techniques that could ascertain whether or not teaching strategies are realising affective objectives.

The work of several social psychologists has added new meaning to the search for attitude measuring instruments, particularly that of Likert (6)and Thurstone (7).

Only/...

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(2) Lowery L.F., "An experimental investigation into the attitudes of 5th grade students towards science." School Science and Mathematics Vol. 67. No. 6. (1967).

(3) Fraser B.J., "Are ASEP pupils achieving the aims"? The Australian Science Teachers' Journal Vol. 22. No. 3. (1976)

(4) Simmons J. and Esker W., "Investigating the attitudes towards science fostered by the Process Approach Programme." School Science and Mathematics. Vol. 72. (1972)

(5) Simon S.B. and Harmin M., "Subject matter with a focus on values." Educational Leadership. Vol. 26. No. 2 (1968).

(6) Likert R., "A technique for the measurement of attitudes." Archives of Psychology No. 140. (1932)

(7) Thurstone L., The Measurement of Values. (1963)

Only recently have social psychologists arrived at a general conceptual framework that accomodates the leading theories of attitude formation. (8)

What still hampers educational research workers seeking to measure the attitudes of experimental groups, is not the measuring techniques but rather agreement on what objectives to measure. The two extreme schools of thought supporting Immediate Behavioural Objectives on the one hand and Broad aims on the other hand are beginning to create an awareness of the possibility of the practical intermediate objectives called for by Nisbet (9) in 1957.

2. The Origin of the Scales.

This author having been aware for some time of the apparent paradox existing in the discrepancy between the aims and recommended method of the Cape Education Department's Biology Syllabus and it s sequence and statement of prescribed content concluded independently that:

1. The content of the said syllabus ought to be reworked along environmental lines to achieve the clear statement of affective objectives listed in the six broad aims.
2. The aims themselves needed to be expanded at an intermediate level to promote successful affective teaching and evaluation.

In/...

(8) Fishbein M. and Ajzen I., Belief, Attitude and Intention: An Introduction to Theory and Research. (1975).

B. THE PURIFICATION OF THE SCALES.

1. Pilot Trial One

(a) The Organisation of Pilot Trial One.

Oppenheim (12) has described the act of item analysis of attitude scales as,

"...an act of faith...rather like trying to pull ourselves up by our own bootstraps. ... (a) procedure not uncommon in the field of mental measurement..."

The problem emerges that purification of the scales should take place by correlating each item with some reliable outside criterion. It is just the lack of these reliable criterion groups that make it so difficult to establish any sort of validity for the scales.

Having constructed the 166 items based on the 84 intermediate affective objectives this author sought to establish the content validity of the scales by approaching five local biology teachers in the hope that they would be the closest approximation available to a stable criterion group.

One obvious problem at this stage was the scale items were designed for Standard 8 pupils not adults.

The/...

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(12) Oppenheim A.N., Questionnaire Design and Attitude Measurement. (1966)

The 5 judges were asked to respond as science teachers, thus acting as a criterion group, but to use their imagination for those items that were more specifically directed towards the younger age group.

In order to protect these judges from feeling they were "affectively evaluated" they were asked to return their response sheets through the mail in such a way as to preserve their anonimity.

The author had anticipated, in accordance with the Likert technique, certain "correct" responses to each item and accordingly classified each item as being a favourable or unfavourable attitude statement.

Each judge received a photocopy of the entire item pool listed in appendix B minus the classification of affective objectives and evaluation of favourable/unfavourable statements.

Favourable statements were those items where agreement was considered to be a favourable response.

In these cases the items were scored as follows:

Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
4	3	2	1	0

Unfavourable statements were those items where disagreement was considered to be a favourable response. In these cases the items were scored as follows:

Strongly Agree/...

Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
0	1	2	3	4

Full details of this scoring are to be found in the item pool section of Appendix B; namely, Scoring the Item Pool.

Overall this author anticipated 85 favourable statements and 81 unfavourable statements.

If all 5 judges had returned the maximum score of 664 (166 x 4) this author would have deemed:

1. The 5 Biology teachers to have formed a perfect criterion group.
2. The 6 scales to be completely valid in terms of content.

(b) The Results of Pilot Trial One : Unpurified Scores.

The impossibility of achieving such optimal results was inheritant in the selection of the criterion group and in this author's selection of items.

However, the results recorded in Appendix B : Pilot Trial One were far from disappointing. (All Tables listed in this Chapter whose number includes the suffix B are extracted from Appendix B.)

Table 7. 1B - Pilot Trial One : Unpurified Scales. The Mean percentagé of scores on each scale.

A	B	C	D	E	F
72,9	73,3	77,8	69,1	77,1	78,9

From these initial unpurified means this author concluded that:

(i) Scales C. E and F indicated the highest degree of concurrence with this author's favourable/ unfavourable response rating.

(ii) Scale D was revealed as needing more purification than most of the other scales.

Table 7.2 B - Pilot Trial One : Unpurified Scales. The range of scores on each scale as a percentage.

A	B	C	D	E	F
11,7	11,1	27,8	15,9	10,3	18,1

From these initial unpurified ranges this author concluded that:

Scales C, D and F accomodated some widely differing opinions.

When referring to the raw scores of the five judges for each scale, it was noted, that with the exception of Scale D, all top-scorers in individual scales obtained almost 80% of the anticipated maximum score or better.

Table 7.3 B Pilot Trial One : Unpurified Scales. The scores of the top scoring judges for each scale expressed as a percentage.

A	B	C	D	E	F
81,4	79,6	95,8	76,1	82,4	85,0

Analysing these unpurified results the author was fairly satisfied with the high degree of concurrence expressed allowing that this was not a perfect criterion group nor had the scales as yet been purified.

When/...

When analysing the performance of each judge individually the author noticed that one of the five judges was inclined to be less conservative in his responses, often preferring the maximum response to the more moderate response. Although anonimity had been offered to the five judges this particular judge had not been concerned to conceal his identity. This author felt it was significant that the judge in question was a university lecturer and not a secondary school teacher as were the other four judges. This led the author to examine the role that basic conservatism had played in the unpurified scoring as it was felt that conservatism was not a special characteristic of Standard Eights. If no distinction was allowed between the extreme and the moderate agreement and visa versa, the effects of teacher conservatism in selecting extreme response options was eliminated.

The results obtained showed a much higher level of agreement:

Table 7.4 B <u>Pilot Trial One : Unpurified Scales. Analysis of responses to eliminate the effects of teacher conservatism. Means and Top-Scorers expressed as percentages.</u>

SCALES	A	B	C	D	E	F
MEANS	77,9	80,7	85,6	71,4	87,1	88,0
TOP-SCORERS' MEANS	89,5	88,9	100	73,3	94,1	97,5
MEAN IMPROVEMENT	5,0	7,4	7,8	2,3	10,0	9,1

It was concluded from these results that:

(i) Teacher conservatism did play a significant role in depressing the degree of concurrence anticipated.

(ii)/...

(ii) Scale D was definitely unsound in comparison to the other scales.

(iii) All other scales indicate an almost 80% agreement; scales C, E and F in excess of 85% agreement with this author's assessment of the "correct" response. This confirmed the author's belief that this group of judges did in fact form a rough criterion group.

(c) The Results of Pilot Trial One : Purified scores.

In order to purify the six scales to establish their content validity beyond doubt, it was decided to eliminate all ambiguous or confusing items from the scales.

(See Appendix B. Pilot Trial One : Unpurified Scales : Analysis of Contrary Responses)

Where two or more judges indicated an agreement as to a response judged by this author to be the "correct/favourable" response or indicated uncertainty, the item in question was rejected.

On this basis 28 of the 166 items were discarded, but later one of the items was retained after it s scoring sequence had been reversed, as all 5 judges were unanimous in their disagreement with this author's assessment.

Table 7.5 B/...

Table 7.5 B <u>The state of the scales after purification.</u>

SCALES	A	B	C	D	E	F
UNPURIFIED ITEMS	19	27	18	45	17	40
PURIFIED ITEMS	17	23	15	32	16	36

It can be readily seen that:

(i) A total of 139 items were deemed to have content validity by the criterion group and 27 items were discarded.

(ii) Scale D lost a total of 13 items. This was anticipated by the poor performances of the criterion group on scale D.

The scores of the five judges were now computed again for these reduced purified scales in anticipation of higher degrees of concurrence.

Table 7.6 B <u>Pilot Trial One : Purified Scales. The mean percentage of scores on each scale and its improvement over the unpurified scale.</u>

SCALES	A	B	C	D	E	F
MEAN	74,1	77,2	80,3	76,4	77,8	82,2
MEAN IMPROVEMENT	1,3	3,9	2,6	7,4	0,8	3,4

From these purified means the author concluded that:

(i) Scale D has shown marked improvement as anticipated.

(ii)/...

(ii) The longer scales B, D and F have shown larger improvements than the shorter scales.

Table 7.7 B. Pilot Trial One. Purified Scales. The scores of the top scoring judges for each scale expressed as a percentage.

A	B	C	D	E	F
79,4	85,9	95,0	85,2	82,8	89,6

All top-scoring judges, with the exception of scale A, obtained in excess of 82%, which is a 2% improvement over the unpurified scales.

If the effects of teacher conservatism are once more eliminated by ignoring distinction between extreme and moderate responses the improvement in concurrence is even better.

Table 7.8 B Pilot Trial One : Purified Scales. Analysis of responses to eliminate the effects of teacher conservatism. Means and Top-scorers expressed as percentages.

SCALES	A	B	C	D	E	F
MEANS	82,4	89,6	92,0	85,0	90,0	94,0
TOP-SCORERS MEANS	94,1	95,7	100	93,8	100	100
MEAN IMPROVEMENT	4,5	8,9	6,4	13,6	3,0	2,0

It was concluded from these results that:

(i) All scale means yield a better than 82% concurrence; four scales yielding a 90% or better concurrence.

(ii)/...

(ii) All top scoring judges obtained in excess of 93%.

(iii) Six judges (on 3 of the scales) are now in complete accord with this author's estimation of what constitutes a "correct response."

(iv) On the basis of the results shown in Table 7.6 B and 7.8 B all six scales were deemed to have a high degree of content validity in their purified form as established by an acceptable external criterion group.

2. Pilot Trial Two.

(a) The Organisation of Pilot Trial Two.

Having established the content validity of 139 of the original items in the item pool by assuming that a high degree of concurrence expressed by judges in an external criterion group indicates item validity, this author proceeded to purify further the remaining items in the scales by the more conventional method of internal consistency between the items.

This method proceeds from the assumption that the best available measure of the attitude concerned is the total item pool. By purifying it, the items retained will all be measuring the same thing. (13)

The scales purified in Pilot Trial One were administered to a sample of pupils as similar as possible to the experimental and control groups who would write the final/...

(13) Oppenheim A.N., Op. Cit. (1966)

Pre- and Post tests.

As the experimental and control group were to come from the standard 8 group of a local secondary school in the Cape Peninsula, the pilot sample was selected from the standard 8 class one year ahead of the experimental and control group, with the proviso that pupils failing and repeating the year with the experimental and control group should be eliminated from the test programme to prevent contamination of results.

There were two standard eight classes of biology pupils available for the Second Pilot Trial, but they were not particularly homogenous in all respects. The larger group were studying Physical Science and Biology and were clearly an academically more capable group as was established from their mean intelligence quotient. The remaining smaller group studied Biology only and were considered to be academically less competent.

In order that the number of pupils following particular courses should not add an extra variable to the results of the Pilot Trial, 20 pupils were selected at random from each group, prior to scoring, to balance the groups.

Table 7.9 /...

Table 7.9 <u>The selection of the Pilot Sample</u>

Courses studied	Total Pupils	Mean I.Q.	Pilot Sample
Physical Science and Biology	35	118,7	20
Biology only	22	107,6	20
Totals	57		40

A copy of this Second Pilot Trial can be found in Appendix B: Pilot Trial Two. Prior to administering this trial the items with each scale were randomised in order to eliminate any "simple to complex" gradient that may have tired the pupils and also to prevent them establishing a pattern in the sequence of responses.

Each pupil was presented with a completely truthful frame of reference to prevent guesswork contaminating the results.

The anonimity of each pupil's identity was preserved in order that there should be complete freedom of response and to prevent them from selecting "ideal" responses to impress the class teacher.

The class teacher administered the scales and reported that the pilot sample had taken the trial very seriously indeed; only one pupil failing to complete all six scales.

(b) The Results of Pilot Trial Two : Establishing Validity.

Pilot Trial Two was scored in the traditional Likert Method described under Pilot Trial One earlier in this Chapter.

(Full details of all raw scores and computation of results can be found in Appendix B : Pilot Trial Two.)

The means for the Biology Only and the Physical Science and Biology Group were computed separately in order to establish whether or not there was any difference in mean attitude for each group that could be attributed to academic ability.

Table 7.10 B/...

Scales	A	B	C	D	E	F
Maximum possible score	68	92	60	128	64	144
Mean of "Biology Only" Group	43,25	52,65	39,30	77,45	41,95	97,75
Mean of "Physical Science and Biology" Group	45,85	60,30	42,45	79,35	39,25	98,45
Total Mean of Entire Pilot Sample	44,55	56,48	40,88	78,40	40,60	98,10
Mean expressed as a percentage	65,51	61,39	68,13	61,25	63,44	68,13
Mean Range expressed as a percentage	3,82	8,32	5,25	1,48	4,22	0,49

Table 7.10 B Pilot Trial Two: The means of the total pilot sample on the six scales.

It/...

It was concluded from these results that:

(i) The difference in means between the two halves of the pilot sample was insignificant, and that academic ability as expressed by Intelligence Quotients was not a variable in determining attitude formation. This conclusion is confirmed by Lowery's research. (14)

(ii) The Physical Science/Biology group performed:

(a) Slightly better on Scales A and D.

(b) Substantially better on Scale B and C.

(c) About the same on Scale F.

(d) Slightly worse on Scale E,

...than the Biology only Group.

(iii) Some of these small differences can be accounted for as follows:

(a) We would expect pupils who take Physical Science as well as Biology to rate "Science as being more important" than those who only study Biology. This accounts for the large discrepancy in Scale B.

(b) We would expect pupils who only study Biology to have a keener interest in popular biological articles, (that are more readily available than popular physical science articles), than those who have to divide their interests between two science courses. This/...

(14) Lowery L.F., "An experimental investigation into the attitudes of fifth grade students towards Science", School Science and Mathematics. Vol. 67. No. 6 (1967)

This might account for the moderate discrepancy in Scale E.

The author now set out to further purify the six scales using the internal consistency method described by Murphy and Likert (15) as being most suited to this rather small pilot sample.

Essentially this involved:

1. Ranking the scores obtained for each scale.
2. Identifying the top-scoring 25% and the bottom-scoring 25% who are then considered to be two internal criterion groups.
3. In order to identify the items that best distinguish between these two groups, the mean of each group for each item is computed to obtain a difference in means between the groups.
4. These differences of means are ranked from greatest to least and those items that best differentiate between the groups are selected for the purified scales.

   (Full details of the purification of each scale according to this method can be found in Appendix B : Pilot Trial Two.)

Using this method a further 61 items were eliminated during the Second Pilot Trial, leaving 78 of the original 139 items.

These/...

(15) Murphy G, and Likert R., Public Opinion and the Individual. (1937)

These 78 items are deemed to have construct validity by the Second Pilot Trial and content validity by the First Pilot Trial.

A full list of the items included in the final purified scales can be found in Appendix B : Pilot Trial Two : A Summary of the Purified Items by Scales.

The following two tables summarise the items in the original item pool discarded during the Two Pilot Trials and show the relationship between the remaining items and the classification of affective objectives on which they were originally based.

Table 7.11/....

Table 7.11

Summary of the purification of the item pool by the pilot trials

Note: All numbering on this page is based on the initial item pool notation and not necessarily that of the pilot trials themselves.

■ **Eliminated by the first pilot trial (27 items)**

● **Eliminated by the second pilot trial (61 items)**

SCALES	A	B	C	D	E	F
	●	●	1	●	1	1
	2	2	2	●	2	2
	■	3	●	■	3	3
	4	●	●	●	4	4
	5	●	5	5	5	●
	6	6	●	●	●	●
	■	7	●	■	■	●
	8	8	8	■	8	8
	9	9	9	●	9	9
	●	10	■	10	●	10
	●	11	11	11	●	11
	●	12	■	12	●	●
	13	■	■	■	●	●
	14	14	14	14	14	●
	15	15	■	●	15	15
	●	16	16	■	16	16
	17	■	17	●	●	17
	●	●	18	18		18
	●	19		19		19
		20		20		●
		■		●		21
		22		●		●
		●		●		●
		■		●		●
		●		●		●
		●		26		●
		●		27		■
				■		28
				■		●
				30		30
				■		31
				■		32
				●		33
				●		34
				●		●
				36		●
				●		■
				■		■
				■		■
				40		●
				■		
				■		
				■		
				44		

Table 7.12

Relationship between items retained/discarded and classification according to affective domain taxonomy

Note: All numbering on this page is based on the initial item pool notation.

SCALES

ITEM POOL BY CLASSIFICATION GROUPS IDENTIFIED IN THE AFFECTIVE DOMAIN TAXONOMY AFTER PURIFICATION IN PILOT TRIALS.

	A	B	C	D	E	F
1	2	2 3 6 7 8 10	1 2		1 2	1 2 3 4
2	4 5 6 8 9	11 12 14	5 8 9	5 10 11 12 14 18	3 4 5 8 9	8 9 10 11 15 16 17 18
3	13 14 15	15 16 19 20 22	11 14 16 17 18	19 20 26 27 30	14 15 16	19 21 28 30 31 32 33 34
4	17			36 40		
5				44		

Note: Only the items retained in the pretest are reflected in this table.

Table 7.13/...

Table 7.13 summarises the results shown in Table 7.11.

Table 7.13 Item fates expressed as percentages.

SCALES	A	B	C	D	E	F
Items discarded in First Pilot Trial	10,5	14,8	16,6	28,8	5,8	10,0
Items discarded in Second Pilot Trial	36,8	29,8	27,7	40,0	35,2	40,0
Total items discarded	47,3	44,4	44,3	68,8	41,0	50,0
Percentage of original item pool retained	52,7	55,6	55,7	31,2	59,0	50,0

From this table we conclude that:

(i) With the exception of Scale D, between 40% and 50% of the original item pool for each scale has been discarded during purification.

(ii) Pilot Trial Two was a much more radical purification in which the two longest scales D and F were particularly abbreviated.

(iii) Generally speaking a sound balance between the scales was preserved during purification and with the exception of Scale D, The items are in approximately the same ratio after purification as before purification.

(iv) Scale D has retained only ⅓ of it's original items, in keeping with earlier predictions of a special need for much purification.

Table 7.12/...

Table 7.12 illustrates the fact that the surviving items are well spread throughout the hierarchy of affective objectives from which they were originally constructed.

A reasonable balance was also maintained between the ratios of the items anticipating favourable and unfavourable responses.

Table 7.14 The ratios of favourable and unfavourable item statements before and after purification.

	RATIO FAVOURABLE : UNFAVOURABLE			PERCENTAGES FAVOURABLE : UNFAVOURABLE		
ORIGINAL ITEM POOL	85	:	81	51,2	:	48,8
AFTER THE FIRST PILOT TRIAL	67	:	72	48,2	:	51,8
AFTER THE SECOND PILOT TRIAL	34	:	44	43,6	:	56,4

This sound balance of items anticipating opposite responses, helped to prevent a response pattern of the majority of responses being of one nature most of the time.

Thus after the purification of the scales their essential pre-purification characteristics survived with only very slight modifications of little consequence.

The/...

(c) The Results of the Pilot Trial Two : Establishing reliability.

The product-moment correlation co-efficient was employed using a split-half technique to correlate the part scores of the two halves of the purified scales against each other for each pupil in the pilot sample.

Table 7.15 The reliability of the scales compared to the number of purified items in each scale.

SCALES	A	B	C	D	E	F
r =	0,64	0,66	0,72	0,80	0,79	0,92
TOTAL ITEMS	10	14	10	14	10	20

From these results we conclude that:

(i) All scales have a reasonable degree of reliability taking into account the limitations of the split-half technique.

(ii) Scales E, D and F are particularly reliable measuring instruments ; while C, B and A are less reliable, in this order.

(iii) Scale D has as a result of extensive purification become one of the most reliable scales.

(iv) Scale F is the largest scale as a result of the extensive discarding of items in Scale D and this could account for it s higher reliability.

(v) Generally longer scales D and F have higher reliabilities while shorter scales A and C have lower reliabilities.

(vi)/...

(vi) Scales B and E are somewhat anomalous in that;

(a) Scale B has the same number of items as Scale D but a much lower reliability.
This could be an indication of the additional variable of some pupils studying Physical Science and thus favouring "The Importance of Science" Scale. This scale may in fact partially discriminate between the group studying Physical Science in addition to Biology and the Group studying Biology only. As such it is obviously a less reliable measuring instrument in this situation.

(b) Scale E has scored a much higher reliability rating than its number of items would naturally lead us to anticipate, but high reliabilities on scales containing small numbers of items are reported in the literature. (Hall 16).
Possibly Scale E is based on a more homogenous range of affective objectives all being related to "Reading Scientific Literature" in some way or another. This would definitely account for the higher reliability of the scale.

The/...

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(16) Hall O.M. "Attitudes and unemployment" _Archives of Psychology_ No. 165 (1934)

The Pilot trials have established the validity and reliability of all the scales to the satisfaction of this author, and these purified scales consisting of some 78 items will be used to establish the status of the affective development of the experimental and control groups during the experimental programme.

CHAPTER 8

THE CLASSROOM TRIALS: ORGANIZATION, DESIGN AND PLAN OF RESEARCH

CHAPTER 8 : THE CLASSROOM TRIALS: ORGANISATION, DESIGN AND PLAN OF RESEARCH

A. THE SCHOOL

1. The selection of a school.

The school finally selected was located in an upper, middle-class suburb of Cape Town, reasonably remote from the coast. It was a moderately big, co-educational, secondary school (650 pupils).

The headmaster and staff were interested in the proposed research programme and once permission had been granted by the Cape Education Department it was decided to introduce the programme during the first term of 1979.

2. The basis of selection of the School.

There were several cogent reasons for finally deciding on the experimental school:

(a) The school was controlled by the Cape Education Department and hence any successes would probably be applicable to other schools equipped by the Cape Education Department.

(b) The headmaster and biology staff were enthusiastic about the proposed research programme ensuring that it would at least be given a fair trial.

(c) The school is one of the larger schools in the Cape Peninsula ensuring that there would be a reasonably large number of Standard 8 pupils studying Biology.

(d)/...

(d) The school was a co-educational secondary school ensuring that there would be boys and girls in the experimental and control groups, thus eliminating sex variables from the programme results.

It should be borne in mind however that Lowery (1) has shown that sex differences do not influence attitude formation towards science.

(e) The School was located in a large, homogenous, upper, middle-class, european suburb where the mean income was certainly well above average incomes. Research workers appear divided as to the impact of socio-economic differences on affective development.

Lowery claims that socio-economic differences do not influence affective development towards the sciences, but Fraser (2) found that high socio-economic groups are likely to benefit more from an environmental programme than low socio-economic groups. Thus it seemed important to introduce the programme at a school where the pupils stood the maximum opportunity of benefitting from the programme.

(f)/...

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(1) Lowery L.F., "An experimental investigation into the attitudes of fifth grade students towards science". School Science and Mathematics. Vol. 67. No. 6 (1967)

(2) Fraser B.J., "Are ASEP pupils achieving the aims"? The Australian Science Teachers Journal, Vol 22. No. 3 (1976)

(f) The school was not on the coast and approximately 25 kilometres from the study area thus reducing the chances of the bulk of the pupils having any educational experience of the inter-tidal environment.

B. THE PUPILS AND THE TIMING

1. The selection of the pupils.

The entire 1979 standard 8 population of the experimental school studying Biology was selected for the experimental programme.

There were three Biology classes in 1979 constituted in the manner summarised in Table 8.1.

CLASS	1	2	3
NUMBERS of PUPILS	28	35	20
	EXPERIMENTAL GROUP	CONTROL A	CONTROL B

Table 8.1 The numbers of pupils in each group.

Pupils repeating the year were eliminated from the results of the pre- and post-tests as having had one extra exposure to the attitude scales during Pilot Trial Two in the third term of 1978. The scales might possibly prove to be a learning experience in themselves as they force pupils to clarify their values in order to express opinions.

Ideally/...

Ideally this author had hoped for four classes (i.e. two experimental and two control groups) but as the schools number of biology classes fluctuated from year to year this was not possible.

All classes were mixed (boys and girls) and the only significant difference between the three groups was the fact that group 1 (Experimental Group) studied Physical Science in addition to Biology while the two Control Groups did not study Physical Science. This did not disturb the programme at all as the experience of Pilot Trial Two showed that any I.Q. ability difference did not influence affective development significantly.

2. <u>The basis of selection of the pupils</u>.

Standard 8 pupils were chosen for a variety of reasons already documented in Chapter 1 of this report, namely:

(a) The standard eight class still contained several pupils who might leave school at the end of the standard 8 year (being the limit of compulsory school attendance for europeans) and it would be a pity to lose them from the programme, especially as affective development has been shown to be independent of cognitive development. (Shock 3).

(b)/...

(3) Shock N.H., "Analysis of the relationship which exists between cognitive and affective educational objectives." Journal of Research in Science Teaching. Vol. 10. No. 4. (1973)

(b) The standard 8 class is in the third year of the secondary school but it is in the first year of the Senior Secondary Course Phase. Any prior experience of Biology has been within the framework of General Science, a combined course in Physical Science and Biology. The pupils thus had few preconceived ideas about what Biology should or should not be. This enabled the pupils to participate in the programme with a certain atmosphere of normality prevailing.

(c) Shock (4) further suggests that it is only during the secondary school phase that increasing cognitive development and deteriorating affective development intersect each other. (See Fig. 1.1) In other words during standard 8 any cognitive differences would not be likely to influence affective development and so the academic ability variable is eliminated.

(d) The first term of standard 8 was particularly well suited to experimentation as there are no examinations at the end of the term thus providing researchers with a full 10 teaching weeks, and there were no external examinations at the end of the year, thus enabling teachers to compensate for any discrepancies in cognitive content of the classes in their own internal examination papers.

(e)/...

(4) Shock N.H., Op. Cit. (1973)

(e) The first term was also suitable for an experimental programme involving field trips due to the fair weather experienced during the summer term and the absence of a heavy commitment to rugby football practices.

(f) The first term of 1979 was particularly well suited to this programme as the spring tide coincided with the timing of the first field trip enabling the pupils to study the rocky shore during a period of maximum exposure.

C. THE EXPERIMENTAL DESIGN AND PLAN OF RESEARCH

1. The five research questions to be answered by the classroom trials

There are five basic questions that this research sought to answer:

(a) What difference, if any, between the mean attitudes of the experimental group and the control group could be detected before the experimental period began?

(b) How did the pattern of responses differ between the experimental and control group before and after the environmental programme?

(c) What difference, if any, did the environmental programme produce between the experimental and control groups?

(d) Did the taking of a pretest affect the results obtained on the post test?

(e)/...

(e) After a further term of normal educational experience (the lecture/demonstration method) by all groups, were the differences, if any, referred to in question (c) still apparant, or was there a tendency on the part of the experimental group to revert to former attitudes?

The relationship between these research questions are indicated in Figure 8.1 on page 215.

Figure 8.1/...

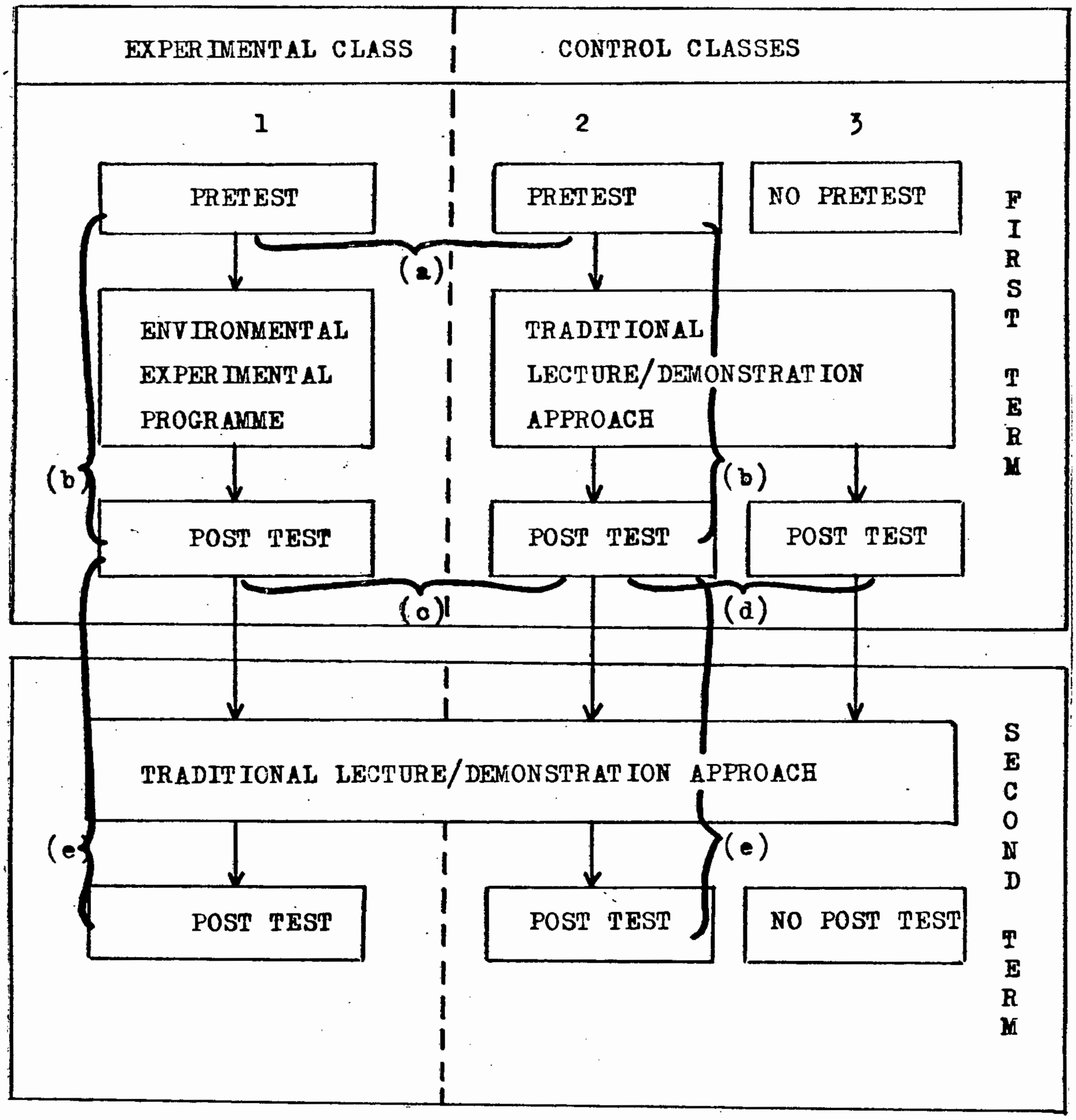

Figure 8.1 <u>The relationship between the research questions</u>.

2. <u>The relationship between the research questions and the classroom trials.</u>

The classroom trials were in three distinct phases:

(a) <u>The Pretest.</u>

The purified scales were administered to classes 1 and 2 as the pretest. By comparing the mean attitude for each class on all six scales, the initial status of the attitudes of each class , with repect to the six affective attitude clusters incorporated in the Biology Syllabus Aims, was determined. This provided an answer to question (a).

(b) <u>The First Post Test</u>

After randomising the sequence of items within each scale of the pretest, the same scales were administered to all three classes as the first post test at the end of the first term. The results from the pre and post tests provided an answer to questions (b), (c) and (d).

<u>Question (b).</u>

By comparing the mean scores for each item for classes 1 and 2 on the pre- and post tests, the pattern of responses and any alterations in them was revealed.

The range of scores on each item could also differ significantly before and after the experimental programme in each class.

Question (c)/...

Question (c).

By comparing the total mean score for classes 1 and 2, evidence was supplied for indicating whether or not a group improvement in attitudes had occurred as a result of the experimental programme alone, as all other variables had been held constant.

Question (d).

In order to establish to what extent the pretest was in itself a learning experience, the post test results of classes 2 and 3 were compared. If there were any significant difference in the results it could only be due to the pre-test written by class 2 as all other variables had been held constant.

(c) The Second Post Test.

After randomising the sequence of items in the six scales of post test one, these scales were readministered at the end of the second term as the second post test.

If the results of Classes 1 and 2 are compared after this second post test with the results obtained by the same two classes on the first post test it should be possible to establish whether any differences observed in Question (c) are still apparent after the second post test or if the attitudes learned are less stable and are reverting to pretest levels. See Question e.

3./...

3. <u>A summary of the organisation of the classroom trials</u>.

In conclusion, there were three classes of Std. 8's and three phases of testing spread over the first two terms of 1979. The experimental class experienced the environmental programme during the first term only. All other classes continued with the normal educational experience, as did the experimental class during the second term of 1979.

By means of a research design incorporating pretesting at the commencement of the first term and post testing at the end of the first and second terms, the five basic research questions were be answered. Part III of this report is devoted to an analysis of the results obtained in this three phase testing programme and the answers elicited by the research questions and their implications for Biology teaching in the Cape Province.

PART THREE:

RESULTS AND ANALYSES

CHAPTER 9

THE PRETEST : ADMINISTRATION AND ANALYSIS OF RESULTS.

CHAPTER 9 : THE PRETEST : ADMINISTRATION AND ANALYSIS OF RESULTS.

A. THE ORGANISATION OF THE PRETEST.

1. The method of administration of the Pretest.

As Table 9.1 indicates, only two of the three classes involved in the experiment were asked to complete the pretest. Full details of the pretest are recorded in Appendix B pages 49 to 54.

	PRETEST		NO PRETEST
CLASS	1	2	3
NUMBER OF PUPILS	28	33	20
	Experimental Group	Control A	Control B

Table 9.1 The pupils in each group who wrote the pretest.

It will be noted from a study of the pretest that the two classes were clearly told the purpose of the test in order that they should not feel threatened or exposed by statements that might have elicited anti-social responses. Every effort was made to preserve complete anonimity and eliminate any tendency to motivate pupils to give answers that they anticipated would be considered "socially correct". This test was completed by both groups within one day of each other. The teacher reported that both groups were very interested in the task and took it very seriously indeed.

While/...

While the original pilot trials (described in Chapter 7 and documented in Appendix B 30 to 39) were based on the full item pool (documented in Appendix B 1 to 20), the pretest was a purified test in which only some 78 of the original 166 items were retained.

Table 7.12 (page 202) lists the items retained in each scale in terms of the original classification of affective objectives listed in the item pool. These results have been graphed in Table 9.2 to illustrate the range of these objectives retained in the pretest when the scales are compared.

This table indicates that the items retained cover a wide range of affective objectives in all scales. However Scale D has lost it s lower order affective objectives, while Scale F has lost it s higher order affective objectives. Generally speaking all scales are well represented in the area of middle order affective objectives at the Responding and Valuing levels. These findings are encouraging as research workers generally consider levels 2 and 3 to be the main areas affected by formal schooling, thus the pretest should serve as a competent measure of affective objectives commonly considered to be moulded by schooling.

Table 9.2/...

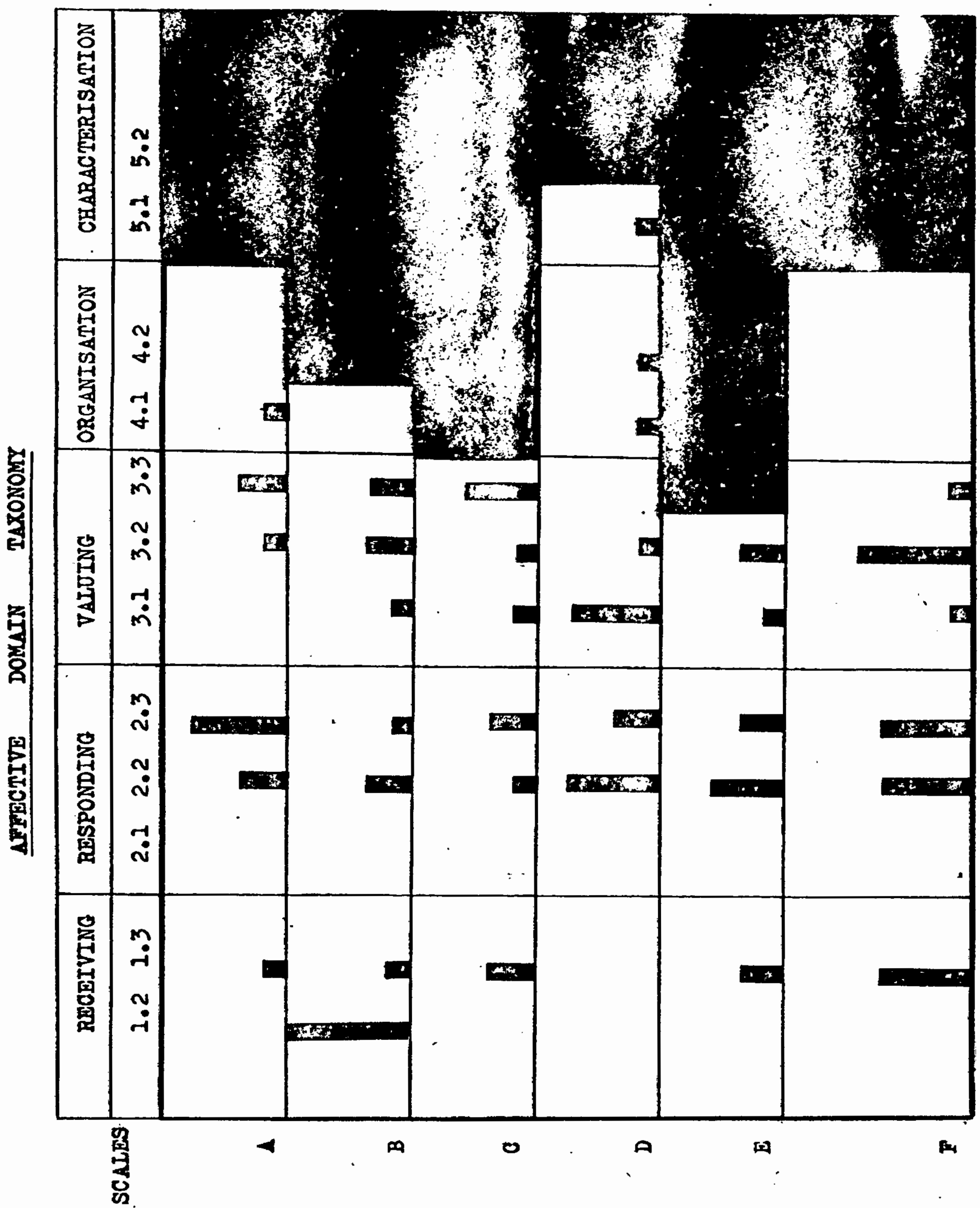

Table 9.2 The distribution of affective objectives as represented by pretest items

(Shaded portions indicate the limit of objectives indentified in the original item pool.)

SCALE LENGTHS OF LINE: represents one item at this level

represents five items at this level

2. <u>The method of assessment of the pretest.</u>

The purpose of the pretest was to measure the differences, if any, between the mean attitudes of the experimental group and the control group, (control A only) before the experimental period began. This was defined as research question one.

In order to establish the mean differences and test their degree of significance or otherwise the following method was developed:

(a) The response sheets for the experimental group and control group A were scored according to the weighting listed in Appendix B 21. (It should however be borne in mind that the sequence of items within each Scale was first randomised to obliterate the obvious sequence of increasing internalisation and separate items that were at all similar sounding in their wording.)

(b) The mean scores for the 6 scales were computed and the results of the experimental group and control group A were compared.

(c) A t - test was used to establish the existence or otherwise of significantly different mean scores, the following formula being applied:

t =/...

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\left(\frac{\Sigma x_1^2 + \Sigma x_2^2}{N_1 + N_2 - 2}\right)\left(\frac{1}{N_1} + \frac{1}{N_2}\right)}}$$

Where $\bar{X}_1$ = The mean of the raw scores of the experimental group.

$\bar{X}_2$ = The mean of the raw scores of the control group.

N_1 = The number of pupils in the experimental group.

N_2 = The number of pupils in the control group.

x = The deviation from the mean of each raw score, and

$$\Sigma x_1^2 = \Sigma X_1^2 - \frac{(\Sigma X_1)^2}{N}$$

(d) Significant differences between the experimental and control groups were sought at two levels:

(i) Significant differences between the means obtained by each group for <u>each scale as a whole</u>.

(ii) Significant differences between the means obtained by each group for <u>each item within each scale</u>.

B./...

B. THE RESULTS OF THE PRETEST

1. Comparison of the results of whole scales.

Table 9.3 summarises a more complete table of results provided in Appendix B 58 in which mean scores are interpreted as percentages.

SCALES

	A	B	C	D	E	F
Mean of Experimental Group	63,23	59,27	69,20	64,21	62,78	62,36
Mean of Control Group A	62,65	52,05	64,10	48,05	57,05	64,44
Difference in Means (E-A)	+0,58	+7,22	+5,10	** +16,16	+5,73	-2,08

Table 9.3 A comparison of means obtained by the Experimental group and Control A in terms of percentages.

An analysis of these results indicates:

(a) The attitudes measured by the six scales used in the pretest showed an interesting range.
The range of the means for the Experimental Group was approximately 10% between best and worst scores for scales (59% to 69%). The range of the means for the Control Group was approximately 16% between best and worst scores for scales (48% to 64%).

(b) With the exception of Scale F the Experimental Group had a higher mean score that the Control Group on all scales.

(c)/...

(c) However, this difference in means, was only significant in the case of Scale D where a t value of 8,26 for 30 degrees of freedom was obtained. Thus the means of the control and experimental group were significantly different at the 1% level of confidence for Scale D.

(d) Scale B, which had the second largest difference in means, just missed being classified as a significant difference in means at the 5% level of confidence for 30 degrees of freedom.

(e) The large differences in means recorded on Scales D and B can to a large extent be attributed to the differing academic interests of the two groups. The experimental group voluntarily chose to study Physical Science in addition to the Biology selected by the control group.
Scale D - "Scientists at Work" and
Scale B - "The Importance of Science",
might have provided opportunities for the experimental group to show their greater insight into science as a result of their chosen subject orientation.
On the basis of these differences between the two groups, it was decided to examine the significant differences within each scale, particularly in scales D and B, where most of the significantly different responses occurred.

(f)/...

(f) The combined means for the pretest as a whole (E+A) (see Appendix B 58) range between 55% and 66%, indicating a fair degree of uniformity in initial preprogramme attitudes for the group as a whole, especially if Scales D and B are excluded as containing additional variables. These findings tend to support Lowery's (1) and Shock's (2) conclusions that most teaching variables have no significant link with the development of attitudes. Clearly cognitive development has no significant effect on affective development. To what extent the choice of Physical Science by the control group is an indicator of higher motivation and perhaps more advanced affective development will be examined in the next section of this report.

2. Comparison of the results within scales.

A full set of tables of the results obtained during a comparison of item means within each scale for the experimental group and control group A can be found in Appendix B 59 to 64.

Table 9.4/...

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(1) Lowery L.F., "An experimental investigation into the attitudes of fifth grade students towards science", School Science and Mathematics. Vol. 67. No.6. (1967)

(2) Shock N.H., "Analysis of the relationship which exists between cognitive and affective educational objectives." Journal of Research in Science Teaching. Vol. 10. No. 4 (1973)

Table 9.4 is a brief summary of the significant differences found between the individual item means of the two groups.

As anticipated there are more significant differences in Scales D and B than the other scales. For a more complete picture see Appendix B 65.

	SCALES					
	A	B	C	D	E	F
5% level of confidence	-	3	2	5	2	-
1% level of confidence	-	2	-	2	-	-
Totals	-	5	2	7	2	-

Table 9.4 <u>Comparison of numbers of items with significantly different means</u>.

The results tabled in Appendix B 59 to 64 were graphed for ease of interpretation. For the purpose of analysis it was decided to consider means of less than 1,50 as indicating an unfavourable response, as determined in Appendix B 21. Means between 1,50 and 2,50 were considered to be neither favourable or unfavourable responses while those means in excess of 2,50 were regarded as favourable responses for the group as a whole. (It should be constantly borne in mind that these results are means and reflect the general tendency for the whole group.)

These graphs served three purposes:

1. They identified the items where there was a significant difference between the control and the experimental groups.

A/...

A mean difference of at least 0,59 was needed to establish a significant difference at the 5% level of confidence , while a mean difference of at least 0,83 was needed to establish a significant difference at the 1% level of confidence.

2. They identified the items where there was a uniformly favourable response.

3. They identified the items where there was a uniformly unfavourable response.

Where an item elicited an extreme response from only one group and the difference was not deemed to be significant at the 5% level of confidence at least, the item was ignored as being due to chance alone.

From this method of analysis of results within each scale, a picture emerged which is summarized in Figures 9.1 to 9.6.

Figure 9.1/...

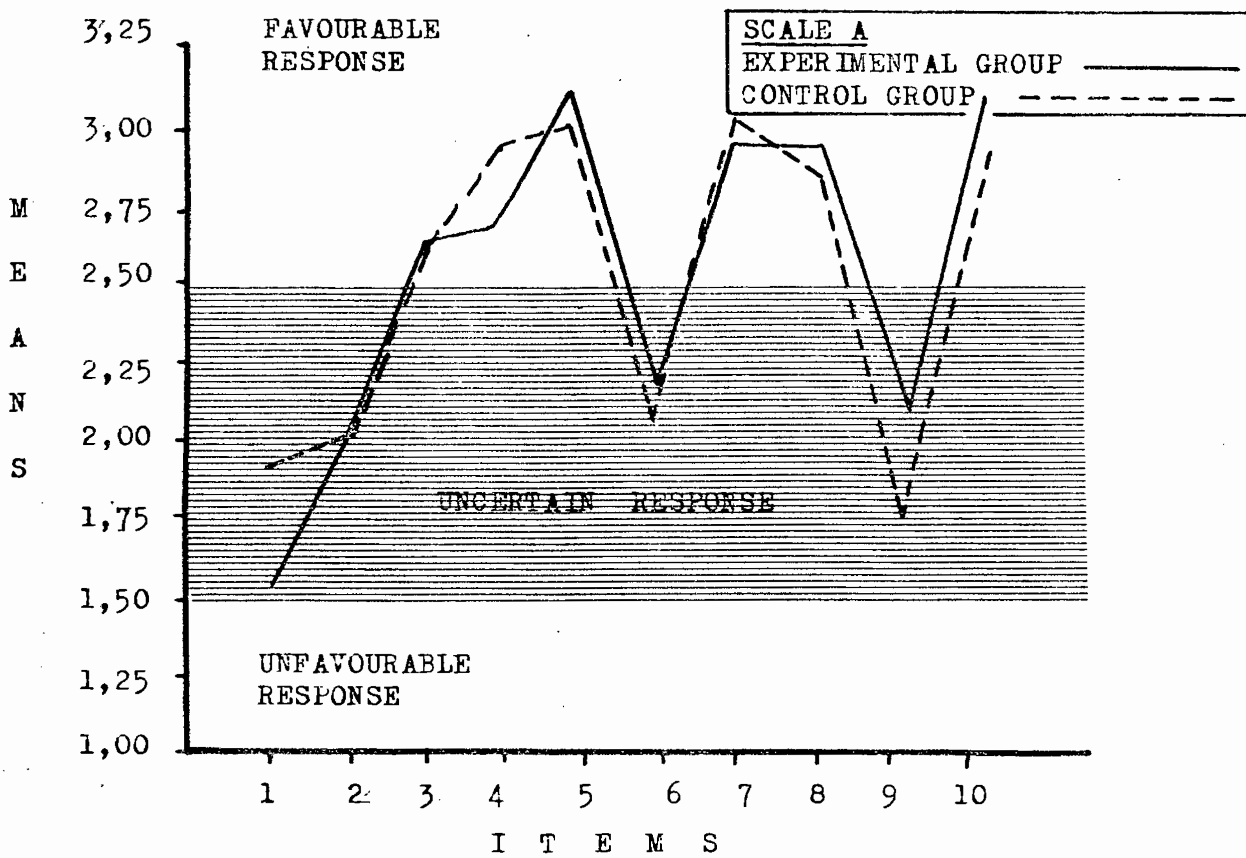

Figure 9.1 A comparison of item means obtained by the Experimental and Control Group A on Scale A of the pretest.

(a) Commentary on Scale A

(i) There was no significant difference in the means obtained by the Experimental ans Control Groups on any of the ten individual items.

(ii) Items 5,7,8 and 10 elicited a clearly favourable and closely matched response on Scale A. (Item 3 was considered to be a borderline case and Item 4 was considered not to be sufficiently closely matched to merit a comment.)

Item	Interpretation of Attitudes
5	Both groups showed a keen interest in field trips and habitat studies.
7	Both groups understood the need for rules to regulate society in the interests of nature conservation.
8	Both groups enjoyed learning about the interaction between animals and the environment.
10	Both groups showed an interest in all living things irrespective of their usefulness or otherwise.

(iii) There were no uniformly unfavourable responses on Scale A.

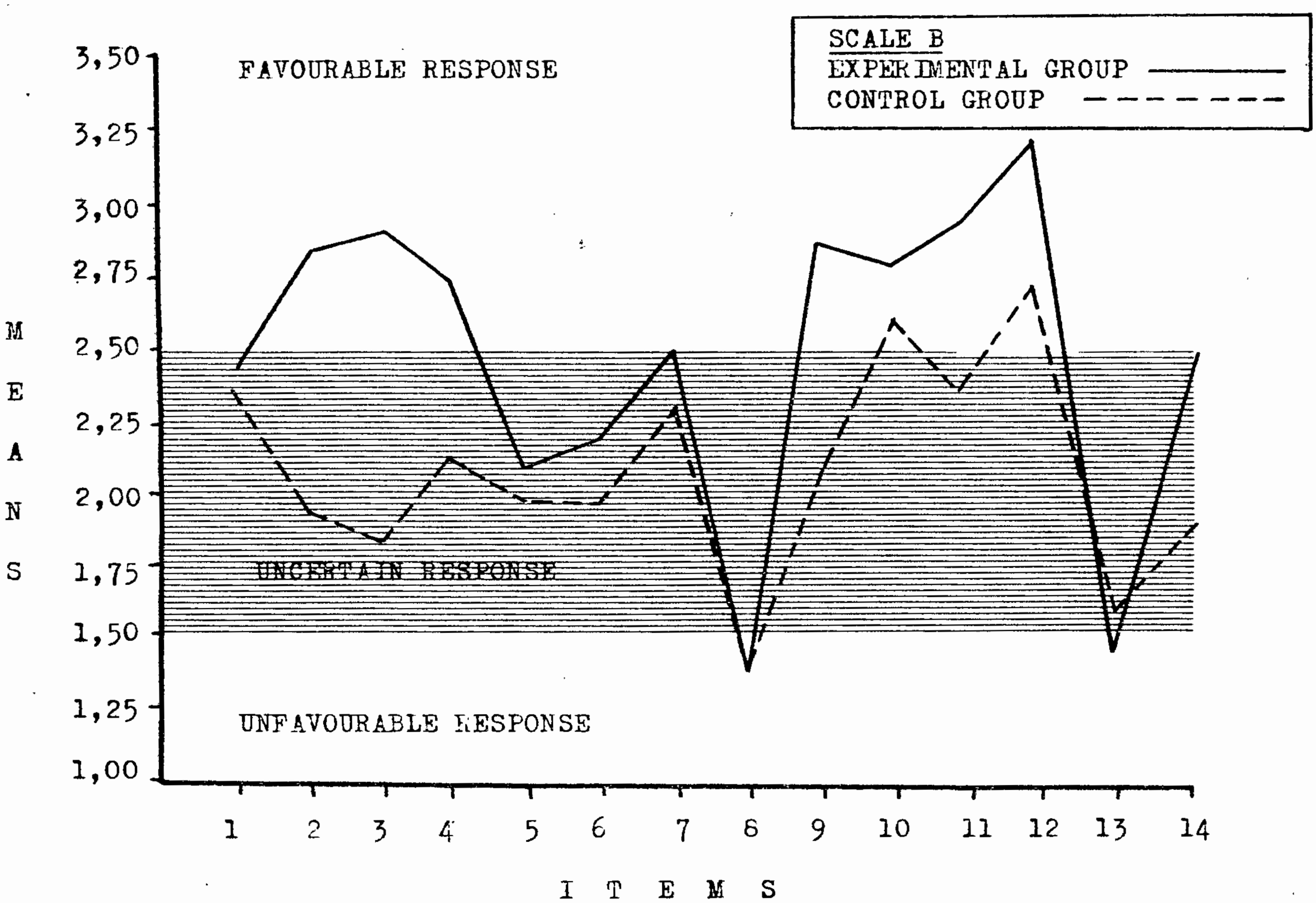

Figure 9.2 A comparison of the item means obtained by the Experimental Group and Control Group A on Scale B of the pretest.

(b)/...

(b) Commentary on Scale B

(i) A significant difference between means was found for items 2, 3, 4, 9 and 14.

Significant difference at the 1% level:-

Item	Interpretation of Attitudes.
2	The experimental group was much more aware of the interdependence of all branches of knowledge than the control group. ($p = 0{,}01$)
3	The experimental group was much more interested in scientific discoveries and how they relate to society than the control group. ($p = 0{,}01$)

Significant difference at the 5% level:-

Item	Interpretation of Attitudes.
4	The experimental group was more aware of the contributions of scientists to society than the control group. ($p = 0{,}05$)
9	The experimental group was more convinced of the value of scientific endeavour as a means of solving social problems than the control group. ($p = 0{,}05$)
14	Both groups appreciated the contribution of the scientist in society, but the experimental group was more appreciative in this respect. ($p = 0{,}05$)

(ii) Item 12 elicited a uniformly favourable response on Scale B.

Item	Interpretation of Attitude.
12	Both groups acknowledged the importance of Chemistry as vital to the study of Biology.

(iii) Items 8 and 13 elicited a uniformly unfavourable response on Scale B.

Item	Interpretation of Attitude.
8 and 13	Neither group was prepared to voluntarily participate in any class research project of obvious personal relevance if it involved sacrificing some of their own free time after school hours.

Figure 9.3./...

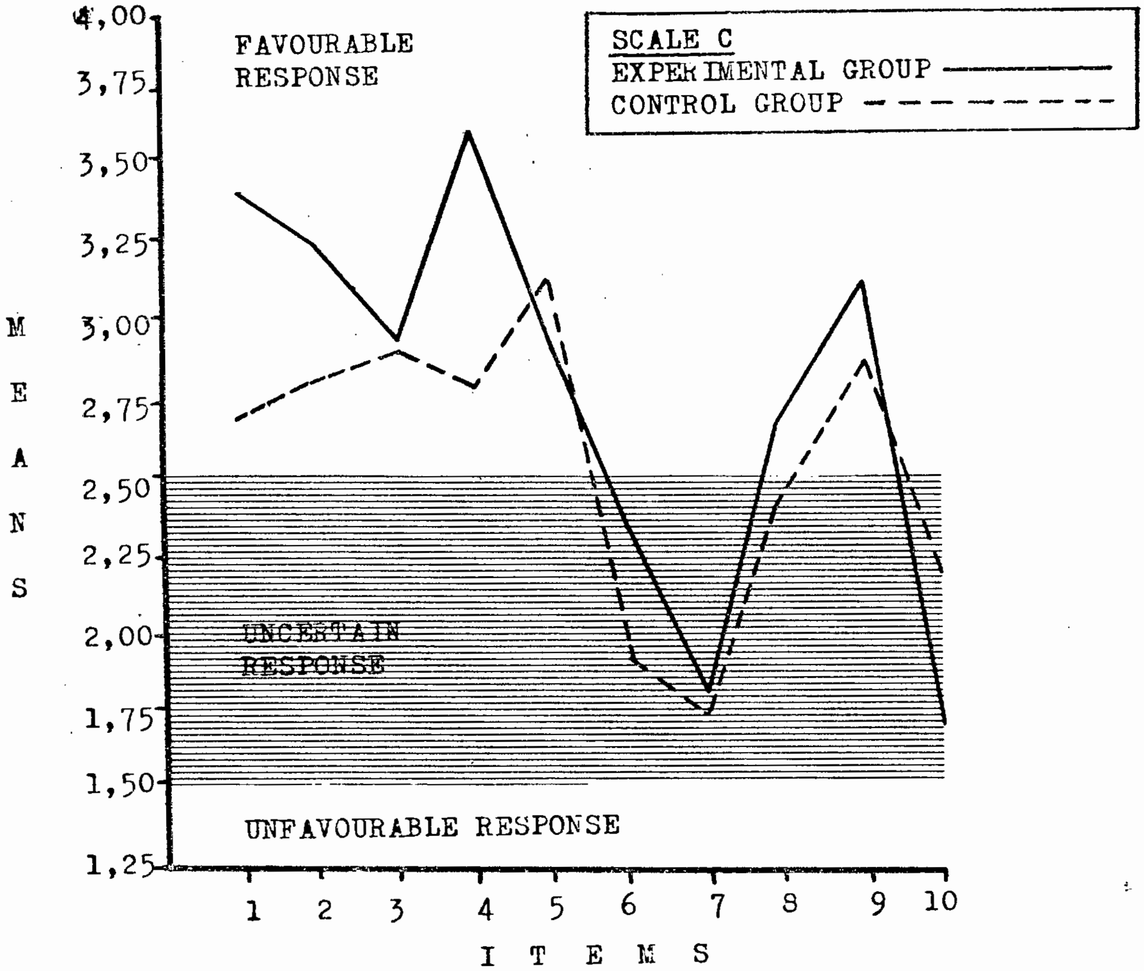

Figure 9.3 <u>A comparison of the item means obtained by the Experimental Group and Control Group A on Scale C of the pretest.</u>

(c) <u>Commentary on Scale C</u>

(i) A <u>significant difference</u> between means was found for items 1 and 4 at the 5% level:-

Item/...

Item	Interpretation of Attitude.
1	Both groups showed signs of experiencing a measure of creative frustration over unsolved problems that serve as a source of intrinsic motivation. However the experimental group was significantly more motivated than the control group. ($p = 0,05$)
4	Both groups take pleasure in debating solutions to biological problems and in imaginative solutions, but the experimental group get more pleasure from this than the control group. ($p = 0,05$)

(ii) Items 3, 5 and 9 elicited uniformly favourable responses on Scale C.

Item	Interpretation of Attitude.
3	Both groups showed a positive awareness of living things.
5	Both groups showed a positive awareness of wild life.
9	Both groups were acquiring a respect for creative, imaginative thinking.

(iii) There were no uniformly unfavourable responses to to items on Scale C.

Figure 9.4/...

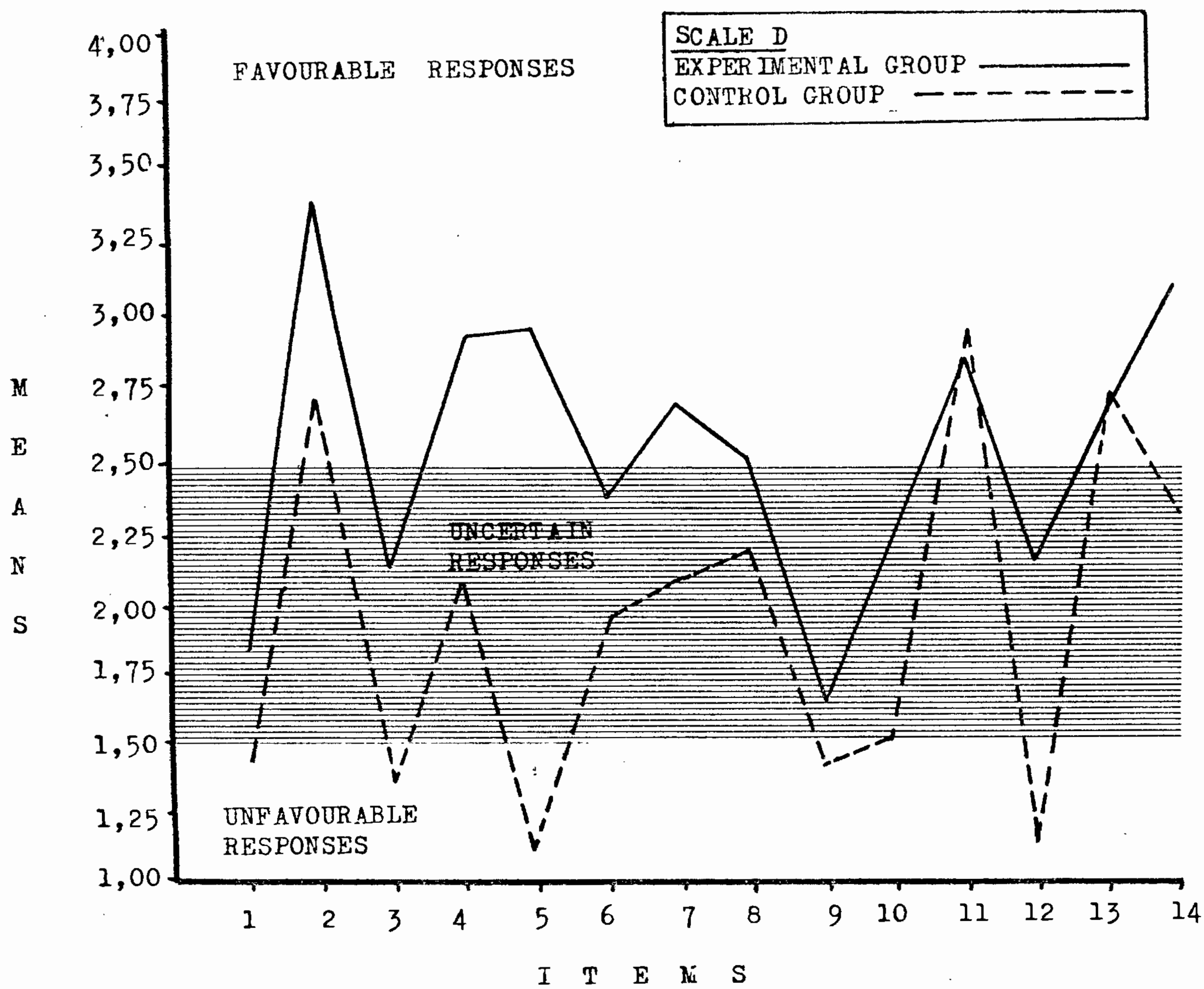

Figure 9.4 A comparison of the item means obtained by the Experimental and Control Group A on Scale D of the pretest.

(d) Commentary on Scale D

(i) A significant difference between means was found for items 2,3,4,5,10,12 and 14.

Significant diffence at the 1% level:-

Item/...

Item	Interpretation of Attitude.
5	The most marked difference between the two groups was with regard to the enjoyment of science. The experimental group identified science as one of its favourite subjects; the opposite applied in the case of the control group. This might be a function of intellectual ability to cope with the conceptual thinking demanded by science, or associated with the fact that more highly motivated students tend to select Physical Science in conjunction with Biology, than those who select Biology alone. ($p = 0{,}01$)
12	The experimental group showed a higher commitment to science by being prepared to devote its own time to research investigations for intrinsic motives alone, which the control group was unprepared to sacrifice in the interests of science. ($p = 0{,}01$)

Significant difference at the 5% level:-

Item	Interpretation of Attitude.
2	While both groups showed an interest in experimental work, the interest of the experimental group was more pronounced. ($p = 0{,}05$)
3	The experimental group seemed to have a limited understanding and acceptance of the limitations of the Scientific method, but this was lacking in the control group. ($p = 0{,}05$)
4	The experimental group was reasonably enthusiastic regarding the possibility of voluntary experimental work at school after hours, indicating a high degree of intrinsic motivation which the control group lacked in this respect. ($p = 0{,}05$)
10	While both groups seemed uncertain about the application of scientific methods in other areas of human endeavour, the control group was less perceptive in this regard. ($p = 0{,}05$)
14	The control group was generally against any incursion of "scientific" investigations into its holiday time. By comparison the experimental group was generally more positive in this respect. ($p = 0{,}05$)

(ii) Items 2, 11 and 13 elicited <u>uniformly favourable responses</u> on Scale D.

Item	Interpretation of Attitude.
2	See above under significant differences.
11	Both groups showed confidence in the power of logical deduction as an approach to problem-solving.
13	Both groups showed a reasonable tolerance and acceptance of objective criticism at the personal level. This was felt to indicate an awareness of personal limitations and the accompanying humility and caution.

(iii) Items 1 and 9 elicited <u>uniformly unfavourable responses</u> on Scale D.

Item	Interpretation of Attitude.
1	Neither group felt confident of its ability to formulate testable hypotheses.
9	Both groups showed an unwillingness to re - consider cherished values, that approached the characterisation level, regardless of evidence.

Figure 9.5/...

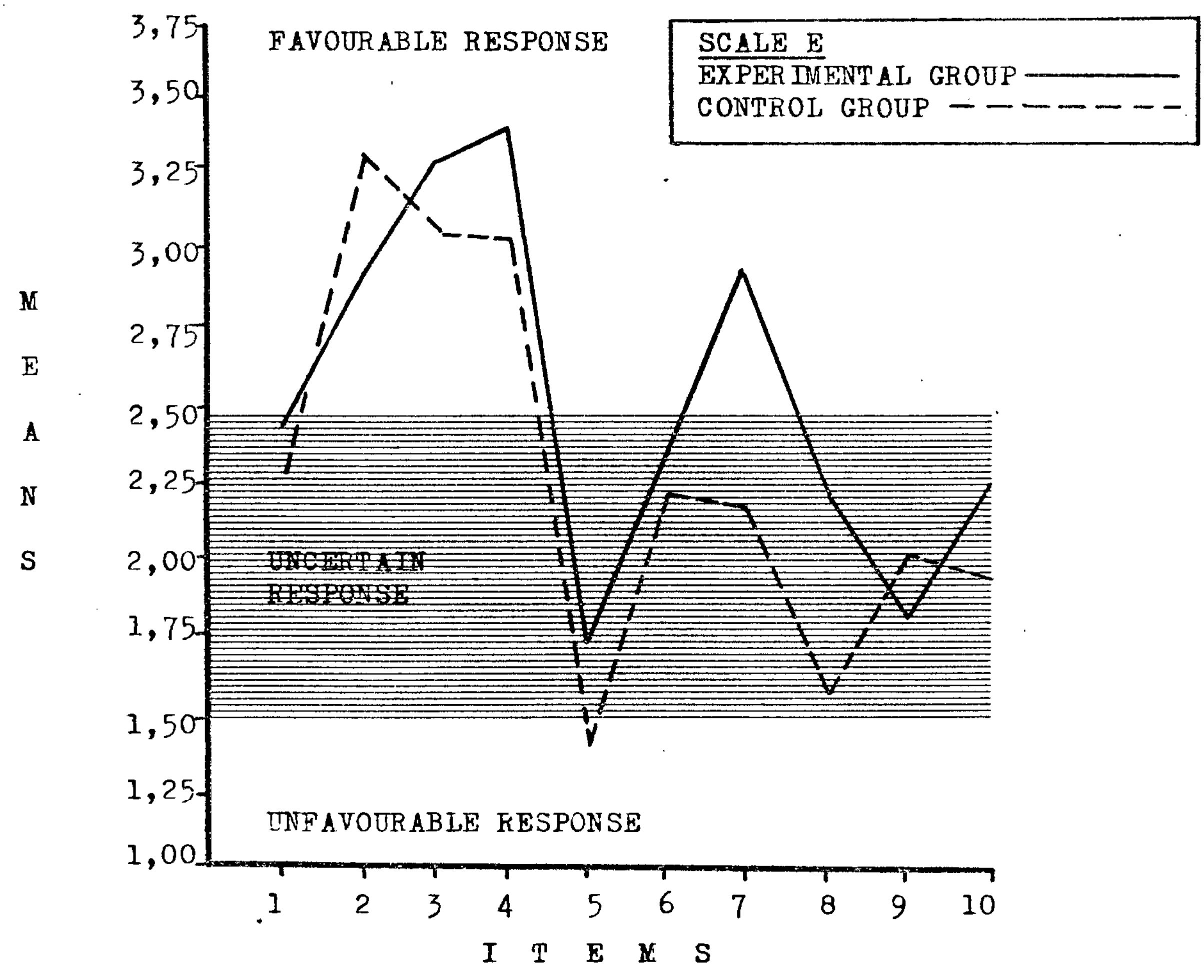

Figure 9.5 A comparison of the item means obtained by the Experimental and Control Group A on Scale E of the pretest.

(e) Commentary on Scale E.

(i) A significant difference between means was found for items 7 and 8.

Significant difference at the 5% level:-

Item/...

Item	Interpretation of Attitude.
7	The experimental group showed a definite interest in scientific information presented in popular form, while the control group was relatively indifferent. ($p = 0,05$)
8	The experimental group were generally more alert to biological news than the control group. ($p = 0,05$)

(ii) Items 2, 3 and 4 elicited uniformly favourable favourable responses on Scale E.

Item	Interpretation of Attitude.
2	Both groups were aware of conservation measures reported in the press affecting the local environment.
3	Both groups showed a sound appreciation of the need to compensate for media bias.
4	Both groups indicated their enjoyment of popular television programmes promoting wild life conservation.

(iii) Item 5 elicited a fairly unfavourable response on Scale E.

Item	Interpretation of Attitude.
5	Both groups admitted they did not read all the articles of biological interest they came across.

Figure 9.6/...

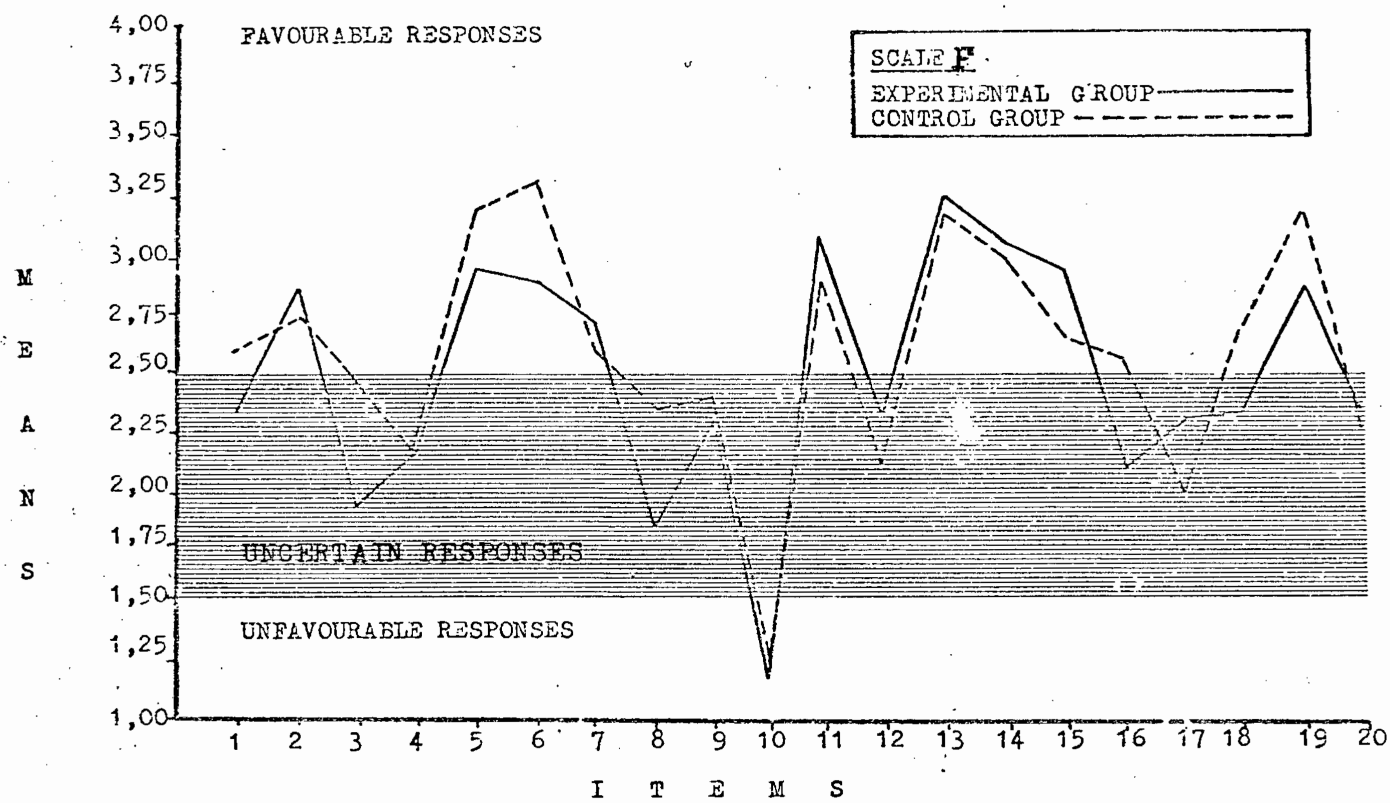

Figure 9.6 A comparison of the item means obtained by the Experimental and Control Group A on Scale F of the pretest.

(f) Commentary on Scale F

(i) There was no significant difference between the means obtained by the Experimental and Control Group A.

(ii) Items 5,6,11,13,14,15 and 19 elicited uniformly favourable responses on Scale F.

Item	Interpretation of Attitude
5 and 14	Both groups enjoyed hikes in natural and unspoilt surroundings.
6	Both groups showed signs of wanting to know more about conservation ethics.

Item	Interpretation of Attitude.
11	Both groups were sensitive to the beauty of our fauna and flora.
13	Both groups were interested in conservation and wild life management techniques.
15	Both groups were curious, taking pleasure in wild animals and plants.
19	Both groups respected the conservation laws in principle and appreciated the need for such laws.

(iii) Item 10 elicited a uniformly unfavourable response on Scale F.

Item	Interpretation of Attitude.
10	Both groups were against any commitment to environmental improvement that involved sacrificing their own time.

C. SUMMARY OF SIGNIFICANT DIFFERENCES AND SIMILARITIES BEFORE THE INSTITUTION OF THE EXPERIMENTAL PROGRAMME.

This chapter has been designed to answer research question one of this study, namely to emphasise significant differences that exist between the two groups at the outset of the programme.

However, if whole scales are compared, only Scale D is significantly different in terms of the means obtained by the two groups. This is felt to be in some measure associated with the fact that the experimental group selected to study Physical Science in addition to Biology, and is probably indicative of a better insight into Physical Science obtained in Std. 6 and 7. Scale D would tend to favour pupils who had a better insight into Physical Science.

If/...

If the significantly different items within each scale are isolated, then only 16 of the 78 items (20%) are found to be significantly different. In other words, there is a high percentage of items where any differences recorded are probably due to chance alone (80%).

Generally speaking the two groups are very similar in terms of their initial affective development prior to the programme.

An analysis of similarities at this stage based on extremely favourable responses highlights mutually positive attitudes towards:

1. Outdoor education
2. All facets of nature conservation
3. Objective reasoning and criticism
4. Living things.

An analysis of unfavourable responses highlights these mutually negative attitudes:

1. Any incursion into personal free-time regardless of purpose.
2. A lack of commitment to reading scientific articles.
3. Basic unwillingness to change deep-seated ideas regardless of evidence.

An analysis of significant differences existing at this stage identify the experimental group as being:

1. The more highly motivated group with a deeper commitment to science, experimental work and reading scientific material.

2. The group more interested in scientific endeavour and discovery. They have a better understanding of scientific methods and applications in society. They are more inclined to regard science as one of their favourite subjects.

3. The group that appreciates the interdependence of knowledge and the value of lateral thinking.

While these differences will obviously affect the experimental programme, it should be emphasized again that there are far more points of basic similarity between the two groups than significant differences.

CHAPTER 10

THE POST TEST : AN ANALYSIS OF RESULTS

CHAPTER 10 : THE POST TEST : AN ANALYSIS OF RESULTS

A. THE ORGANISATION OF THE POST TEST

The Post Test was to all intents and purposes a repetition of the pretest scales. The method of assessing the post test was identical to that described in Chapter 9 for the pretest.

However there were some note worthy differences in the administration of the post test :

(a) All three Std. 8 classes wrote the post test, thus ensuring that there was a control group that had previously written the pretest and one control group that had not been exposed to a pretest. (See Table 10.1)

CLASS	1	2	3
GROUPING	Experimental Group	Control A	Control B
	PRETEST		NO PRETEST
NUMBER OF PUPILS	28	33	20
	POST TEST		
NUMBER OF PUPILS	28	32	20

Table 10.1 The pupils who wrote the pre- and post- tests.

Full details of the post test results are recorded in Appendix B pages 66 to 76.

(b) It will be noted from the explanatory note provided as a prefix to the post test (see page B67), that all pupils were encouraged to reconsider their opinions regarding the statements in the six scales in the light of recent fresh understandings of their world situation, emphasising the changes that might hopefully have taken place as a result of the experimental programme.

In all other respects the two tests were identical, and a full description of the post test can be read into the pretest description given in pages 219 to 223 of Chapter 9.

B. THE RESULTS OF THE POST TEST

The purpose of the post test was to answer three of the research questions posed in Chapter 8 (see pages 213 to 215), namely questions b,c and d.

<u>Question (b).</u>

How did the pattern of responses differ between the experimental and control group before and after the experimental programme?

<u>Question (c).</u>

What differences, if any, did the environmental experience produce between the experimental and control groups?

Question (d)/...

Question (d)

Did the taking of a pretest affect the results obtained on the post test?

These questions will be dealt with in reverse order for the sake of preserving a uniform format for Chapters 9 and 10.

1. Comparison of the results of whole scales.

   (a) The pretest as a learning experience.

   Question (d) was designed to establish whether or not the pre-test itself could affect the attitudes of pupils, with regard to the content of the six scales. To this end Control A and Control B post test results were compared to establish if the exposure to the pretest made a significant difference or not. (Control B were not exposed to the pre-test.)

   Table 10.2. summarises the more complete table of results provided in Appendix B 76 in which mean scores are interpreted as percentages.

SCALES	A	B	C	D	E	F
Mean of Control A	62,0	55,4	61,1	46,6	54,5	63,0
Mean of Control B	51,1	52,7	59,1	45,4	50,5	62,0
Difference in Means	** +10,9	+2,7	+2,0	+1,2	+4,0	+1,0

(These results are graphically presented in Graph 10.1, p. 252)

Table 10.2 A comparison of means obtained by Control Groups A and B in terms of percentages on the post test.

An/...

An analysis of these results indicates:

(i) That, with the exception of Scale A, there was no significant difference between the post test scores of Control A and B. On the contrary, the results were remarkably similar for scales B to F.

(ii) In respect of Scale A the "significant difference" (1% level of confidence) is regarded by this author as being a "red herring" and of no special significance for this research question.

It could be accounted for in terms of:

(a) Pretest sensitation of Control A to Scale A <u>alone</u>; which is considered unlikely in view of the overlapping attitudes dealt with in Scales A and F.

(b) A basic difference between Control A and B with regard to attitudes tested by Scale A <u>alone</u>; which view is also rejected on the grounds of the close similarity of Scales B to F.

(c) Faulty measurement of significant difference based on Control B containing far too few pupils (N=20) for effective t-testing. This latter view enjoys this author's support.

(iii) While Control A has slightly better results than Control B on all scales. This difference is not significant (if Scale A is ignored).

(iv) We conclude that the pretest was not a learning experience and that any differences in attitude over and above initial differences noted in the pretest are due to the experimental programme alone, all other variables being held constant.

(b) The impact of the environmental programme.

Question (c) was designed to measure the gross differences resulting from the experimental programme between the experimental class and a control class. Both groups wrote pre- and post-tests. Table 10.3 summarises the more complete table of results provided in Appendix B68 in which mean scores are interpreted as percentages.

SCALES	A	B	C	D	E	F
Mean of Experimental Group	67,5	67,7	72,8	68,2	66,6	69,4
Mean of Control A	62,0	55,4	61,1	46,6	54,5	63,0
Difference in means (E-A)	+5,5	+12,3*	+11,7*	+21,6**	+12,1*	+6,4*
Mean of Control B	51,1	52,7	59,1	45,4	50,5	62,0
Difference in means (E-B)	+16,4**	+15,0*	+13,7*	+22,8**	+16,1*	+7,4*

(These results are graphically represented in Graph 10.1 , p. 252)

Table 10.3 <u>A comparison of means obtained on the post test for all groups in terms of percentages before discounting initial pre-test differences.</u>

An/...

An analysis of these results indicates:

(i) That there was a significant difference between the post test results of the Experimental and Control Groups for all scales, with the exception the difference between the Experimental Group and Control A on Scale A.

The difference between the two control groups has already been dealt with on page 246.

(ii) The differences were most marked in Scale D, were they reached the 1% level of confidence. The difference noted between the Experimental Group and Control B was ignored for the reason dealt with on page 246.

(iii) That <u>the environmental programme has made a measurable impact on the Experimental Group, the extent of which can only be determined after discounting initial pre-test differences</u>.

(c) The improvement and deterioration of attitudes during the experimental period.

Question (b) was designed to make adjustments to post test results for initial pretest differences, and expose response patterns and their variations.

Only the experimental group and control A were compared, being the only groups who wrote both pre- and post tests.

Table 10. 4 summarises the more detailed table of results provided in Appendix B 75 in which mean scores are interpreted as percentages.

Table 10.4/...

	SCALES	A	B	C	D	E	F
EXPERIMENTAL GROUP	Pretest Means	63,2	59,3	69,2	64,2	62,8	62,4
	Post test Means	67,5	67,7	72,8	68,2	66,6	69,4
	Difference in Means	+4,3	+8,4	+3,6	+4,0	+3,8	+7,0
CONTROL A	Pretest Means	62,7	52,1	64,1	48,1	57,1	64,4
	Post test means	62,0	55,4	61,1	46,6	54,5	63,0
	Difference in Means	-0,7	+3,3	-3,0	-1,5	-2,6	-1,4

(These results are graphically presented in Graph 10.1, p. 252)

Table 10.4 Comparison of pre-and post-test results of Experimental and Control Group A in terms of percentages.

An analysis of these results indicates:

(i) That there was a general improvement in the affective development of the Experimental group, while there was a general deterioration in the affective development of Control A (with the exception of Scale B.) These results echo the findings of Shock (1) who pointed out the general deterioration of attitudes with increasing cognitive development. They also support the findings of Fraser (2) who found that pupils of a higher socio-economic status sub-group studying science along environmental lines show a slight increase in affective development thus reversing the general trend documented by Shock.

These/...

These results also reinforce the findings of Lowery (3) and Simmons and Esker (4) in establishing the environmental process approach to Biology teaching as a significantly more successful method of reducing the rate of affective deterioration than the traditional lecture/demonstration approach – even to the extent of producing substantially more positive attitudes in science pupils in the secondary school.

(ii)/...

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(1) Shock N.H., "Analysis of the relationship which exists between cognitive and affective educational objectives". Journal of Research in Science Teaching. Vol. 10. No. 4. (1973)

(2) Fraser B.J., "Are A.S.E.P. pupils achieving the aims?" The Australian Science Teachers' Journal, Vol. 22. No. 3 (1976)

(3) Lowery L.F., "An experimental investigation into the attitudes of fifth grade students towards Science.", School Science and Mathematics. Vol. 67. No. 6. (1967)

(4) Simmons, J. and Esker, W., "Investigating the attitudes towards science fostered by the process approach," School Science and Mathematics. Vol. 72. (1972)

(ii) That the differences between the pre- and post- test means are not significant in the case of either group; and that, if the effects of pretest differences on post test results are eliminated, the differences due to the experimental programme alone are rather small.

SCALES	A	B	C	D	E	F
Pretest difference of means (E-A)	+0,6	+7,2	+5,1	+16,2**	+5,7	-2,1
	(From Table 9.3)					
Post test difference of means (E-A)	+5,5	+12,3*	+11,7*	+21,6**	+12,1*	+6,4*
	(From Table 10.3)					
Difference due to experimental programme alone	+4,9	+5,1	+6,6	+5,4	+6,4	+8,5*

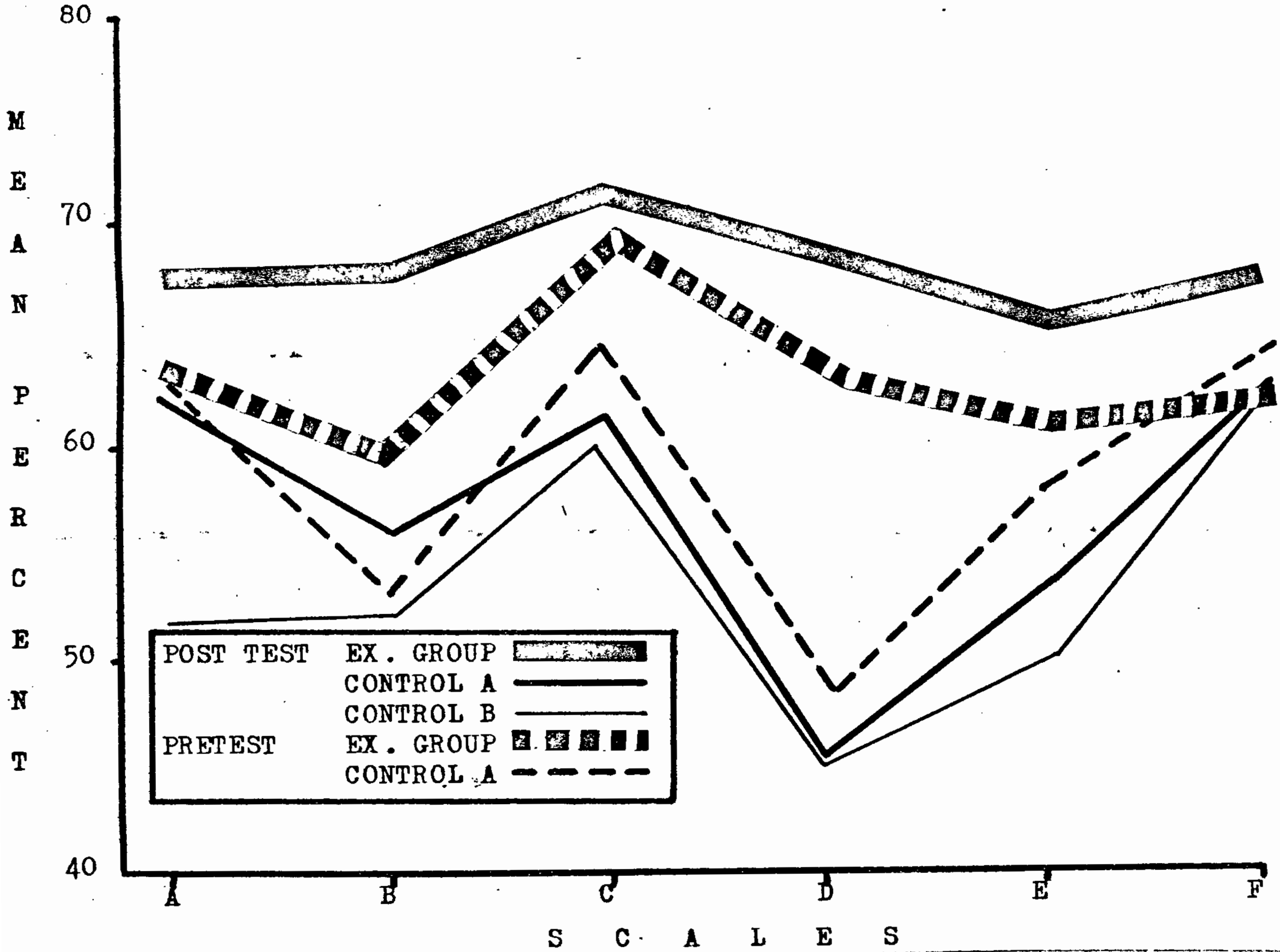
Table 10,5 Comparison of pre- and post- test differences of means for Experimental and Control A Groups, expressed as percentages.

The above table indicates that there was a significant difference (p = 0,05) between the Experimental Group and Control Group A on Scale F after correcting for pretest differences. This writer feels that this result could well have been anticipated as Scale F is based on the CONSERVATION AIM and the experimental programme that produced this difference is basically an environmental-awareness programme. The other five scales were not significantly different after adjustments. The fact that the other five scales appear from the above figures to be unaffected by the experimental programme, conceals the rapidly developing trends within the scales that have not yet cumulatively reached the 5% level of significance during the two months of the programme. These trends will emerge when we take

a/...

a closer look at what is happening within the scales.

The answers to the three research questions are graphically summarised in Graph 10.1.



Graph 10.1 <u>A comparison of the response patterns during the pre- and post- tests for all groups</u>.

This graph establishes clearly:

(i) The similarity between the post test results of Control A and B; indicating that the pre test did not affect the post test results. (Research Question (d).)

(ii) The difference between the post test results of Control A and the Experimental Group; indicating the increasing difference in the affective development of the two groups. (Research Question (c).)

(iii)/...

(iii) The similarity of response patterns within the experimental and control groups before and after the experimental programme, and the clear tendency for developing in opposite affective directions; the experimental group towards improvement, and the Control Group (A) generally towards deterioration. (Research Question (b)).

2. <u>Comparison of the results within scales.</u>

A full set of tables of the results obtained during a comparison of item means within each scale for the Experimental and Control Group A can be found in Appendix B 69 to 74.

Table 10.6 is a brief summary of the significant differences found between the individual item means of the two groups.

As anticipated there are many more significant differences in Scale D than any other scale, before adjustment for pretest differences. The picture changes dramatically after adjustments have been made, but if the developing trends ($0,10 < p \leqslant 0,20$) are born in mind(See Table 10.7) it becomes clear that most of the affective mobility is expressed in Scale F as anticipated in Table 10,5.

Table 10,6/....

BEFORE AJUSTMENT FOR PRETEST DIFFERENCES						
SCALES	A	B	C	D	E	F
p = 0,05	-	6 13	8	8	10	6 17
p = 0,01	-	-	9	6 7 9	-	-
(See Appendix B 59 - 64)						
AFTER ADJUSTMENT FOR PRETEST DIFFERENCES						
SCALES	A	B	C	D	E	F
p = 0,05	1	4	5	-	9	-
p = 0,01	-	13	-	9	-	6
(See Appendix B 69a - 74a)						

Table 10.6 Items highlighting significant differences between the Experimental Group and Control A after the post test.

The above table indicates that only 9% of the items yielded a statistically significant difference between the Experimental Group and Control A after the initial pretest differences are compensated for. A closer examination reveals that one of these seven items, (B4), shows a significant deterioration of the Experimental Group compared with the improvement shown by Control Group A.

It should be borne in mind that these significant differences, whose origin has now been traced back to the experimental programme alone, emerged after only two months of teaching using an environmental approach to the biology syllabus.

Accordingly it was decided to examine the developing trends in affective development that have not as yet reached the 5% level of confidence, by lowering the threshold criteria for recognition of statistical significance to p = 0,10 and p = 0,20.

These results are shown in Table 10.7:

		FIRM CONCLUSIONS		DEVELOPING TRENDS	
	Level of statistical significance P <	0,01 **	0,05 *	0,10 ++	0,20 +
ANTICIPATED RESULTS	Experimental Group improve alone	B13 D 9	C 5	F 3 F10 A 3	B 6 B 8 B 9 C 7 D 6 F 7
	Experimental Group improve/ Control A deteriorates	F 6	A 1 E 9	C 3 C 9 D14 E 7 F 8 F17 A 2	C10 D 4 E 6 F 5 F 9 F16 F20
	Control Group deteriorates alone				C 8
ANOMALOUS RESULTS	Experimental Group deteriorate/ Control A improves	-	B 4	A 9	
	Control A improves alone	-	-	B 3	B14

These results were obtained from Appendix B69a - 74a.

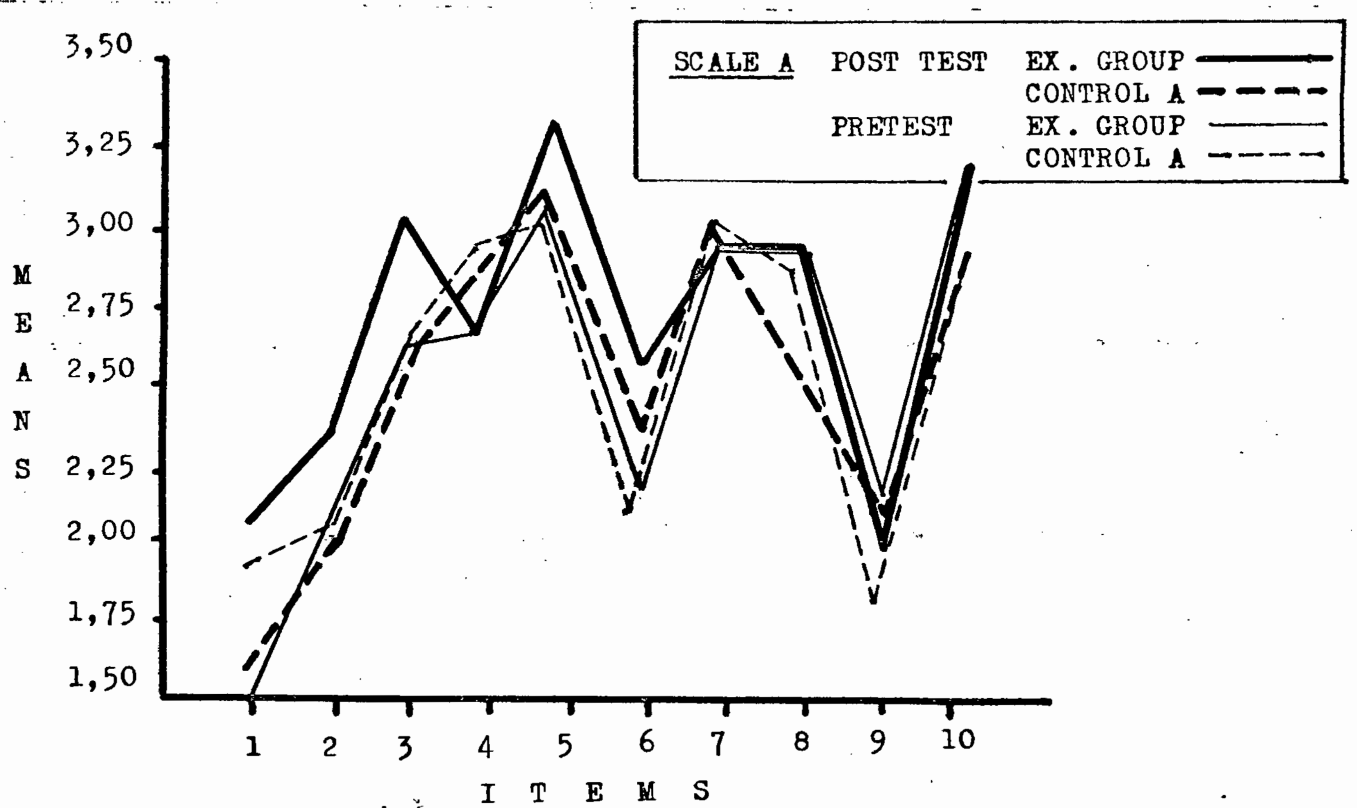
Table 10.7 Significant items classified as firm conclusions and developing trends after final adjustments for initial pretest differences.

The means obtained on the 78 post test items were graphed in order to facilitate comparisons between the two groups. The data on which these graphs were based can be found in Appendix B 69 - 74.

The/...

The 6 attitude scales are considered individually under two headings; firm conclusions and developing trends.

(a) Scale A



Graph 10.2 Comparison of item means obtained on Scale A before and after the experimental term.

(i) Firm conclusions

The Experimental Group did not appear to have gained much from the programme that has affected its attitudes to Scale A. After two months only one attitude difference has reached the statistically significant level, namely:

Item	Interpretation of Attitude
1	The experimental group showed a definite increase in their willingness to assume a more active role in helping to preserve a threatened habitat. e.g. helping to clean up litter at the beach. The control groups attitudes with regard to this item deteriorated during the same period. The difference between the two groups is statistically significant(p = 0,05).

This/...

This illustrates a common trend on the scales overall. Affective improvement of the Experimental Group and affective deterioration of the Control Group often proceed simultaneously, as anticipated. See Table 10.7.

(ii) Developing trends

Items 2 and 3 exposed a difference between the two groups at the 10% level of confidence:

Item	Interpretation of Attitude
2 and 3	These items related to the same attitude. They illustrate that the willingness to assume an active role in preserving a threatened habitat (item 1) might stem from a developing conviction of the worth and value of natural habitats. Unhappily there is no evidence of a similar growth of affective development in the Control Group (item 3) and some evidence of affective deterioration (item 2). ($p = 0{,}10$)

Item 9 yielded an anomalous result ($p = 0{,}10$) which suggested that the Experimental Group were losing interest in studying animals and plants in their natural surroundings, while the opposite was true of the Control Group his development was ignored as an anomalous result as it did not seem to match the positive affective development of either group as exposed by Scale F.

(b) Scale B

(i) Firm conclusions

After two months of the experimental programme two items registered attitudes that were significantly different for the Experimental Group and Control A:

Item/...

Item	Interpretation of Attitude
13	The Experimental Group showed a significant growth in their commitment to science ($p = 0,01$) that finds no matching response in the Control Group. They showed signs of willingness to participate in voluntary research projects in preference to going home in the afternoons.

Item 4 yielded an anomalous result ($p = 0,05$) which suggested that the Experimental Group were less sure of the importance of science, while the Control Group showed an improvement in their appreciation of the role of science. This writer concluded that the term "science" could possibly mean different things to each group. Possibly the Experimental Group are more inclined to confuse "science" with "physical science" and this deterioration reflects an uncertainty of the relevance of physical science for solving environmental problems. The Control Group, who do not study physical science, are perhaps less likely to show this bias, and may be using science the the more general sense.

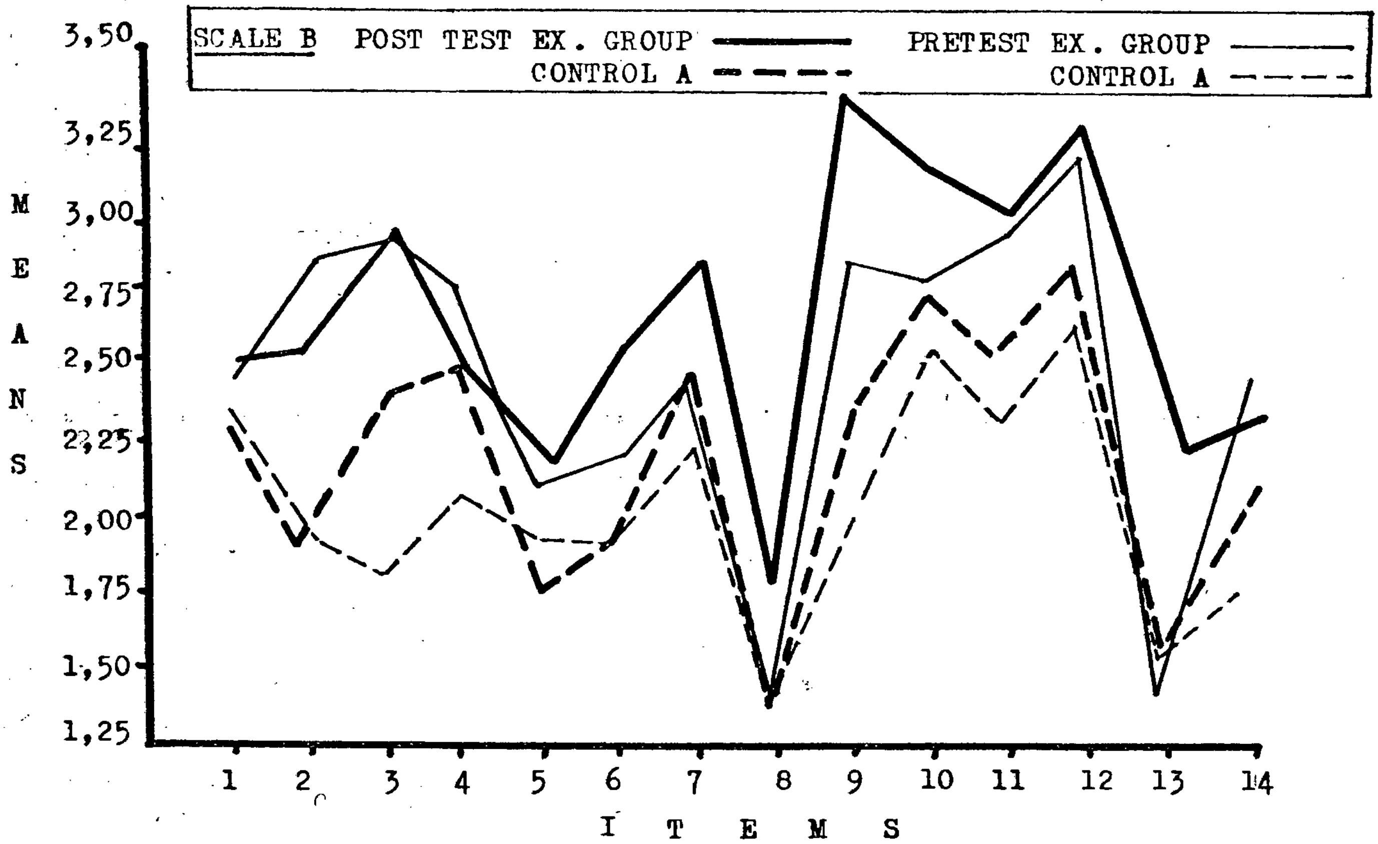
Graph 10.3 illustrates these two statistically significant results very clearly. See page 259.

(ii) Developing trends

A further anomalous result emerged at the 10% level of confidence. Item 3 showed that the Control Group alone show an increased interest in scientific discoveries and their significance for society. This attitude expresses itself through an item that challenges the amount of time devoted to science programmes on television. This desire to see more scientific programmes on television

could/...

could indicate a need for actuality that the Experimental Group found on the two field-trips and the laboratory follow-up work. This would explain the apparently anomalous results.



Graph 10.3 Comparison of item means obtained on Scale B before and after the experimental term.

Four items exposed a difference between the two groups at the 20% level of confidence:-

Item	Interpretation of Attitude
6	The Experimental Group alone showed a tendency to believe in the worth of scientific endeavour as a means of solving social problems.
8	This item supported the validity of item 13 dealt with under firm conclusions. It again reflected the Experimental Group's willingness to participate in voluntary research projects.

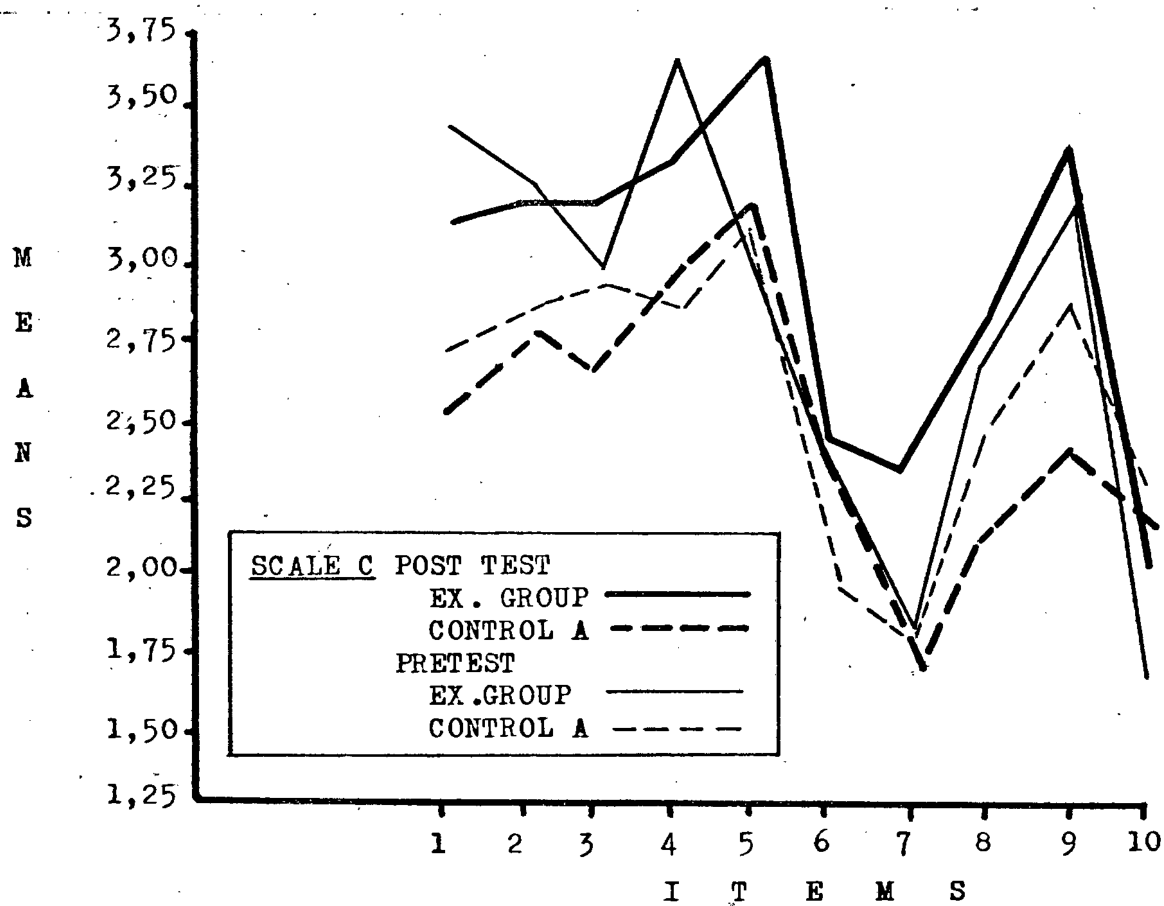
9	This item supported the validity of item 6 dealt with under developing trends. The Experimental Group alone showed a tendency to believe in the worth of scientific endeavour as a means of solving social problems.

Item 14 yielded an anomalous result (p = 0,20) which suggested that the Control Group showed greater appreciation, after the experimental term, of the scientist's contributions to society. This result was unhesitatingly rejected in the light of items 6 and 9 (p = 0,20) which both supported the opposite view that it is the Experimental Group that showed the greater appreciation of scientists and their work. Such built-in cross-checks preserved the analysis of results from gross error.

It can be concluded that positive affective development, due to the implementation of the experimental programme with the Experimental Group, has occurred. Their increased willingness to participate in voluntary research programmes (p = 0.01) stems from a greater valuing of the worth and role of the scientist in society (p = 0,20).
There is no evidence of deterioration in the attitudes of the Control Group with regard to items within the range of statistical significance being examined on this scale. Where the Contol Group has shown an improved affective development and the Experimental Group has not, the anomalous items (3, 4, 14) have been accounted for fully.

Scale C /...

(c) Scale C



Graph 10.4 Comparison of item means obtained on Scale C before and after the experimental term.

(i) Firm conclusions

After two months of the experimental programme one item registered an attitude that was significantly different for the Experimental Group and Control A:

Item	Interpretation of Attitude
5	The Experimental Group showed a significant increase (p = 0,05) in the ammount of attention they are prepared to pay to biological phenomena. No improvement was noted in Control A to match that of the Experimental Group.

(ii)/...

(ii) Developing trends

Two items exposed a developing difference between the two groups at the 10% level of confidence:

Item	Interpretation of Attitude
3	This item supported the validity of item 5 dealt with under firm conclusions. It again reflected the increased attention being paid to biological phenomena by the Experimental Group, but in addition reflected a deterioration in the affective development of Control Group A. (p=0,10).
9	The Experimental Group showed signs of gaining a deeper respect for creative, imaginative thinking. (p = 0,10) The Control Group appeared to be developing in the opposite direction. This could be a result of the Experimental Group seeing the value of hypothesis building as a prerequisite to meaningful research.

A further three items emerge as differentiators between the two groups at the 20% level of confidence:

Item	Interpretation of Attitude
7	Only the Experimental Group seemed to be developing a greater sense of creative frustration over unsolved problems. Clearly they were more inclined to try to repeat some of the experimental work associated with school biology at home in their own time, or were conducting their own simple experiments. (p = 0,20)
8	The Control Group was fairly emphatic in their rejection of independent research study techniques. The Experimental Group by contrast was marginally more favourably disposed towards independent research. (p = 0,20)

10	This item linked up with items 5 and 3 already dealt with in this section. Now the phenomenon of paying attention to biological phenomena became an interest in the same. Again the increased affective development of the Experimental Group was contrasted with the decreased affective development of the Control Group. ($p = 0,20$)

It can be concluded that during the experimental period of two months the only positive affective development occuring as measured by this scale was strictly confined to the Experimental Group, whose progress has been shown to be due to the experimental programme alone (where $p < 0,20$). During the same period the Control Group showed an affective deterioration on four of the six items reflecting significant differences between $p = 0,05$ and $p = 0,20$.

While the sample is admittedly small and the period of two months is rather short, nevertheless the picture of two groups of pupils taught by the same teacher in the same classroom yet developing affectively in opposite directions is a matter for concern.

The Experimental Group was shown to be more biologically aware ($p = 0,05$); more interested ($p = 0,20$) and more inclined to scientific methods of investigation ($p = 0,20$) as a result of the programme. There is also some evidence that they experienced satisfaction from the research programmes ($p = 0,20$) and are developing a respect for creative logic and reasoning ($p = 0,10$).

Conversely/...

Conversesely, it is a matter of some concern that the opposite might be true of the Control Group in a general sense. The more they learnt, the less biologically aware they become ($p = 0,10$). The more they were taught by traditional methods (lecture/demonstration methods) the less willing they become to participate in independent research investigations ($p = 0,20$). Their natural curiosity appeared to be being slowly stifled by easy learning techniques aimed primarily at cognitive objectives evaluated by formal examinations, and so the less they were required to think for themselves the less respect they had for the creative, imaginative hypotheses of others ($p = 0,10$).

(d) Scale D

(i) Firm conclusions

After two months of the experimental programme one item registers an attitude that is significantly different for the Experimental Group and Control A:

Item	Interpretation of Attitude
9	The Experimental Group showed a significant growth in open-mindedness ($p = 0,01$). They showed an increased willingness to reconsider and, if necessary, set aside cherished theories when confronted with fresh evidence that negated them. No corresponding growth of open-mindedness could be found in the Control Group.

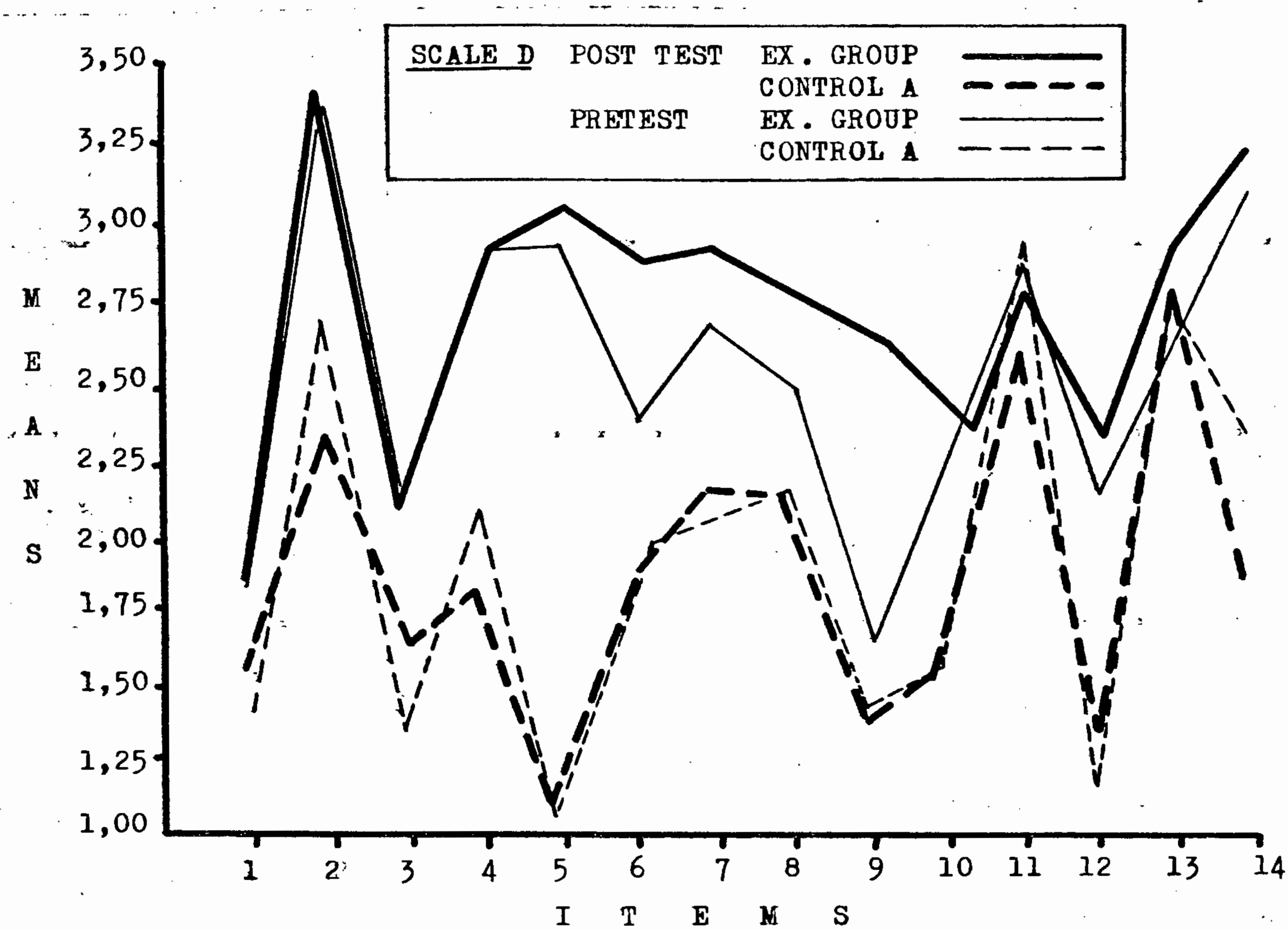
(ii) Developing trends

One item exposed a developing difference between the two groups at the 10% level of confidence:

Item/...

Item	Interpretation of Attitude
14	The Experimental Group showed a definite increase in interest in the way that scientists work, even to the point where most were beginning to long for an opportunity to work alongside a scientist ($p = 0,10$). The Control Group were definitely less interested in this area and hence did not share the same aspirations.

Graph 10.5 illustrates these differences:



Graph 10.5 <u>Comparison of item means obtained on Scale D before and after the experimental term.</u>

A/...

A further two items emerged as differentiators between the two groups at the 20% level of confidence:

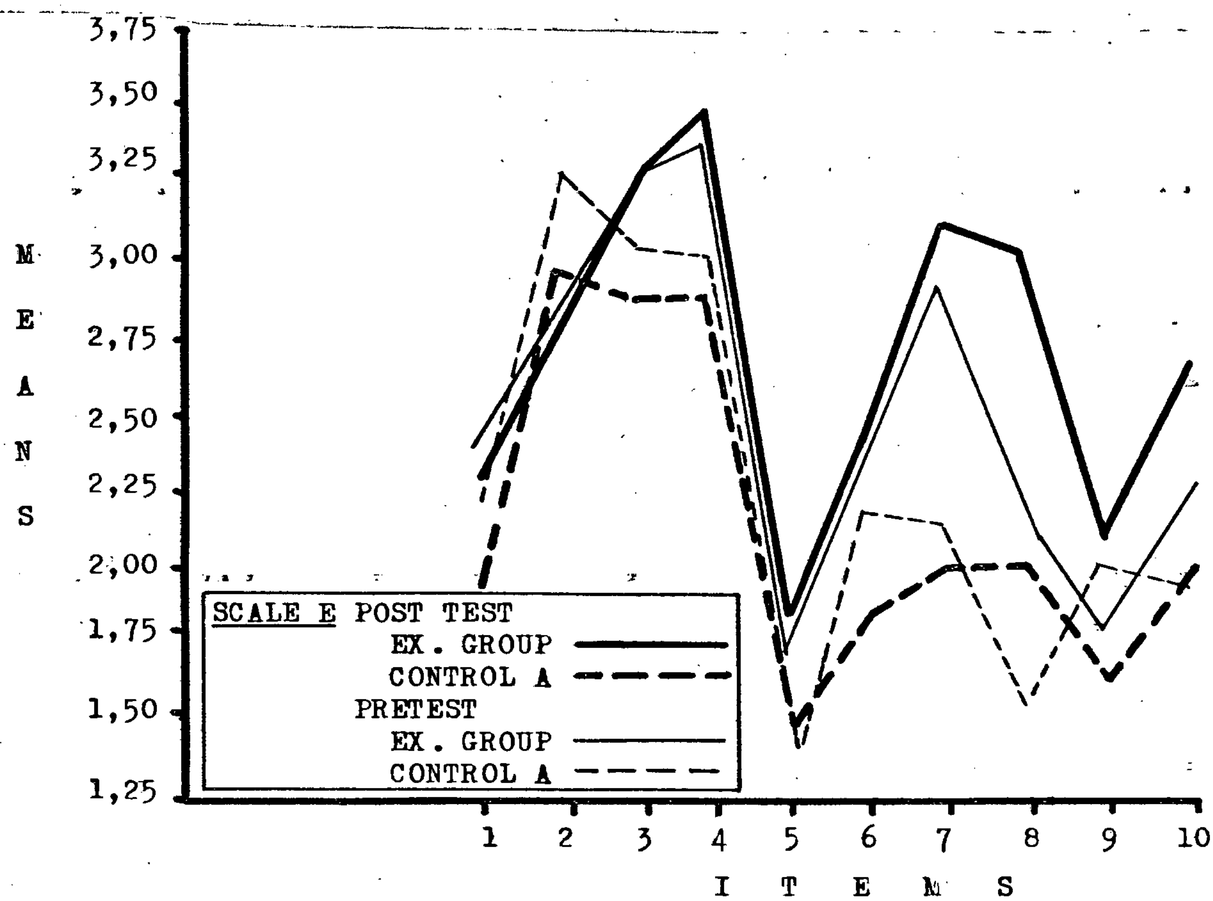
Item	Interpretation of Attitude
4	In keeping with the attitude exposed by item 14, the Experimental Group were keen to have access to laboratory facilities, even if this meant investing some of their personal free-time in the afternoons to work after school in the laboratory on an unsolicited voluntary basis ($p = 0,20$). The Control Group were emphatic in their increased rejection of this idea.
6	This item supported the validity of item 4 dealt with above. It again reflects the enthusiasm of the Experimental Group for experimental practical laboratory work at any time. ($p = 0,20$).

It can be concluded that during the experimental period of two months the only positive affective development occuring as measured by this scale was strictly confined to the Experimental Group, whose progress has been shown to be due to the experimental programme alone (where $p < 0,20$). The Experimental Group was shown to be moving in the direction of increased open-mindedness and rejection of prejudice that would ensure a high degree of tolerance to new ideas and concepts ($p = 0,01$). They also were shown to display a greater interest in and enthusiasm for the way that scientists work ($p = 0, 10$) and are showing definite signs of real enthusiasm for practical laboratory work, even if it is after school ($P = 0, 20$).

Conversely/...

Conversely, the Control Group remained at pretest levels with regard to old prejudices and cherished beliefs and were still notably "closed to new ideas" that may be interpreted as threatening. They showed signs of affective deterioration regarding their interest in the way that scientists work and in laboratory practical work.

(e) Scale E



Graph 10.6 Comparison of item means obtained on Scale E before and after the experimental term.

(i) Firm conclusions

After two months of the experimental programme one

item/...

item registered an attitude that was significantly different for the Experimental Group and Control A:

Item	Interpretation of Attitude
9	The Experimental Group showed a significant increase in willingness ($p = 0{,}05$) over the Control Group as regards their readiness to make use of scientific literature in the course of their studies. The Control Group showed a definite deterioration in their willingness to make use of scientific literature.

(ii) Developing trends

One item exposed a developing difference between the two groups at the 10% level of confidence:

Item	Interpretation of Attitude
7	The experimental Group showed a positive increase in interest ($p= 0{,}10$) in articles of a scientific nature. The Control Group by contrast showed a deterioration in interest during the same period.

A further item emerged as a differentiator between the two groups at the 20% level of confidence:

Item	Interpretation of Attitude
6	The Experimental Group showed an increased preference ($p = 0{,}20$) for leisure-reading of literature dealing with biological topics. The Control Group by contrast showed a deterioration of interest in biological literature during the same period.

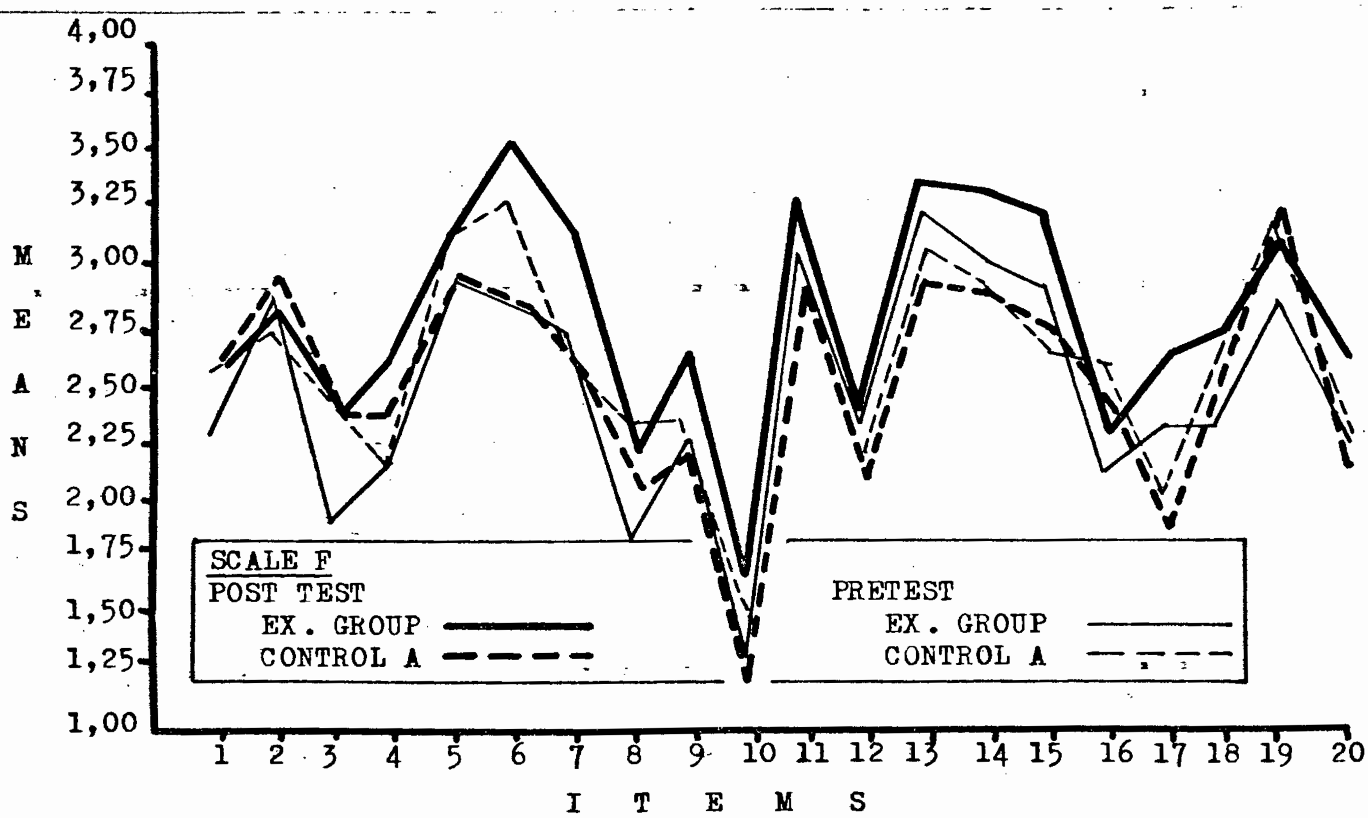
It can be concluded that during the experimental period of two months the only positive affective development occuring as measured by this scale was strictly confined

to/...

to the Experimental Group, whose progress has been shown to be due to the experimental programme alone (where p< 0,20). The Experimental Group were shown to be more ready to make use of scientific literature (p = 0,05); were more interested in (p = 0,10) scientific literature and were even beginning to show a preference for scientific literature of a biological nature during their leisure-reading (p = 0,20).

Conversely the Control Group showed signs of being unwilling to persevere with scientific literature; lack of interest in scientific literature and were definitely beginning to exclude it from their leisure-reading. This unwillingness to know may be interpreted as an ominous sign.

(f) Scale F



Graph 10.7 Comparison of item means obtained on Scale F before and after the experimental term.

(i) Firm conclusions

After two months of the experimental programme one item registered an attitude that was significantly different for the Experimental Group and Control A:

Item	Interpretation of Attitude
6	The Experimental Group showed a very significant increase in sympathy for the cause of conservation. The Control Group were noticably less sympathetic and also were developing in the opposite affective direction(p=0,01).

(ii) Developing trends

Four items exposed a developing difference between the two groups at the 10% level of confidence:

Item	Interpretation of Attitude
3	The Experimental Group was beginning to take a definite pleasure in indigenous plants and animals(p=0,10). This improvement of attitude was not matched by the Control Group.
8	This item supported the validity of item 3 above. The Experimental Group also showed themselves to be more interested in the indigenous fauna and flora, while the Control Group were losing interest in the indigenous fauna and flora.(p=0,10).
10	The Experimental Group developed a definite sense of worth and commitment to the preservation and dissemination of indigenous flowers that was not matched by the Control group (p=0,10).
17	The Experimental Group showed a willingness to commit themselves to an organisation supporting conservation practices, while the Control Group were less willing than previously (p=0,10).

Five/...

Five items emerged as differentiators between the two groups at the 20% level of confidence:

Item	Interpretation of Attitude
5	The Experimental Group showed that they enjoyed being out of doors and particpating in trail walks through unspoilt areas. The Control Group were losing interest in walking through natural unspoilt areas (p=0,20).
7	The Experimental Group showed an increased sensitivity to the threat posed to indigenous flora by alien plant invaders. The Control Group's attitude remained at pretest levels (p= 0,20).
9	This item supported the validity of item 10 dealt with previously. Once again the Experimental Group were seen to have developed a definite appreciation and desire to preserve wild flowers. The Control Group were seen to have lost interest in this respect during the experimental period(p=0,20)
16	The Experimental Group were shown to be more sensitive to the beauty of the indigenous flora and fauna than the Control Group, who were becoming less and less aware of nature (p=0,20).
20	This item supported the validity of item 5 above. The Experimental Group were shown to enjoy visiting nature reserves for pleasure and that their interest was increasing with time. Conversely the Control Group were shown to be losing the interest they had at the start of the experiment (p = 0,20).

It can be concluded that during the experimental period of two months the only positive affective development occuring as measured by this scale was strictly confined to the Experimental Group, whose progress has been shown to be due to the experimental programme alone (where $p < 0,20$).

The/...

The Experimental Group was shown to be increasingly: - sensitive to the beauty of the indigenous flora and fauna (p= 0,20); keen on out-door walks in unspoilt surroundings (p = 0,20); taking pleasure in the indigenous flora and fauna (p = 0, 10) and visiting nature reserves for pleasure (p = 0,20); commited to the preservation of threatened natural flora (p = 0,20) and sensitive to alien plant invaders (p = 0,20); in sympathy with conservation practices (p = 0,01) and willing to support organisations that are commited to the conservation ethic (p = 0, 10).

Conversely the Control Group showed signs of affective deterioration with respect to all the attitudes embodied in the significant items of this scale. They were losing: the awareness of the beauty of the indigenous flora and fauna; their enthusiasm for nature rambles and visits to nature reserves; interest in preserving threatened flora and were insensitive to alien invaders; sympathy for conservation practices and were less willing to associate with organisations that do support the conservation ethic.

Once again it is necessary to remind ourselves that both groups were taught by the same teacher in the same classroom yet due to a difference in teaching methods are clearly developing in opposite affective directions.

C./...

C. SUMMARY OF DIFFERENCES AND SIMILARIES IMMEDIATELY AFTER THE EXPERIMENTAL PROGRAMME.

This chapter has been designed to answer three research questions, namely, (1) Whether the pretest was a learning experience that affected the post test results or not?; (2) What attitudinal impact the experimental (environmental) programme made on the Experimental Group?; and finally (3) What affective development took place during the experimental period within each group? The answers to these three questions are dealt with seperately below:

(1) It was shown that the pretest was not a learning experience.

The pretest did not affect the post test results significantly. There was no significant difference between five of the six scales when pre-and post- test means were compared. Scale A yielded an anomalous result which was discounted as being due to the uncertainty caused by using t-test methods with an exceptionally small sample group.

(2) The experimental programme made a definite impact on the Experimental Group.

An analysis of the results obtained by the Experimental Group before and after the experimental programme (See Table 10.4, p. 249) indicated that there was a general attitudinal improvement on all six scales, while the same comparison of results for Control A indicated a general deterioration of attitudes on all scales with the single exception of Scale B. After an adjustment had been made to these results to compensate for pretest differences between the two groups, it was found that the differences were only significant ($p = 0,05$) in the case of Scale F. (See Table 10.5, p. 251).

Nevertheless/...

Nevertheless, the fact remains that while only one of the six scales reached the level of significant difference when the adjusted means were compared, clear trends were beginning to emerge in all six scales that indicated that the two groups were beginning to diverge in terms of their affective development and that this divergence was due to the experimental programme alone.

(3) <u>The two groups were shown to be developing in opposite affective directions</u>.

After only two months' work in the experimental programme some six items in the scales had reached the level of statistical significance ($p<0,05$), this representing almost 8% of the items in the scales. One item in Scale B yielded an anomalous result and hence was excluded from the above score.

It was clear that not all attitudes were developing at the same rate, and that while some were effected almost immediately, others would certainly need longer than two months to reach the level of statistical significance where $p<0,05$. Accordingly it was decided to distinquish between <u>firm conclusions</u> (where $p<0,05$) and <u>developing trends</u> (where $0,20 \geq p > 0,05$) that might need longer to rise to statistically significant levels.(See Table 10.7, p. 255). A further 24 items were identified as developing trends, and <u>three items were identified as anomalous results and excluded</u>

from/...

from the following score. This meant that 31% of the items in the scale were identified as positive developing trends. In all some 44% of the items (34 items) were affectively mobile. Table 10. 7 shows that some 30 of the 34 mobile items were in favour of the group that had been exposed to the experimental programme. (Table 10.7 is on p. 255).

When the affective development is considered in terms of actual attitudes rather than items, of which several often refer to the same attitude, an interesting picture emerges:

SCALES	A	B	C	D	E	F	Totals
No. of attitudes tested in purified scales	7	8	7	14	6	14	56
No. of attitudes reaching level of moderate difference ($p < 0,20$)	3	5	5	4	3	9	29
% of significantly mobile attitudes	43	63	71	28	50	64	$\bar{X}$= 52
% of moderately mobile attitudes excluding anomalous results	29	25	71	28	50	64	$\bar{X}$= 45

Table 10.8 Comparison of percentages of moderately mobile attitudes during the experimental period.

This/...

This table indicates that a high percentage of attitudes were moderately significantly mobile during the experimental period, particularly in scales C,E and F. This result was somewhat surprising when the short term of the experimental period is born in mind. In Scales C,D,E and F the significantly mobile items without exception indicated positive affective development for the Experimental Group and Deteriorating affective development for Control A. The other two scales included a few items yielding anomalous results which tended to cloud this clear trend of two classes developing in opposite affective directions.

SCALES	A	B	C	D	E	F
LEVEL OF SIGNIFICANT DIFFERENCE	FIRM CONCLUSIONS					
1%	-	13 ↑	-	9 ↑	-	6 ↑⇣
5%	1 ↑⇣	4 ↓⇡	5 ↑	-	9 ↑↓	-
	DEVELOPING TRENDS					
10%	2 ↑↓ 3 ↑ 9 ↓⇡	3 ⇡	3 ↑⇣ 9 ↑⇣	14 ↑↓	7 ↑⇣	3 ↑ 8 ↑⇣ 10 ↑ 17 ↑⇣
20%		6 ↑ 8 ↑ 9 ↑ 14 ⇡	7 ↑ 8 ⇣ 10 ↑⇣	4 ↑⇣ 6 ↑	6 ↑⇣	5 ↑⇣ 7 ↑ 9 ↑⇣ 16 ↑⇣ 20 ↑⇣

Key to symbols

↑ Affective improvement of Experimental Group

↓ Affective deterioration of Experimental Group

⇡ Affective improvement of Control A

⇣ Affective deterioration of Control A

Table 10.9 Comparison of significant items in each Scale and direction of mobility after final adjustments.

Table/...

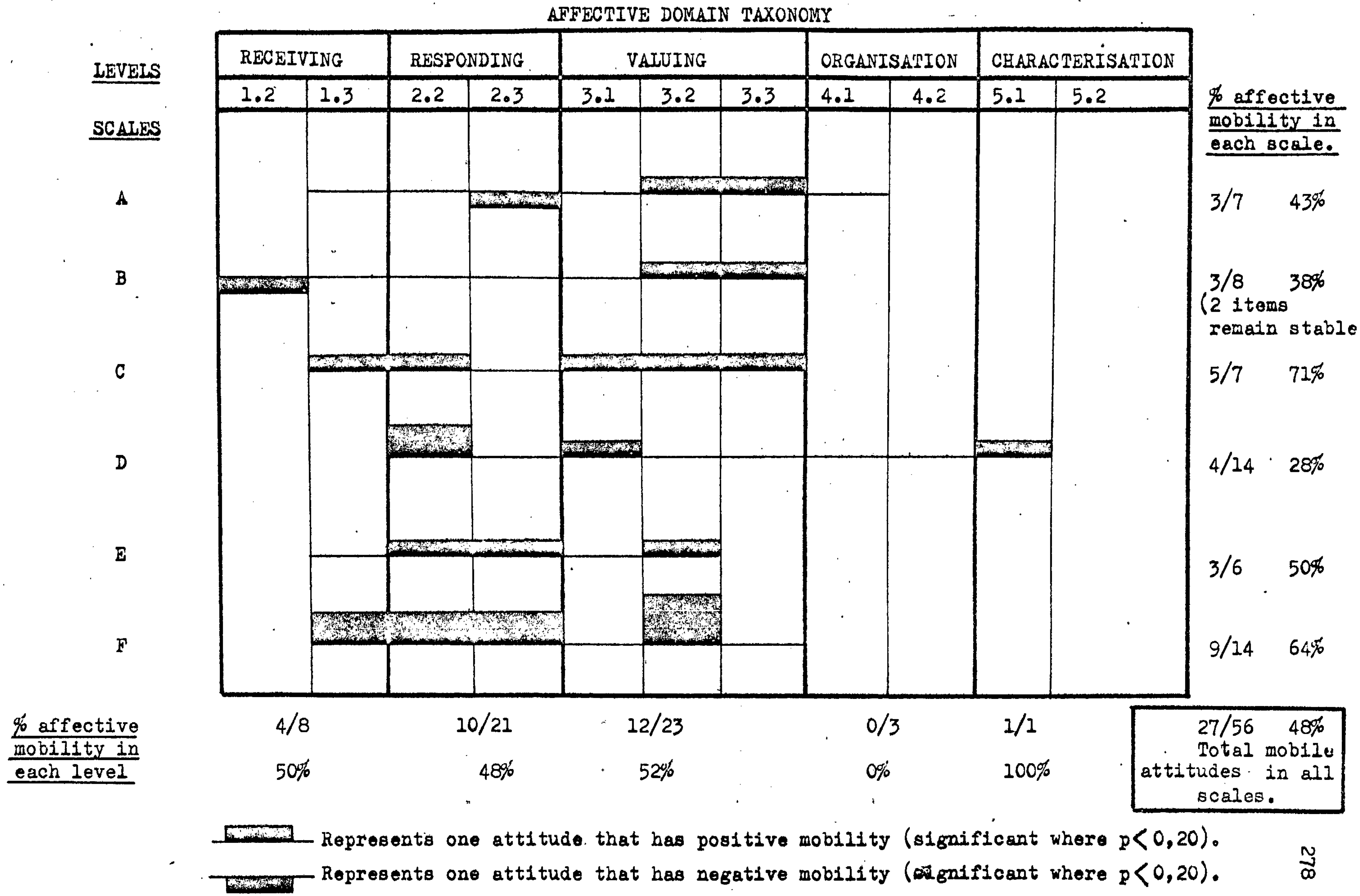
Table 10.9,p. 276 indicates the two affective directions very clearly. This mobility was fairly evenly spread over the whole range of the affective domain. (See Graph 10.8, P. 278).
The lower range of affective educational objectives was particularly well represented in the purified test and all three levels(Receiving, Responding and Valuing) indicate about a 50% mobility of attitudes in the case of the Experimental Group during the two month period. It was deemed unnecessary to graph the results for the Control Group as a glance at Table 10.9 reveals that their mobilty was limited to about 2/3 that of the Experimental Group and largely in the opposite affective direction, but, with the exception of three items, the area of mobility is identical to that of the Experimental Group.
In some senses the Experimental Group has exceeded this writer's expectations voiced on pages 121,122 and 123 (Chapter 4). There has been a great deal of significant improvement and deterioration in the middle order objectives (3.1 to 3.3) and it seems that many attitudes are fairly easy to change after only a single term's experimentation. Other objectives (some 48%)have not yet reached the level of significant mobility ($p<0,20$) being used as a criterion in this study.

Summary of affective improvement brought about solely as a result of the experimental progamme.

(a) Scale A

This scale yielded little significant change at this early stage. It was felt that either the attitudes needed more time to develop to significant levels or else that there was a high degree of overlap with Scale F and that the Ecological Aim as such could not really be separated from the Conservation Aim.

Graph /...



Graph 10.8 Areas of affective mobility during the experimental period (direction of affective development refers to the Experimental Group).

Changes/...

Changes that did reach the level of significant difference between the two groups included:

A tendency for the Experimental Group to develop a sense of the worth and value of natural habitats ($p = 0,20$). This led to them being willing to participate actively in helping to preserve a threatened habitat ($p = 0,05$).

In both cases the Control Groups attitudes deteriorated.

(b) Scale B

This scale was a bit more encouraging, but was bedevilled with several anomalous items, explained fully earlier in the Chapter. Changes that did reach the level of significant difference between the two groups included:

A tendency for the Experimental Group to develop an increased willingness to participate in voluntary research programmes ($p = 0,01$). This stems from an increased belief in the worth of scientific endeavour ($p = 0,20$).

The Control Group did not match this improvement, remaining stable at pretest levels of affective response.

(c) Scale C

The differences exposed by Scale C were definitely rather radical:

A tendency for the Experimental Group to be more biologically aware($p = 0,05$), more interested ($p = 0,20$) and more inclined to favour scientific methods of investigation($p=0,20$). They experienced greater satisfaction from research programmes ($p = 0,20$), and are developing a greater respect for creative logic and reasoning($p = 0,10$).

Conversely the Control Group showed an affective deterioration in these same areas.

(d) Scale D

The only development of a positive nature was confined to the Experimental Group, hence the differences between the two groups:

A/...

A tendency for the Experimental Group: To be more open-minded (p = 0,01).
To be more interested in and enthusiastic about the scientific method of work (p = 0,10).
To be enthusiastic about the practical laboratory work even if it involved their personal free-time (p = 0,20).

The Control remained static with regard to these attitudes or showed actual affective deterioration.

(e) Scale E

Again the only development of a positive nature was confined to the Experimental Group:

A tendency for the Experimental Group to be more willing to make use of scientific literature (p= 0,05). This stems from a greater interest in scientific literature (p = 0,10) to the extent of becomming a prefer nce in leisure reading habits (p = 0,20).

The Control Group showed definite signs of affective deterioration with regard to these attitudes.

(f) Scale F

All the positive affective development of any significance was again confined to the Experimental Group:

A tendency for the Experimental Group to be increasingly sensitive to the natural beauty of the fauna and flora (p=0,20). This relates to enthusiasm for walking in natural areas (p=0,20), visiting nature reserves for pleasure (p = 0,20), a commitment to the preservation of threatened flora (p = 0,20), an awareness of alien plant invaders (p = 0,20), a sympathy with conservation practices (p=0,01) and a willingness to support organisations commited to the conservation ethic (p = 0,10).

The Control Group showed definite signs of affective deterioration with regard to all the attitudes embodied in the above statement.

These results were taken to prove that the Experimental Group have benefitted measurably by their exposure to the experimental programme, while the Control Groups attitudes have shown the general decline anticipated, which the traditional lecture/ demonstration approach has not countered.

CHAPTER 11

TEACHER AND PUPIL RESPONSES TO THE EXPERIMENTAL PROGRAMME.

CHAPTER 11 : TEACHER AND PUPIL RESPONSES TO THE EXPERIMENTAL PROGRAMME.

A. TEACHER RESPONSES.

Once the experimental programme was completed at the end of the first term of 1979, the class teacher was asked to comment on the impact that the course had made in particular areas. His response was generally very positive and encouraging and the quotations detailed in Section A of this chapter are taken from the teacher's written report (the brackets, however, belong to this writer.)

1. General changes noticed in the Experimental Group during the experimental programme.

> The majority of the class... became (as a result of the programme) more enthusiastic about their work than usual. They seemed to see more point in what they were doing and felt it to be worthwhile.

This comment confirms this writer's belief in the necessity of making use of local specimens as teaching types wherever possible. The class must see for themselves the way in which Biology helps them to relate to their environment.

2./...

2. <u>Changes noticed in the attitude of the Experimental Group as a whole during the Experimental period</u>.

The teacher noted a high degree of pupil enthusiasm for Biology and was aware of the increased willingness of some to accept leadership responsibilities. He also commented on initial apprehension on the part of some less able children and a small group of girls who seemed to withdraw, particularly during the field trip activities.

> (The class were) <u>basically enthusiastic</u>. <u>A few girls reacted slightly negatively</u> (showing) signs of not wanting to appear involved at all. On field trips they hung around (and) failed to get 'stuck in' to the tasks assigned.
>
> <u>One or two of the weaker boys showed apprehension at the beginning</u> due to (the) lack of a textbook and the usual, purely cognitive approach. After reassuring them, they became enthusiastic.
>
> Most leaders...developed responsibility for seeing that their (group's) tasks were completed on time.

3. <u>Special advantages of this type of teaching programme</u>.

Here again the teacher emphasized the importance of the highly relevant material leading to the intrinsic motivation of many pupils, and the increased opportunities for personal development in some.

...the /...

> '...the main strength is that pupils see what they are doing as relevant to their own lives, future careers and to reality as it exists around them. The programme offered excellent opportunities for exercising leadership (and for identifying potential leaders) as well as for (promoting better) public speaking. This led to greater self-confiedence in some pupils.

4. Weaknesses and possible improvements that could be made to the teaching programme.

The teacher was aware of the problems created by differentiated group work of a varied nature.

> (The) pupils acquired a great deal of cognitive information as a 'spin-off' of the programme. The only problem of course (was) that, because this (was) incidental knowledge, each pupil gain(ed) different knowledge, (which was) not easily examinable in formal examinations for the purpose of comparing pupils' progress and grading them (accordingly).
>
> Another problem in introducing this programme arises when new pupils join the course later in the year or pupils move off to other schools. Of course, if the programme became part of the accepted syllabus this problem would not arise.

The teacher felt that the problem of trying to examine different cognitive experiences could be solved by supplementing the programme with common homework assignments. It was particularly difficult to set homework beyond the recommended reading required for preparing class reports.

5./...

5. <u>The ease of presenting the experimental programme</u>.

No problems were experienced by the teacher in presenting the programme, however it should be noted that some teachers may well find difficulty in adjusting to the method of group teaching.

> Preparation was fairly minimal due to the fact that (a complete teacher's manual and kit) had previously been assembled.
> Much of the time the pupils were doing the work themselves and the teacher's role was merely one of going from group to group offering advice and help.

The manual referred to above is Appendix A of this thesis.

6. <u>The degree of teaching-satisfaction experienced while presenting this programme</u>.

While the teacher had no means of measuring the affective progress of the class, he was obviously aware that affective objectives were being realised.

> <u>One felt that one was achieving</u> 'less measureable' but <u>more worthwhile objectives</u>.
> The programme is more likely to make pupils enter a Biology/Ecology-related career field than the normal approach.
> <u>The fieldwork was found to encourage a good working relationship with pupils and parents</u>.

The teacher expressed his desire to adapt a shortened form of the programme for use in teaching the Ecology section of the syllabus normally in Std. 9 or 10.

7./...

7. The Response of staff colleagues to the experimental programme.

The degree of interest shown by other staff members was, predictably, a function of their involvement with the programme.

> ...Many colleagues individually commented (after a verbal report in a staff meeting) on how interested they were in the ideas expressed. The librarian was particularly enthusiastic and pleased about the increased use of the library for book research and was keen to co-operate in any way possible.
> The Headmaster warmed to the idea as time went on and was keen to follow the progress of the course and what was being (achieved).

The Headmaster expressed some initial reservations about the feasibility of two field trips in one term and seemed to be uncertain as to the practicability of the group work and control of the programme. These initial reservations were however overcome as the enthusiasm of the teacher and pupils and co-operation of interested parents went a long way in overcoming difficulties.
A high level of organisation ensured that all pupils were kept busy with meaningful activities at all stages of the programme and discipline never appeared to have been a problem. The Headmaster's constant interest and growing enthusiasm was an encouragement to both teacher and this writer.

8./...

8. <u>The response of parents to the experimental programme</u>.

While parent responses were not directly elicited at any stage in the programme, some indications could be obtained.

> An indication of a favourable response from some parents was their willingness to help with transport for <u>both</u> field trips.

This was particularly significant when it is borne in mind that the field trip site was some 25 kilometres from the school.

> A few parents expressed reservations over the fact that less formal homework was set than usual.

Significantly these were the parents of the same group of "problem" girls who were unwilling to enter into the spirit of the programme.

> ...they showed a tardiness in getting down to work and on the field trip appeared to view the tasks set as unnecessary or 'childish' - a sort of pseudo-sophisticate attitude.

Clearly the programme should not be judged by the negative affective stance of a small clique of pupils whose resentment was probably aimed at the teacher as a representative of a school system rather than any particular subject. It will be noted in Section B of this Chapter that some of the pupils openly claim to have done no homework at all, despite the instructions relating to book research and leisure-reading.

9. Comparison of the cognitive progress of the Experimental Group and Control Group.

While this report is substantially concerned with the affective development of the Experimental Group, the following comment indicates that the Experimental Group had not suffered in their cognitive development as a result of the affective emphasis in the programme.

> A fairly usual distribution of marks was obtained in the May examinations (during the term following the experimental programmes implementation.)

B. PUPIL RESPONSES.

While the six attitude scales served to measure quantitatively the degree and direction of consequent affective development of the Experimental Group and Control Group A, pupils were nonetheless requested to complete a reading list, time chart and opinion poll relating to their experience of the experimental programme. (See Appendix B55 to B57.)

1. Voluntary scientific reading as a measure of pupil interest in the programme.

The results of the reading lists completed by most pupils are shown in Table 11.1.

Table 11.1/...

	% Compulsory Reading (All subjects.)	% Voluntary Scientific Reading.	Mean Number of articles read. (All subjects.)
EXPERIMENTAL GROUP	28,4	24,3	11
CONTROL GROUP A	12,7	12,6	5

Table 11.1 Mean reading record during programme period.

This table clearly indicates that:-

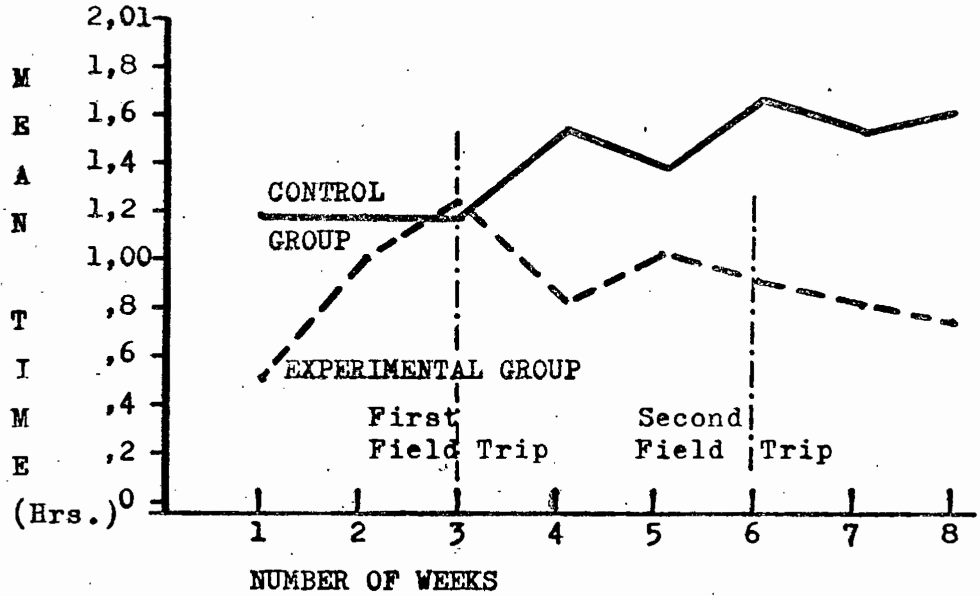
(a) The Experimental Group did more compulsory reading assignments than the Control Group. It would be a safe assumption to make that the bulk of this difference was due to the extra reading requirements of the experimental programme.

(b) The Experimental Group appear to derive greater pleasure from "scientific-type" literature than the Control Group.

2. Time spent on extra biological reading as a function of interest.

The results obtained when the time charts were analysed were at first puzzling.

Graph 11.1/...



Graph 11.1 Mean time chart of pupil's home work assignments during programme period.

This graph seems to indicate that:-

(a) The Control Group did more homework reading on the whole than the Experimental Group, a fact clearly contradicted by Table 11.1 on page 290.

(b) The Control Group was much more industrious than the Experimental group.

This conclusion would however be fallacious because:-

(a) The Control Group clearly read fewer articles on average than the Experimental Group and a much lower proportion of their reading was classified as "scientific."

The Control Group tended to confuse "any biology homework" with "extra biological reading", thus artificailly inflating their results.

(b)/...

(b) This graph makes no allowance for the quality of the work done at home.

It is perhaps more significant to note that the homework assignments of the Experimental Group really got started after the first field trip, once the class had research problems to investigate.

3. An analysis of the Experimental Group's subjective evaluation of the programme.

The pupil's responses were grouped into major categories to simplify analysis. Table 11.2 indicates their opinion of the Experimental programme.

RESPONSE CATEGORY	% SELECTING RESPONSE	NUMBER OF PUPILS N= 25
1. Enjoyed programme.	96	24
2. Uncertain	4	1
3. Did not enjoy programme.	0	0
4. Would prefer learning by this method (environmental-awareness.)	84	21
5. Prefer lecture - demonstration method.	16	4

Table 11.2 Pupils broad responses to the Experimental Programme.

These/...

These responses were solicited to a large degree by questions 1,2 and 4 (Appendix B57.)

Clearly the teacher's evaluation that the pupils were basically enthusiastic was correct, but it appears that the apprehensive weaker pupils still retained their original reservations and felt threatened by the dynamic nature of the programme right to it's conclusion.

REASON OFFERED	% SELECTING REASON	NUMBER OF PUPILS N = 25
1. Self-Activity	44	11
2. Live Specimens	20	5
3. Practical Work	40	10
4. Group Work	8	2
5. Field Trips	28	7
6. Easier to Learn	20	5
7. Topical and relevant.	8	2

Table 11.3 Reasons given for preferring the environmental method of teaching.

The responses listed in Table 11.3 were unsolicited and hence are not really comparable as they largely depended on each pupil's ability to express himself or herself.

They/...

They are included here as an indicator of the pupil's spontaneous reactions to the programme.

They are grouped in a broader classification in Table 11.4.

Reason offered	Main Emphasis	%	Number N = 25
Self Activity Practical Work	I like using scientific apparatus in experimental work.	84	21
Self Activity Easier to learn	I remember what I do.	64	16
Specimens Field Trips Topical and relevant	I prefer reality - learning	56	14

Although it is difficult to separate these categories, they do serve to summarise the feelings of the more articulate members of the Experimental Group.

Individuals were even more positive and some offered spontaneous statements, two of which are paraphrased below:

Pupil E/15 (boy).

> I enjoyed the programme because it was different, and offered interesting activities such as field trips, an interesting syllabus, independent research work during class and after school. It was topical and modern. I became aware of the environment and the impact of man on the sea shore ecosystem. There was also a much greater use of visual aids.

Pupil E/20 (boy)

> I enjoyed the programme because it was realistic and relevant. We did so much and became fully involved in the work, we really felt like scientists. I found myself working much harder than I would normally and with greater interest in Biology. Whereas before I thought Biology articles were too boring to read, now I read every article I see and find that Biology really lives.

Four of the pupils, probably the apprehensive group, identified by the teacher in his report (see page 282) had doubts about continuing studying by means of this method.

Pupil E/10

> Claimed to have learnt nothing despite the fact that it was fun.

Pupil E/16

> Appreciated the practical work but had unspecified reservations.

Pupil E/17

> Was uncertain as to what material would be tested.

Pupil E/24

> Found it very interesting but felt unsure about further studies using this method.

C. SUMMARY OF TEACHER AND PUPIL RESPONSES.

The class teacher, general staff and headmaster, including some interested parents were generally favourably impressed by the improvements brought about by the programme; the class teacher being willing to adopt a shortened, modified form as part of his regular teaching programme.

The/...

The headmaster's initial uncertainty was replaced with interest and enthusiasm for this type of programme. The pupils were unanimous in their agreement that the programme was more exciting and interesting than the lecture/demonstration method.

CHAPTER 12

THE POST-POST TEST : AN ANALYSIS OF RESULTS

CHAPTER 12 : THE POST-POST TEST : AN ANALYSIS OF RESULTS.

A. ORGANISATION OF THE POST-POST TEST.

The post-post test was a repetition of the post test scales, three months after the conclusion of the environmental programme. The method of assessing the post-post test was identical to that described in Chapter 9 for the pretest .

However there were some noteworthy differences in the administration of the post-post test:

(a) Only two of the three Std. 8 classes wrote the post-post test, there being no purpose in using two control groups at this stage. (See Table 12.1).

CLASS	1	2	3
GROUPING	Experimental Group	Control A	Control B
	PRETEST		NO PRETEST
NUMBER OF PUPILS	28	33	20
	POST TEST		
NUMBER OF PUPILS	28	32	20
	POST-POST TEST		NO POST - POST TEST
NUMBER OF PUPILS	26	31	20

Table 12.1 The number of pupils who wrote the tests.

It was noted that one pupil in control group A was transferred to another school during the second term and two pupils in the Experimental Group had influenza on the day that the post-post test was written.

(b) It will be noted from the explanatory note provided as a prefix to the post-post test (see page B 77a), that the pupils were encouraged to reconsider their values as elicited by the statements in the six scales in the light of a further term of traditional Biology teaching; during which time the excitement generated by the experimental programme had had a chance to abate somewhat.

In all other respects the two tests were identical and a full description of the post-post test can be read into the pre-test description given in pages 219 to 223 of Chapter 9.

B. THE RESULTS OF THE POST-POST TEST.

Full details of the post-post test results are recorded in Appendix B pages 78 to 85.

The purpose of the post-post test was to answer the final research question posed in Chapter 9 (see page 214), namely, question (e).

Question (e)/...

Question (e)

After a further term of normal educational experience (the lecture/demonstration method) by all groups, were the differences noted on the post test still apparent, or was there a tendency on the part of the Experimental Group to revert to former attitudes.

This chapter is hence primarily concerned with analysing differences between the post-post test and the post test results.

1. Comparison of the results of whole scales.

Table 12.2 summarises the more complete table of results provided in Appendix B 78 and 79.

	SCALES	A	B	C	D	E	F
EXPERIMENTAL GROUP	Post Test Means	67,5	67,7	72,8	68,2	66,6	69,4
	Post-Post Test Means	67,1	65,7	71,9	68,5	67,2	69,1
	Difference in Means	-0,4	-2,0	-0,9	-0,3	0,6	-0,3
CONTROL GROUP	Post Test Means	62,0	55,4	61,1	46,6	54,5	63,0
	Post-Post Test Means	64,7	54,2	62,6	47,5	59,1	67,9
	Difference in Means	2,7	-1,2	1,5	0,9	4,6	4,9

Table 12.2 Comparison of post and post-post test results of Experimental and Control Group A in terms of percentages.

A general/...

A general analysis of these results indicates:

(i) That there was a slight deterioration in the affective development of the Experimental Group (with the exception of scales D and E), while there was a moderate improvement in the affective development of the Control Group (with the exception of Scale B) during the second term of 1979.

(ii) That the difference between the post and post-post test means are not significant in the case of either group.

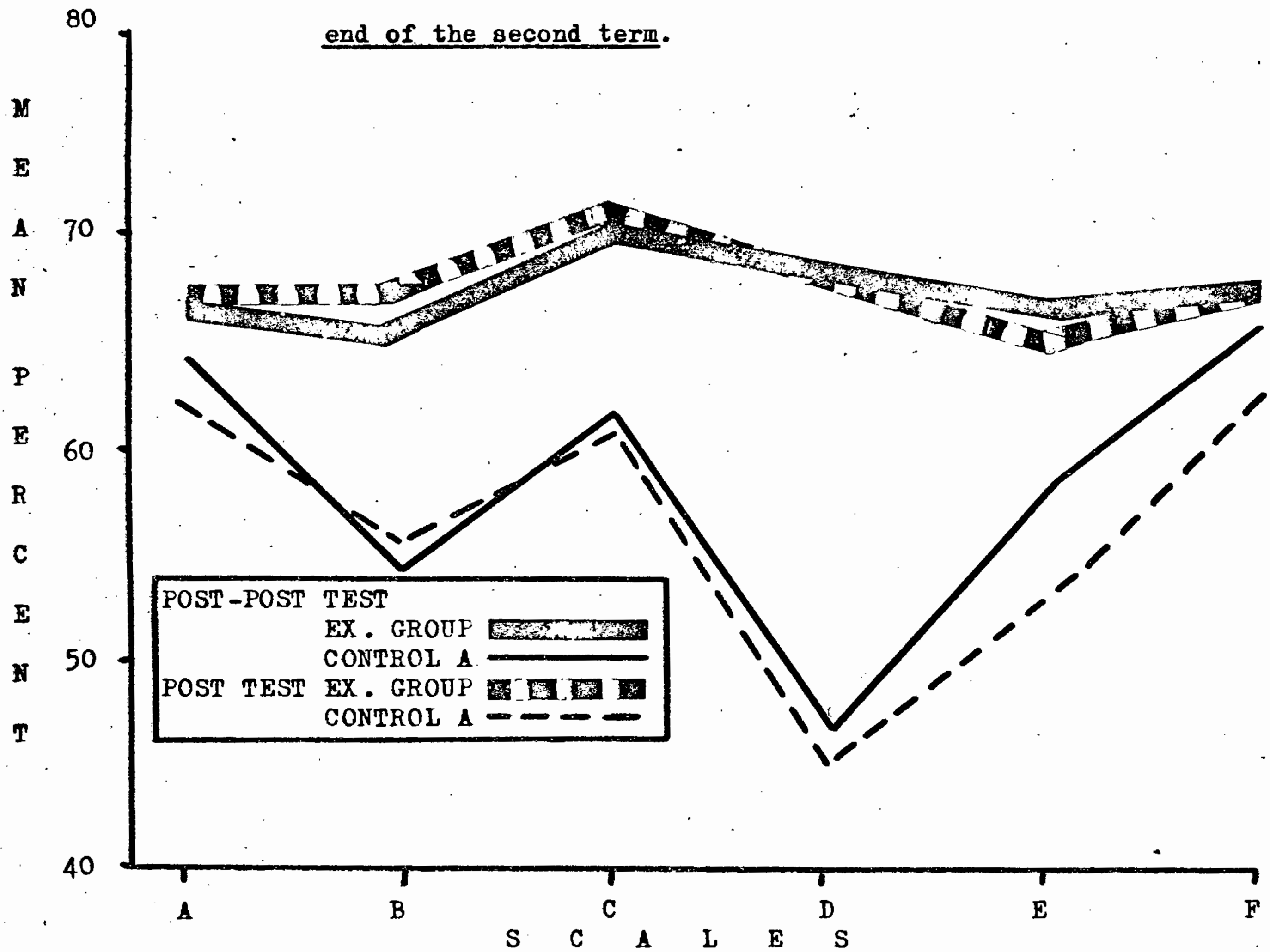
(iii) That the slight negative trend observed in the results obtained by the Experimental Group may be safely ignored and the results considered to indicate that, taken as a whole, the attitudes measured by these six scales are relatively stable for the Experimental Group, three months after the experimental programme.

(iv) That the moderate improvement noted in the Control Group is only noteworthy in the case of scales E and F where it approaches a 5% difference in the mean percentage scores. This difference was deemed to be due to differences in the treatment the two classes received during the course of the second term.

Ideally/...

Ideally they were to have been treated identically, however the class teacher did show the Control Group a film from the experimental programme (Our Vanishing Wilderness PS 951c) which could in part account for the unanticipated results in Scale F.

(v) That the Experimental Group was still ahead of the Control Group in terms of affective development at the end of the second term.



Graph 12.1 A comparison of the response patterns during the post and post-post tests for both groups.

If/...

If the effects of initial pretest differences on the post-post test results were eliminated, the Experimental Group was still shown to be slightly ahead of the Control Group although no significant difference ($p > 0{,}05$) was recorded. (See Table 12.3)

SCALES	A	B	C	D	E	F
Pretest difference of means (E-A) (From Table 9.3)	+0,6	+7,2	+5,1	** +16,2	+5,7	-2,1
Post test difference of means due to first term's work alone (E-A) (From Table 10.5)	+4,9	+5,1	+6,6	+5,4	+6,4	* +8,5
Post-Post test difference of means due to first six months' work of 1979 alone. (E-A) (From Appendix B79)	+1,8	+4,3	+4,2	+4,8	+2,4	+3,3
Post-Post test difference of means due to second term's work alone (E-A)	-3,1	-0,8	-2,4	-0,6	-4,0	-5,2

Table 12,3 Comparison of post and post-post test differences after adjustment for initial pretest differences of Experimental and Control Group, expressed as percentages.

Table 12,3 indicates the slight deterioration of the Experimental Group during the second term and it s overall lead in terms of affective improvement at the end of six months, (three months after the environmental programme was concluded).

(i) These results suggest to this writer that the environmental programme accelerated the rate of positive affective development of the Experimental Group.

These/...

These affective gains appear to have been maintained during the second term.(See Table 12.2)

(ii) Conversely the Control Group's initial deterioration has tended to reverse slightly in favour of affective improvement on a very limited scale, possibly due to the class teacher's greater awareness of the possibility and techniques employed in promoting positive affective development and his confessed employment of some of them.

(iii) It is also interesting to note that the positive affective development that was taking place in the Experimental Group as revealed by the post test appeared to have stopped abruptly once the teaching method employed no longer actively promoted affective development as one of it's teaching goals.

A detailed analysis of results on each scale for the two terms shows that, on: (See page B78)

Scale A

The Experimental Group benefited slightly ($p > 0,05$) from the environmental programme. The improvement appeared to be fairly permanent.

The Control Group results tended to fluctuate slightly, deteriorating in the first term and improving later.

Scale B

Scale B

The Experimental Group benefitted significantly from the environmental programme ($p = 0{,}05$) and the slight deterioration ($p > 0{,}05$) during the second term should be ignored as normal variation.

The Control Group results also indicate an initial slight improvement during this period ($p > 0{,}05$) followed by a slight deterioration that could be accounted for as normal variation.

Scale C

The Experimental Group appeared at first to benefit slightly ($p > 0{,}05$) from the programme but subsequently it appeared as if the "improvement" was within the range of normal variation.

The Control Group similarly fluctuated within fairly narrow limits ($p > 0{,}05$).

Scale D

The Experimental Group benefitted slightly from the environmental programme ($p > 0{,}05$). The improvement appeared to be fairly permanent.

The Control Group fluctuations again suggest normal variation within narrow limits ($p > 0{,}05$).

Scale E

The Experimental Group benefitted slightly from the environmental programme ($p > 0{,}05$).

The/...

The improvement appeared to be fairly permanent.

The Control Group have improved steadily throughout this period. $(p > 0{,}05)$.

Scale F

The Experimental Group benefitted significantly from the environmental programme $(p = 0{,}05)$. The improvement appeared to be fairly permanent.

The Control Group fluctuations again suggest normal variation with limits. $(p > 0{,}05)$.

Fig. 12.1 illustrates these differences graphically.

SCALE	POST	POST-POST	FINAL % AFFECTIVE MEAN LEAD AFTER ADJUSTMENT
A	↑ — e	— ↑	Experimental Group 1,8% ahead $(p = 0{,}20)$
	↓ - - c	- - ↑	
B	↑* — e	— ↓	Experimental Group 4,3% ahead $(p = 0{,}10)$
	↑ - - c	- - ↓	
C	↑ — e	— ↓	Experimental Group 4,2% ahead $(p = 0{,}15)$
	↓ - - c	- - ↑	
D	↑ — e	— ↑	Experimental Group 4,8% ahead $(p = 0{,}08)$
	↓ - - c	- - ↑	
E	↑ — e	— ↑	Experimental Group 2,4% ahead $(p = 0{,}18)$
	↓ - - c	- - ↑	
F	↑* — e	— ↑	Experimental Group 1,2% ahead $(p = 0{,}09)$
	↓ - - c	- - ↑	

Fig. 12.1 General trends in the affective development of the Experimental and Control Group A. during the second term of 1979.

2. <u>Comparison of the results within scales.</u>

While a comparison of whole scales indicates that there was little change in the <u>mean attitudes</u> of the two groups during the second term, it would be an error to assume that there was no mobility of <u>individual attitudes</u> within each attitude cluster mearsured by each scale.

Table 12.4 indicates that twenty-three of the seventy-eight items in the post-post test were mobile and yielded significant ($p < 0,05$) or moderately significant differences ($0,10 < p < 0,20$) between the two groups at the end of the second term. As anticipated, there were far fewer note-worthy differences on the post-post test than on the post test where some thirty-four significant or moderately significant differences were noted. (See Table 10.7 p. 255).

Thirteen of the twenty-three items were identical for both tests indicating that these significant or moderately significant differences were generally maintained after the end of the programme. This left some ten items that were unexpectedly mobile during the second term. These <u>anomalous results</u> will be more fully considered in this section of the report. Similarly some twenty previously significant items have fallen below the accepted limits of significant difference ($p. > 0,20$).

The/...

		FIRM CONCLUSIONS		DEVELOPING TREND	
	Level of statistical significance P ≤	0,01 **	0,05 *	0,10 ++	0,20 +
AFFECTIVE IMPROVEMENT OF EXPERIMENTAL GROUP	Experimental Group improve alone.	-	-	F3	B1 F16
	Experimental Group improves/ Control A deteriorates.	-	A1 C7 C8 D6 F6	E9 E10	B1 E7
	Both groups improve.	-	D9	-	A9 D8 E6 F4 F18
AFFECTIVE DETERIORATION OF EXPERIMENTAL GROUP	Experimental Group deteriorates/Control A improves.	-	C4	-	C1
	Control A improves alone.	-	-	-	D11 F15
	Experimental Group deteriorates alone.				B4

These results were obtained from Appendix B 80b to B 85b.

Table 12,4 Significant items classified as firm conclusions and developing trends (after final adjustments for initial pretest difference) at Post-Post test level.

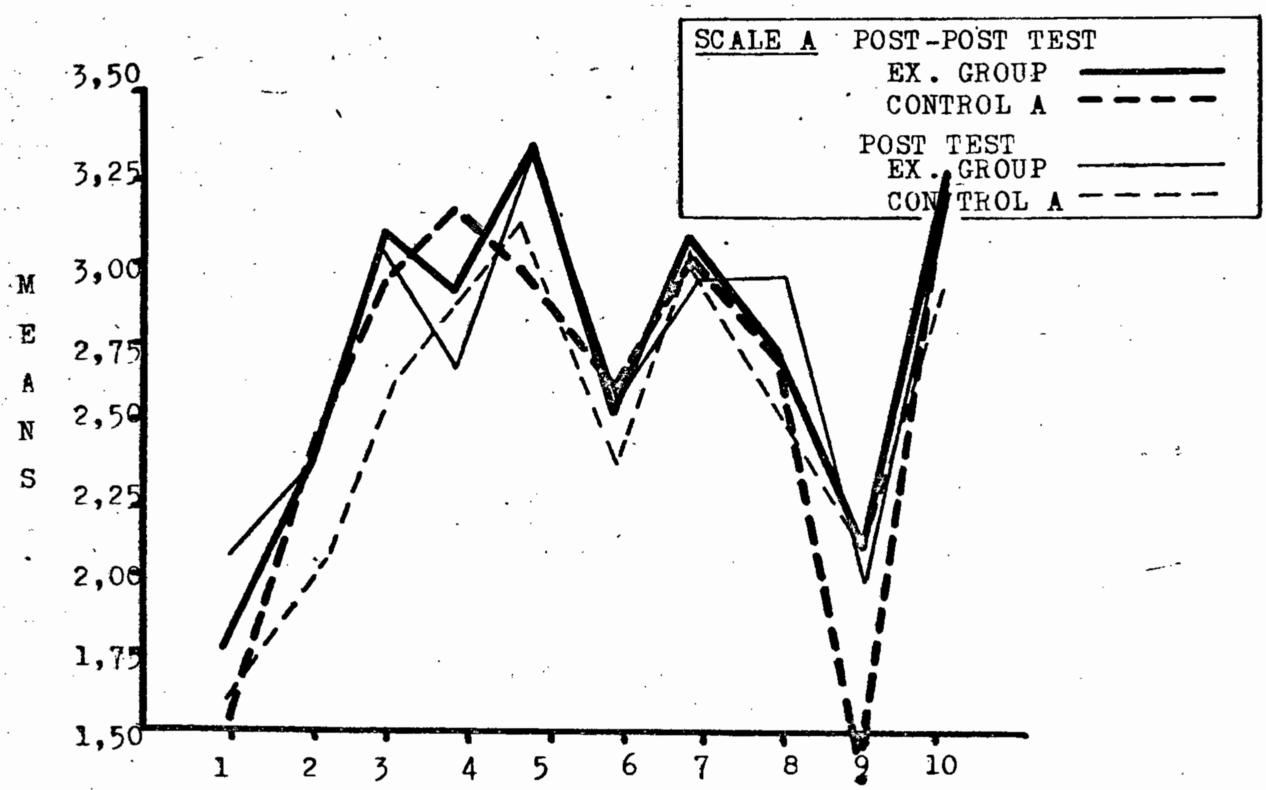
The means obtained on the 78 post-post test items were graphed in order to facilitate comparisons between the two groups. The data on which these graphs were based can be found in Appendix B80 - 85.

If/...

If the graphs are quickly scanned it is seen that the post test and post-post test results are very similar for both independant groups.

* Note that the graphs represent the results <u>before adjustment</u> for pretest differences. Attitude scales were considered individually paying special attention to the differences between the post and post-post test results of each group.

(a) Scale A



Graph 12.2 <u>Comparison of item means obtained on Scale A during post test and post-post test.</u>

There was clearly very little difference between the post and post-post tests (r = 0,93 for Experimental Group and 0,82 for Control Group A). (See Appendix B80).

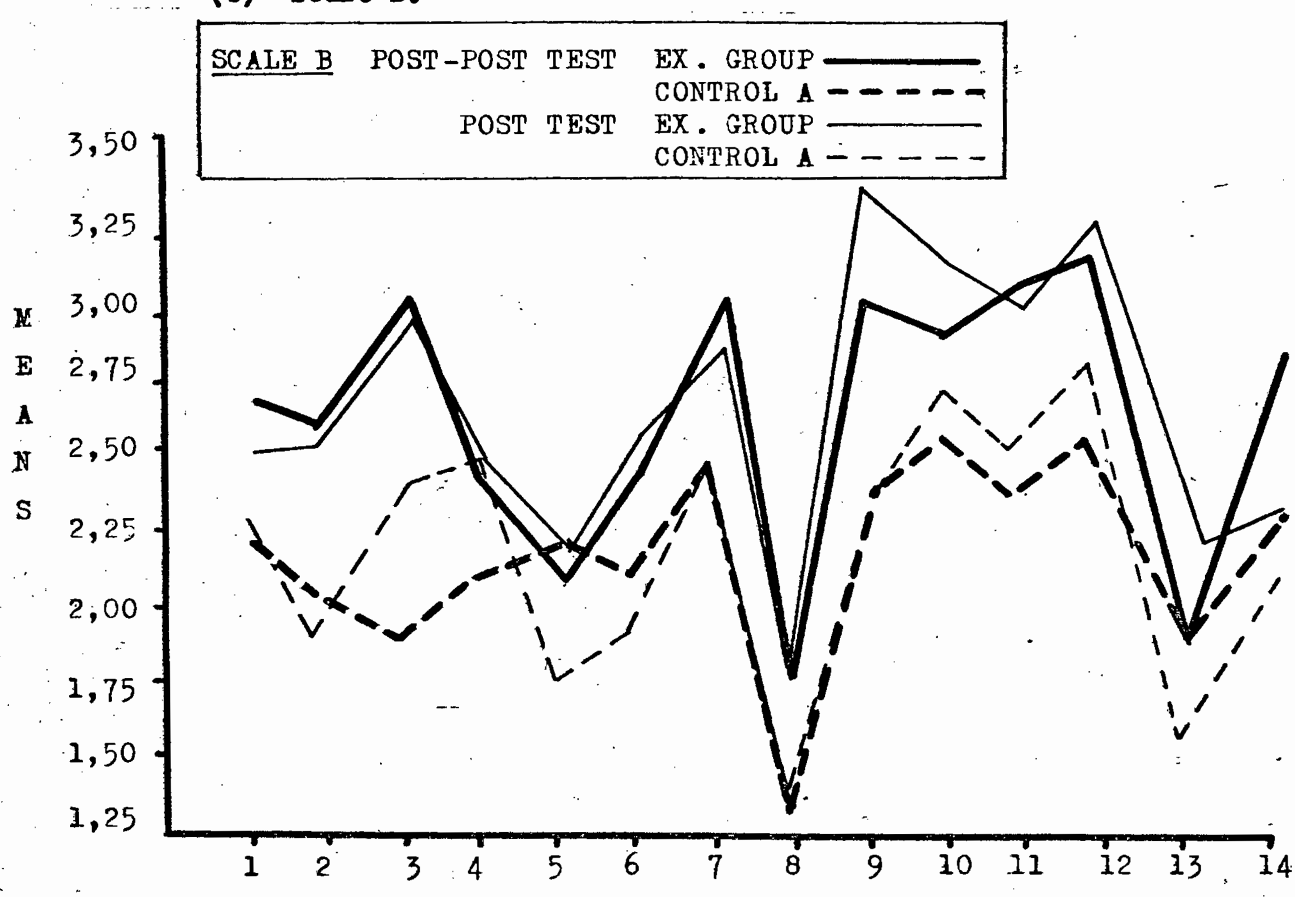
Once/...

Once these results had been adjusted for initial pretest differences, (See Appendix B80a), only items 1 and 9 revealed any significant or moderately significant difference at post-post test level, indicating that these values are continuing to develop in the experimental group, despite normal variation.

Item	Interpretation of Attitude
1	The experimental group were still definitely more willing to get involved in active conservation practice (p = 0,05.)
9	They were also more interested in the study of animals and plants in their natural surroundings. (p = 0,20)

The sense of worth and value of natural habitats has been maintained at post test levels but this does not reflect as an <u>additional difference</u> between the two groups. (Item 2 and 3 ,page 257 (Post test)).

(b) Scale B.



Graph 12.3 Comparison of item means obtained on Scale B during post test and post-post test.

There was a greater range in attitude variation on Scale B during the second term but only two items yielded moderately significant results.

The correlation coefficients indicated that the variation was minimal. ($r = 0{,}85$ for Experimental Group and 0,81 for Control Group A). (See Appendix B81).

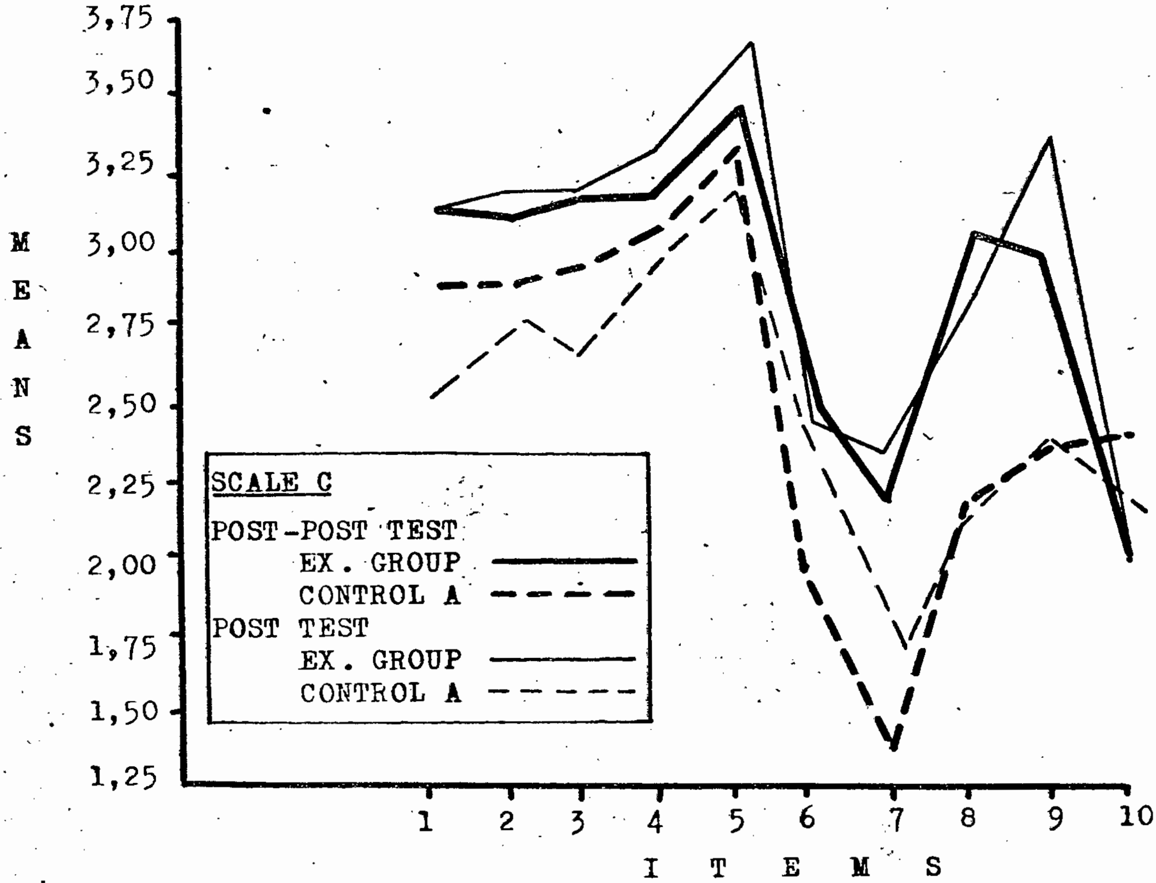
Once these results had been adjusted for initial pretest differences, (see Appendix B81a), only items 1 and 4 revealed a moderately significant difference at post-post test level.

Item	Interpretation of Attitude.
1	The experimental group were increasingly aware of the interdependence of all branches of knowledge. ($p = 0{,}20$)
4	This item dealing with the recognition of the importance of science was still showing a moderately significant difference between the two groups with the experimental group showing greater affective deterioration than the control group. ($p = 0{,}20$)

The Experimental Group's appreciation of the worth of scientific endeavour (item 6 and 9) and their moderate interest in class research projects (Item 8) was maintained during the second term, though they appeared to be less committed to science as a group (Item 13) (See page 258, 259 by 260) at the end of the second term, suggesting that while some attitudes are fairly stable once formed, others are more sensitive and may require more nuturing until stability is reached.

(c)/...

(c) Scale C



Graph 12.4 Comparison of item means obtained on Scale C during post test and post-post test.

There was little difference between the post and post-post tests (r = 0,86 for Experimental Group; r = 0,90 for Control Group A). (See Appendix B82). Once these results had been adjusted for initial pretest differences, (see Appendix B82a), only items 1, 4, 7 and 8 revealed any significant of moderately significant difference at post-post test level.

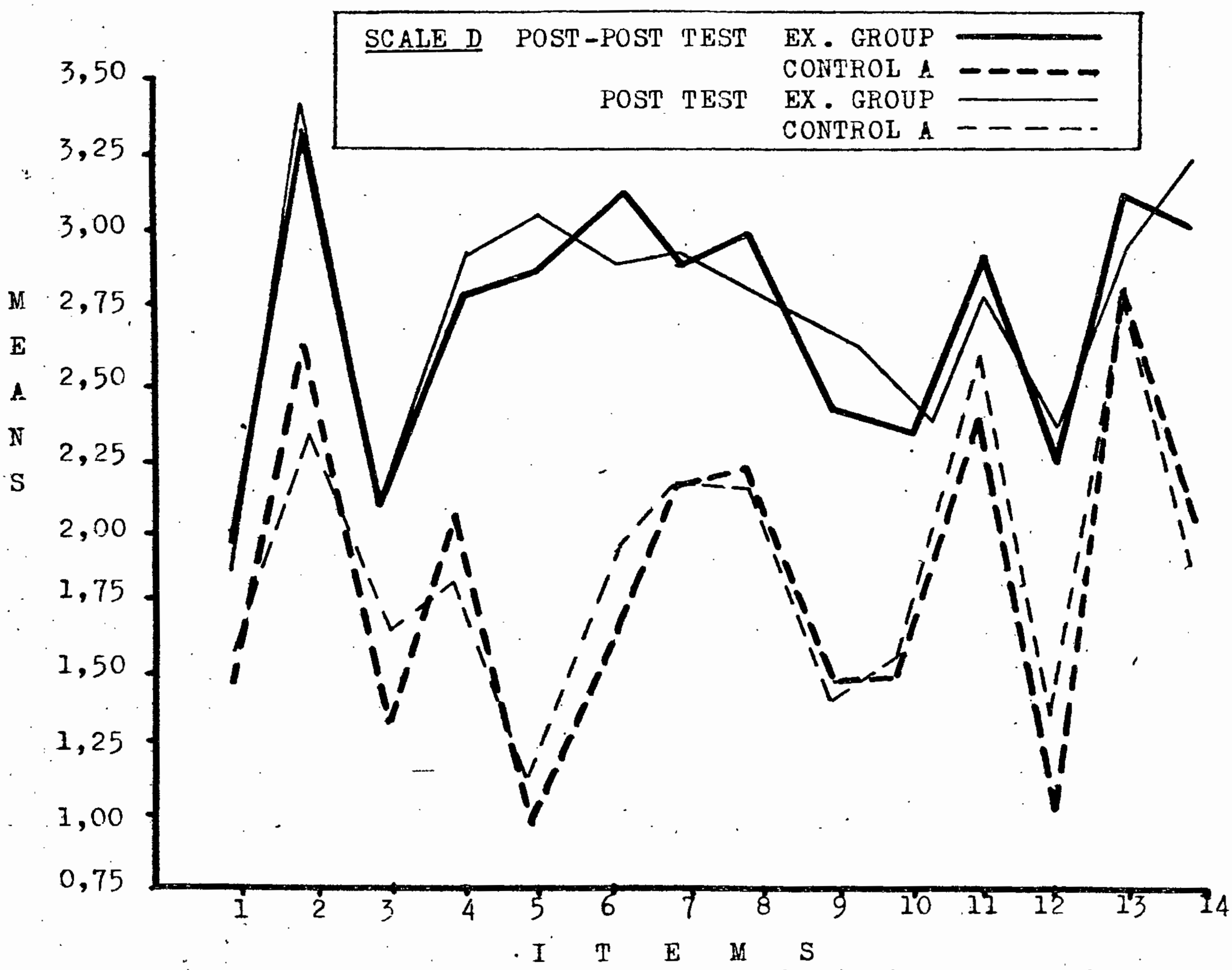
Item	Interpretation of Attitude.
7 and 1	These two items represent contradictory affective development related to the same attitude and at this stage should be accordingly discounted as normal variation.

Item 7/...

	Item 7 (p = 0,05) Item 1 (p = 0,20)
4	The Experimental Group appeared to be taking less pleasure in debating biological problems. Conversely the control group were showing a greater interest. (p = 0,05).
8	The Experimental Group continued to be increasingly favourably disposed toward independent research. (p = 0,05).

Items 5, 3, 9 and 10 noted in the post test (see pp. 261 - 263) generally maintained their affective improvement and hence do not appear as significantly different items in the post-post test. They were related to maintained interest in biological phenomena and the value of creative thinking as a means of hypothesis building.

(d) Scale D



Graph 12.5 Comparison of item means obtained on Scale D during post test and post-post test.

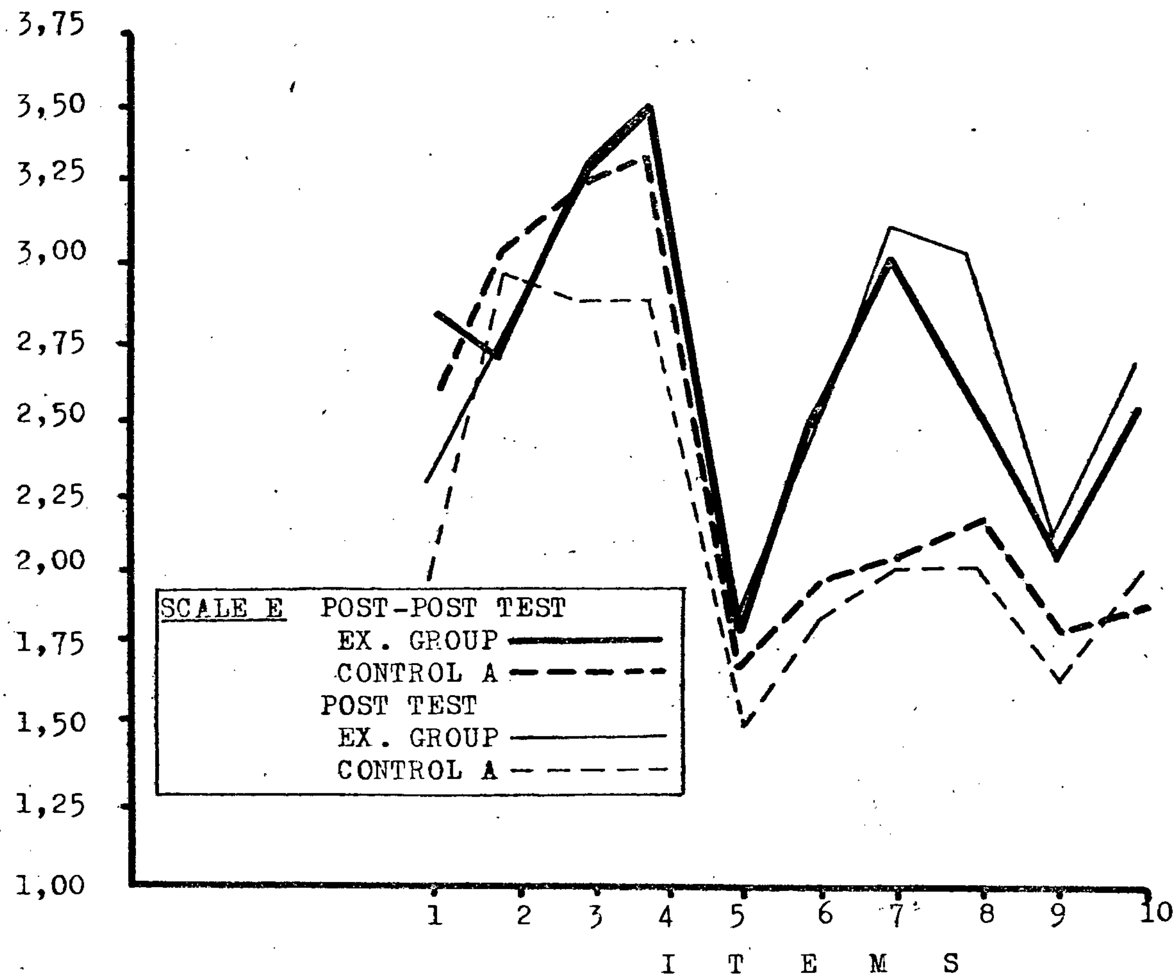
Once again the variation between the post and the post-post test was minimal, (r = 0,96 for Experimental Group; r = 0,90 for Control Group A). (See Appendix B 83). Once these results had been adjusted for initial pretest differences, (see Appendix B83a), only items 6, 8, 9 and 11 revealed any significant or moderately significant difference at post-post test level.

Item	Interpretation of Attitude
6	This item indicated that there was still a significant difference between the two groups at post-post test level. The Experimental Group maintained their increased interest in the ways that scientists work. (p = 0,05).
9	Likewise they maintained their willingness to reconsider their ideas when confronted with fresh evidence. (p = 0,05) although there has been some erosion from post test levels, indicating that this attitude may require more consolidation.
8	Both groups showed an increased interest in good organisation of work, but the Experimental Group has improved more than the Control Group. (p = 0,20).
11	With regard to an appreciation of the value of logical arguements, the Experimental Group showed affective improvement while the Control Group showed affective deterioration. (p = 0,20)

No significant or moderately significant changes of attitude were noted for items 4 and 14 identified as areas of difference in the post test (see pp. 265 - 266). This suggests that these items (after adjustment) indicated that post test levels of improvement were maintained. They were related to a willingness to adopt scientific methods and invest personal time in laboratory experiments.

(e)/...

(e) Scale E



Graph 12.6 Comparison of item means obtained on Scale E during post test and post-post test.

There was some small difference between the post and post-post tests (r = 0,84 for Experimental Group; r = 0,78 for Control Group A). (See Appendix B 84). Once these results had been adjusted for initial pretest differences, (see Appendix B 84a), items 6, 7, 9 and 10 revealed moderately significant differences at post-post test level. The differences are generally in favour of the Control Group.

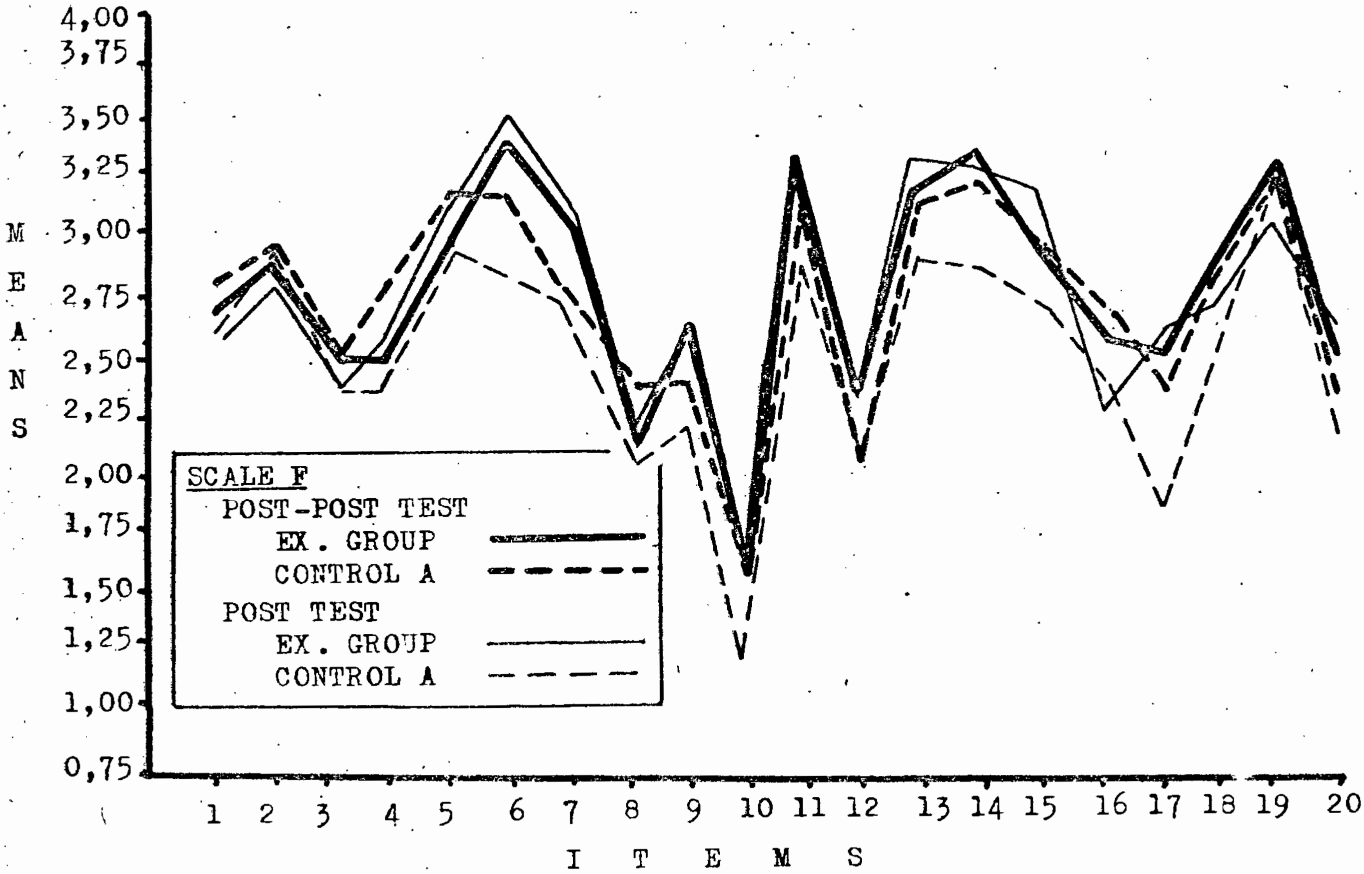
Item/...

Item	Interpretation of Attitude
9	The Control Group were more willing to use scientific periodicals after the second term. (p = 0,10). However they are still well below Experimental Group levels, who tended to maintain their affective lead developed during the experimental programme.
10	The Experimental Group had by now developed a marginal affective lead over the Control Group with regard to their preference for biological literature during their leisure reading time (p = 0,10) despite some affective deterioration of both groups.
6	Similarly, Control A were becoming more science-aware;were more willing to read it in popular form although they were well below the Experimental Group in this regard. (p = 0,20). This result tended to contradict item 10 above and could be accounted for in terms of normal variation.
7	This item reinforces the results noted for item 2 (p = 0,20).

The changes noted in Scale E at post-post test level indicated that the Control Group had tended to lag behind the Experimental Group with regard to reading interests. This could be accounted for as a direct result of the experimental programme accelerating the development of reading interests by exposing the Experimental Group to scientific literature in advance of the Control Group.

(f) Scale F/...

(f) Scale F



Graph 12.7 Comparison of item means obtained on Scale F during post test and post-post test.

There was little difference between the post and post-post tests (r = 0,82 for Experimental Group; r = 0,95 for Control Group A). (See Appendix B 85). Once these results had been adjusted for initial pretest differences, (see Appendix B 85a) only items 3, 4, 6, 15, 16, 18 & 19 revealed a significant or moderately significant difference at post-post test level. The Control Group has matched the earlier development of the Experimental Group at several points probably due to a conservation awareness film shown to them alone during the second term (see p. 298).

Item/...

Item	Interpretation of Attitude.
6	There was some tendency for the Control Group to become more interested in conservation and for the Experimental Group to lose interest. (p = 0,05).
3 and 15	These two items collectively indicated that both groups were more aware of the S.A. fauna and flora (Item 3 (p = 0,10) Item 15 (p = 0,20).
16 and 18	These items indicated that the awareness was linked to appreciation and valuing as there was an increased sensitivity to the beauty of and love for the indigenous fauna and flora. (p = 0,20).
19	This item indicated that the Experimental Group in particular were increasingly more willing to obey the conservation laws and were appreciative of the need for them. (p = 0,10).
4	Both groups were more aware of the threat posed by pollution to the fauna and flora. (p = 0,20).

With respect to items 5, 7, 8, 9, 10, 17 and 20 identified as being significantly different attitude indicators during the post test (see pp. 270 - 271) no significant or moderately significant changes of attitude were noted at post-post test level. This suggests that the affective improvement noted on Scale F of the post-post test for the Control Group was relatively superficial, as the depth of commitment noted in the Experimental Group was notably still lacking in the Control Group.

C. SUMMARY OF DIFFERENCES THREE MONTHS AFTER THE EXPERIMENTAL PROGRAMME.

This chapter has been designed to measure the differences existing between the two groups after a further term of the normal lecture-demonstration technique of teaching.

(a) There was <u>no significant difference between the results obtained on the post test and the post-post test,</u>

including Scale F which indicated a significant difference when post and pretest adjusted results were compared.

These results confirm <u>Parker's</u> (1) findings in a Rhodesian Conservation Teaching Project: that while affective changes are conservative rather than dramatic, the general pattern of change in the Experimental Group persists on post-post testing.

(ii) However, <u>the Experimental Group was clearly affectively ahead of the Control Group at the end of the second term</u> on all six scales ($p \neq 0,05$) despite a slight deterioration of the Experimental Group and a slight improvement of the Control Group (particularly on Scales E and F) during the second term due to differences in the content of the two teaching programmes inadvertently introduced by the class teacher. (See p. 298 and 299.)

(iii) <u>This lead persisted after adjustment for initial pretest differences.</u>

(iv) When the post and post-post test results were correlated for each group very favourable correlation co-efficients were obtained, further reinforcing the emphasis on <u>very limited change</u>. (See Table 12.5).

Table 12.5/...

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(1) Parker S., "A teaching project in an African rural school", In: <u>Proceedings of the Conservation Education Symposium at Skukuza</u>. 1976.

Note: Mrs. Parker's method of assessing affective development was entirely different from that employed in this report.

SCALES	A	B	C	D	E	F
Experimental Group r =	0,93	0,85	0,86	0,96	0,84	0,82
Control Group r =	0,82	0,81	0,90	0,90	0,78	0,95

Table 12.5 The correlation co-efficients obtained when comparing the post and post-post test results of each group independently.

Care should be taken when interpreting the above results to bear in mind the fact that they only indicate the degree of mean difference or correlation between the two groups and a more sophisticated analysis (see section (b) of this summary) is needed to expose the differences.

(v) An analysis of the results in Table 12.2 p. 297 seems to indicate an abrupt cessation of affective development in the Experimental Group at the end of the programme. This too was shown to be an over-simplification of the affective development taking place.

(b) When the affective development within each scale was compared it was noted that:

(i) There was continuing affective development in the Experimental Group that was not matched by the Control Group and that could only be due to the influence of the experimental programme. Some 19 attitudes (rather than items) fall into this category.

(ii) Some 12 attitudes developed by the Experimental Group persisted despite the lack of environmental stimulation.

These/...

These attitudes persisted through to the end of the second term, although they did not develop any further.

(iii) There were signs of affective deterioration of at least four attitudes developed by the Experimental Group during the programme, possibly due to lack of reinforcement during the second term. Other deteriorating attitudes had not yet reached the level of moderate significance. ($p \ll 0,20$).

These changes during the second term can be briefly summarised as follows after adjustment for initial pretest differences:

(a) <u>Scale A</u>

<u>Continuing development</u>

The Experimental Group were more involved in active conservation practice ($p = 0,05$). They had an increasing interest in animals and plants in natural habitats ($p = 0,20$).

<u>Maintained development</u>

The Experimental Group were still more conscious of the worth and value of natural habitats.

(b) <u>Scale B</u>

<u>Continuing development</u>.

The Experimental Group were more aware of the interdependence of all branches of knowledge ($p = 0,20$)

<u>Maintained development</u>

The Experimental Group were still more appreciative of the worth of scientific endeavour. They were still interested in class research projects.

<u>Evidences of affective decline</u>.

The Experimental Group were less willing to recognise the importance of science. ($p = 0,20$). They were also less committed to science. ($p = 0,20$). It should be noted that the Experimental Group were still ahead of the Control Group.

(c)/...

(c) Scale C

Continuing development

The Experimental Group were still more interested in independent research. ($p = 0,05$).

Maintained development

The Experimental Group were still more interested in biological phenomena and creative thinking about them.

Evidences of affective decline.

The Experimental Group were less interested in debating biological topics than previously. ($p = 0,05$). but were still ahead of the Control Group.

(d) Scale D

Continuing development

The Experimental Group were more interested in scientific methods of investigation ($p = 0,05$). They were more open-minded in their approach to new ideas. ($p = 0,05$).
They were more interested in organisation as a method of work. ($p = 0,20$)
They were more appreciative of the value of logical argument. ($p = 0,20$).

Maintained development

The Experimental Group were still more willing to adopt scientific methods. They were still more willing to invest some of their personal time in voluntary laboratory work.

(e) Scale E

Continuing development

The Control Group showed signs of making up the difference that existed between the two groups at the end of the experimental programme.

They were more willing to use scientific literature. ($p = 0,10$)
It should be noted that this improvement did not place the Control Group ahead of the Experimental Group.

(f) Scale F

Continuing development

The Control Group, as pointed out earlier, received additional environmental stimulation that the Experimental Group did not receive during the second term when the programmes were supposed to be identically matched.

This/...

This accounts for the unanticipated affective development of the Control Group in Scale F.

The Control Group were more interested in conservation practice (p = 0,05).

They were more aware of (p = 0,20); sensitive to (p = 0,20) and valued (p = 0,2o) the indigenous fauna and flora than previously. They were more aware of the threat of pollution. (p = 0,20).

All these attitudes were dramatically challenged in the additional film shown by the teacher, but this writer believed that the Control Group's interest was superficial as they failed to give evidence of the depth of commitment to conservation shown by the Experimental Group.

The Experimental Group likewise, without having seen the film in the second term, also were more aware of (p = 0,10); sensitive to (p = 0,20), and valued (p = 0,20) the indigenous fauna and flora than previously. They were more willing to obey the conservation laws and respect there need.(p=0,10). They too were more aware of the threat of pollution. (p = 0,20).

This unscheduled film, which represented a departure from the design of the programme, robbed Scale F of it's initial significance in assessing the growth of conservation awareness promoted by the programme alone, but indicates that *field work* per se may not be essential for the development of certain attitudes.

Maintained development

The Experimental Group were still more aware of alien plants; enthusiastic about nature trails, interested in the cultivation of wild flowers; interested in visiting game reserves and in associating with conservation orientated societies. This indicated the depth of their enduring commitment to conservation.

Evidences of affective decline

The Experimental Group in the absence of reinforcement appeared to be losing some interest in conservation practices (p = 0,05).

Generally speaking, many attitudes whose accelerated affective development was initiated by the environmental programme were sufficiently stable to continue developing without any environmental reinforcement. Most other attitudes were also relatively stable and persisted, without further development, to the end of the second term. A few attitudes however needed further reinforcement and these tended to decline during the second term.

PART FOUR:

CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

CHAPTER 13

SUMMARY AND CONCLUSIONS

CHAPTER 13 : SUMMARY AND CONCLUSIONS

A. THE SUMMARY

In this chapter the writer has sought to present a condensation of the main ideas expressed in this thesis and his conclusions.

1. The problem being investigated.

(a) Most modern curricula, including the Cape Education Department's Senior Secondary Course Biology Syllabus (Higher and Standard Grade), embody three main types of educational objectives: cognitive, affective and psychomotor.

(b) Currently there is a growing emphasis on affective objectives, a previously neglected area, probably due to the world-wide recognition of the steady deterioration in students' interest in Science at a time when scientists are in great demand.

(c) Educators have been slow to apply the research of social psychologists relating to attitude formation largely due to a misconception that positive attitude development is an automatic process, part and parcel of all good cognitive teaching.

(d)/...

(d) Accordingly, little provision has been built into our science syllabuses to promote affective development, although it is mentioned in the aims of each syllabus. No provision has been made for evaluation of affective development. No special provision has been made for emphasizing affective objectives when training our science teachers and consequently no general sense of need exists amongst our science teachers in the Cape.

(e) <u>The purpose of this research project</u> was to identify, implement and evaluate a method of teaching Biology that would:

(i) Ensure that teachers consciously teach with attitude-formation and value-building in mind.

(ii) Ensure that the course incorporates recognised techniques for promoting attitude change, e.g. persuasive communication, peer-group discussion, library research, role play and counter-attitudinal behaviour.

(iii) Ensure that <u>all</u> the aims of our current syllabuses are realised (affective objectives included).

(iv) Ensure that <u>all</u> biology students are interested in the course and find it to be meaningful, irrespective of their ultimate career orientation, (e.g. Standard Grade candidates as well as Higher Grade candidates.)

(v) Ensure that the course is relevant in terms of modern social and environmental challenges.

(vi) Ensure that the course is suitable for South African students and syllabuses.

(A more detailed analysis of the problem can be found in Chapter 1 of this report.)

2. <u>Research findings having a bearing on this problem.</u>

(a) Several recent studies have shown that there is a steady decline in interest and enjoyment in both Physical Science and Biology, particularly in the case of boys.

(b) <u>Teaching method</u> has been identified as the <u>only</u> variable that encourages more positive attitudes towards Science within the secondary school educational context.

(c) <u>The process approach</u> and the <u>environmental approach</u> are both more successful at reducing the rate of affective deterioration on the conventional lecture-demonstration approach.

Other/...

(d) Other research workers believe that the environmental approach may even result in substantially improved affective development towards science in pupils holding higher socio-economic status values.

(e) The process of value-clarification and the main components of the environmental encounter have been identified by research workers and adapted by this writer into a basic model for classroom use.

(f) Recently a general conceptual framework of attitude theory has been proposed by social psychologists which conforms closely to the basic teaching model mentioned above.

(g) Competent methods of evaluating attitude change have existed for a considerable time. This writer has employed the method of summated ratings to measure the affective development of the groups being tested.

(A more detailed analysis of the relevant related research can be found in Chapters 2 and 3 of this report.)

3. Design and development of this investigation.

(a) In the light of the research findings it was decided to investigate the environmental approach as being the teaching method best suited to realising maximum positive affective development.

(b) Paradoxically the Biology course being implemented in Cape schools, while not overtly prescribing a single particular teaching approach, is so worded as to make the full realisation of all syllabus objectives well nigh impossible unless an environmental approach is employed or selected syllabus aims are ignored.

(c) However, notwithstanding this, the syllabus content is arranged in an order more suited to a thematic approach than an environmental approach, favouring lecture-demonstration methods.

(d) Consequently this writer had to reorder a portion of the syllabus content in Standard 8, so as to make it more suited to an environmental approach.

(e) The experimental syllabus drew all it s examples from a rocky shore habitat near Simonstown and the same habitat was studied as a totality.

(A more detailed analysis can be found in Chapter 4 of this report).

(f)...

(f) The environmental programme was designed in two discrete components; an informational base and a value-clarification base.

(g) Methodologically the environmental programme was pupil-centred; group-work orientated; highly differentiated; more natural and relevant in it s selection of learning materials; directed towards value-formation and decision making; in short actively directed towards affective development.

(The programme is recorded fully in Appendix A of this report).

(h) When compiling the programme the following considerations were borne in mind:-

(i) A desire to provide material in living form rather than as digested from a single text book.

(ii) To provide the teacher with maximum freedom to edit and up-date materials in the provided resource collection. (Appendix A).

(iii) To promote the use of the small group method based on highly differentiated tasks.

(iv) To incorporate skills normally associated with other disciplines to promote transfer of training.

(v) To expose pupils to a variety of different viewpoints to promote open-mindedness and value-clarification.

(vi)/...

(vi) To expose pupils to a variety of different presentations of biological literature including media reports, periodicals of learned societies and government publications.

(vii) To provide a highly relevant approach to the teaching of Biology.

(viii) To provide a wider range of educational experience than could be successfully handled by the traditional lecture-demonstration approach.

(A more detailed analysis of the design employed can be found in Chapters 3,4 and 6 of this report).

(f) In order that the affective progress could be quantitatively evaluated a range of 84 <u>intermediate</u> affective objectives were clarified and classified according to the affective domain taxonomy proposed by Bloom. The writer assumed a hierarchical progression of increasing internalisation when clarifying these objectives.

(A more detailed analysis of the intermediate objectives can be found in Chapter 5 of this report.)

(g) As research workers have established that meaningful investigations aimed at demonstrating significant differences in teaching strategies should employ control and experimental groups and pre- and post test designs, this investigation incorporated both techniques.

(h)/...

(h) Three classes of Std. 8 pupils were selected at a local co-educational secondary school and three phases of testing and retesting were spread over the first two terms of 1979. Two of the classes were Control Groups who were taught using the traditional lecture-demonstration method. One class was used as an Experimental Group following the environmental programme during the first term and thereafter the traditional method. Every effort was made to eliminate unnecessary variables. (A more detailed analysis of the design of the classroom trials can be found in Chapter 8 of this report).

(i) The 84 affective objectives were used to construct a total of 166 attitude statements spread over 6 separate scales representing the six basic attitude clusters implicit in the six broad aims of the syllabus.

(j) Two sets of pilot trials were conducted in order that the scales could be refined and purified before use with the environmental programme.

(i) The first pilot trial sought to establish the <u>content validity</u> of the programme by means of a stable external criterion group, composed of local biology teachers.

(ii) The second pilot trial sought to establish the construct validity and reliability using the more conventional method of internal consistency between items.
Two groups, as similar as possible to the final Experimental and Control classes, were employed for this purpose from the 1978 Std. 8 class at the same school.

(Further details of the Pilot Trials can be found in Chapter 7 of this report).

B. THE CONCLUSIONS

1. The results of the pilot trials.

(a) The writer assumed an item to have content validity when 80% of the judges concurred with the writer's estimation of the correct response to the attitude statement. Where the judges indicated uncertainty as to the correct response the item was rejected.
Some 27 items were finally discarded, leaving 139 items deemed to have content validity. Thus all six scales were deemed to have a high degree of content validity after being purified by the first Pilot Trial.

(b)/...

(b) During the second Pilot Trial a further 61 items were eliminated using the method of internal consistency, leaving 78 of the original 166 items which were now deemed to have construct validity and content validity. When the reliability of each purified scale was computed they were all found to have reasonably high reliabilities.

(Full details of the Pilot Trial results can be found in Chapter 7 and Appendix B of this report.)

2. The results of the full-scale classroom trials.

(a) The pretest results.

(i) The six scales were administered to the Experimental and Control Groups before the experimental programme was commenced, to establish what basic differences existed between the two groups initially.

(ii) It was found that the two groups were very similar in terms of their initial affective development before the programme.

(iii) One of the six scales yielded a significantly different result but this difference could be accounted for in terms of the initial difference of the pupils' prior understanding and appreciation of Physical Science.

(iv) Some 20% of the items were found to yield significantly different results that suggested that the Experimental Group were a more highly motivated group with regard to commitment to science, experimental work and willingness to read scientific literature. They were also shown to be more interested in Scientific endeavour; to have a better understanding of scientific methods and to regard science as one of their favourite subjects.

(Further details regarding the Pre-test results can be found in Chapter 9 and Appendix B of this report).

(b) <u>The post test results.</u>

(i) The same six scales were re-administered to the Experimental and Control Groups immediately ater the experimental programme to establish what affective differences noted between the two groups were due to the environmental programme alone.

(ii) Two Control Groups wrote the post test. One Group (Control A) had already written the test in the form of the pre test. The second group (Control B) had not participated in the pretest. Comparing their results it was shown that the pretest was not a significant learning experience affecting post test results.

(iii)/...

(iii) When the post test results of the Experimental Group and Control Group A were compared it was found that the Experimental Group was showing signs of general affective improvement while the Control Group was tending to deteriorate affectively. These differences were only significant at the 5% level of confidence in the case of the Scale dealing with "Environmental Awareness."

(iv) It was concluded that the divergence in affective development was due to the environmental programme alone.

(v) A distinction was made between attitudes reaching <u>significant levels</u> of statistical difference between the two groups (firm conclusions $p = 0{,}05$) and those of more <u>moderate significance</u> (developing trends $0{,}20 > p > 0{,}05$) and it was found that some 44% of the items in the 6 scales registered at least moderately significant affective mobility during the environmental programme. This mobility was largely confined to middle-order objectives. (See page 277 - 280.)

(vi) These results demonstrated that positive attitude change and value-clarification can be achieved fairly rapidly by means of the environmental approach to Biology teaching while the traditional lecture-demonstration approach made little contribution to countering the steady affective deterioration of the Control Group during the first term.

(Further/...

(Further details regarding the post test results can be found in Chapter 10 and Appendix B of this report.)

(c) The post-post test results .

(i) The same six scales were again re-administered to the Experimental Group and Control A at the end of the second term of 1979, (three months after the end of the programme) to access the stability of the affective development resulting from the environmental programme.

(ii) No significant difference could be noted between the two groups when the results of whole scales were compared.

(iii) When individual items were considered as measures of individual attitude change, it was found that 24% of the items appeared to be continuing to develop in a positive affective direction despite lack of further environmental stimulation; 15% were relatively stable at post test levels of improvement in the absence of further reinforcement; and 5% showed signs of affective deterioration in the absence of reinforcement.

(iv) This suggested that:

(i) Some attitudes were very sensitive to the environmental programme and only needed the programme as an affective trigger to initiate independent development.

(2) Some attitudes were sensitive to the environmental programme but needed the constant reinforcement of the programme to ensure their continuing development.

(3) A few attitudes were so dependent on the environmental programme for their development that they started to deteriorate affectively as soon as the stimulation of the programme ceased.

(4) Over half the attitudes were not affected by the programme at all and not even a moderately significantly change was noticed.

(Full details of the post-post test results can be found in Chapter 12 of this report.)

(v) The affective development was always considered in terms of a comparison between the group exposed to the environmental programme and the group exposed to traditional lecture-demonstration methods. The results were consistently adjusted for initial pretest differences before comparisons were made.

(d) <u>Teacher and pupil responses to the experimental programme</u>.

The class teacher, headmaster and pupils were generally enthusiastic about the results of the programme and no prejudicing of examination results as a result of this affective-rich programme was found.

(Further details of their responses are listed in Chapter 11 of this report).

The implications of these conclusions will be dealt with in the following chapter.

CHAPTER 14

IMPLICATIONS AND RECOMMENDATIONS

CHAPTER 14 : IMPLICATIONS AND RECOMMENDATIONS

A. THE CONTRIBUTION OF THIS STUDY

To appreciate the importance of the recommendations made in this Chapter it is necessary to bear in mind to what extent, to the best of this writer's knowledge, this is a pioneer study !

1. This study represents a practical attempt to translate the current principles underlying the Environmental/Conservation Awareness Movement into classroom realities within the physical and economic realities of the South African education system.
2. It is the first study of this type to be based on the modern general conceptual framework of attitude formation and change postulated recently by Fishbein (1) and to consciously incorporate methods recognised by social psychologists as being legitimate promoters of positive attitude development at school level.
3. It is based on an adapted version of Bennett's (2) environmental encounter coupled with Stapp's (3) model for value-clarification.

4/...

(1) Fishbein, M. and Ajzen, I., Belief, Attitude and Intention: An Introduction to Theory and Research (1975)

(2) Bennett D.B., In: "Environmental Education: Strategies towards a more liveable future. (1974)

4. It is the first study in Natural Sciences to attempt to clarify measurable intermediate affective objectives based on the South African Core Syllabus for Senior Biology and to classify these objectives in terms of the Affective Domain Taxonomy proposed by Bloom. (4)

5. It includes the first South African biology teacher's resource manual based on a local study designed to achieve maximum positive affective development.

6. It includes the first locally designed set of refined, purified, valid and reliable attitude scales that can be used to measure the affective development of pupils being taught using this resource manual,(always bearing in mind that the scales were designed for European children in the Secondary School.)

7. It is possibly the first time that the history of the development of individual attitudes fostered by Natural Science teaching has been recorded over a period of time under careful controlled experimental conditions.

8. It is the first local study of the effect of the traditional lecture-demonstration approach on the affective development of secondary school biology students.

9./...

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(3) Stapp W.B., In: Environmental Education : Strategies towards a more liveable future. (1974)

(4) Bloom, B.S. Krathwohl, D.R. and Masia, B.B., Taxonomy of Educational Objectives: Book 2. Affective Domain. (1964)

9. It is one of the first studies of this status to measure the persistance of positive affective development over a period of time and to distinguish between the four different types of attitudes resulting from this study.

B. IMPLICATIONS AND RECOMMENDATIONS.

1. Implications directly related to this study.

(a) It is possible to reverse the general trend of affective deterioration in the Natural Sciences by making use of an Environmental Approach when selecting a teaching method.

(b) It is possible to construct intermediate affective objectives whose development is quantitatively measurable using attitude scales.

(c) The threshold of statistical inference normally accepted as indicating significant difference ($p < 0{,}05$) may not be sensitive enough to highlight developing trends and it is suggested that it be lowered to $p < 0{,}20$ for this purpose.

(d) Not all attitudes are equally mobile. Some are particularly sensitive, some less sensitive; some need only a trigger to start independent development; others need constant reinforcement. This suggests that the programme implemented should be longer than one term.

(e)/...

(e) The effects of the environmental programme are fairly persistant over a period of time, some 89% of the mobile items (representing attitudes) maintaining their positive affective development some three months after the end of the environmental programme.

(d) The C.E.D. Senior Biology Syllabus is not suited in it's present form to an environmental approach and needs to be reorganised to fit this pattern if the affective development stated in the aims of the syllabus is to be achieved.

(e) Environmental programmes must be based on the local environment, studying the interrelationships and interactions of plants, animals and man in the local context.

(f) This requires a locally orientated syllabus, which probably means that the programme could only be effectively implemented at senior level with Standard Grade pupils, as Higher Grade pupils are required to satisfy University enterance requirements, which are not necessarily the best general preparation for life.

(g) It is possible using the environmental approach to motivate and enthuse pupils with regard to their studies and develop qualities not normally regarded as part of the province of Natural Sciences. (e.g. leadership and public speaking abilities).

(h)/...

(h) <u>It is possible to use the present teaching core</u> provided that opportunities for field trips are allowed; local resource manuals are supplied; in-service training in field work and small group methods are provided through the teacher s' centres and matched attitude scales are prepared to enable teachers to access the affective progress their pupils are making during the programme.

(i) <u>It is possible to conduct limited programmes of this nature within the framework of the existing syllabus, at no extra financial cost</u> provided that the recommendations of point (h) above are noted, as all the apparatus needed for the programme can be requisitioned or made from simple materials at home.

2. <u>Wider implications for education.</u>

(a) <u>Problem areas</u>

Before considering the possibility of wider implementation it is important to anticipate some of the <u>problem areas</u> related to such a programme. Schreuder (5) identifies four problems that will have to be faced sooner or later:

(i)/...

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(5) Schreuder D.R., Omgewingkultivering en die omgewingsvraagstuk met besondere verwysing na die rol van Biologieonderrig in die opleiding van primêre skoolonderwysers (1977).

(i) <u>The present overloaded curricula</u>.

He points out that under present conditions any system, no matter how deserving, that makes additional demands, especially for new learning, on teachers will be unpopular especially amongst older teachers to whom these ideas may seem revolutionary.

(ii) <u>The present teaching core is ill-prepared for this approach</u>.

He points out that up until 1977 no suitable preparatory coursee existed at colleges or universities.

(iii) <u>The inter-disciplinary nature of environmental education</u>.

He points out that traditionally secondary school teaching has been compartmentalised and secondary teachers trained in single disciplines. This in itself might well prove to be a problem as teachers have to start teaching in other areas.

(iv) <u>The financial implications</u>.

He points out that environmental education can be implemented on a shoe-string budget as no extra teachers or extra equipment is needed but that finance will have to be allocated to teacher training to provide the necessary orientation.

Hurry/...

Hurry (6) adds the problem of mis-orientated aims to the list of problems above. He points out, as does this report, that there appears to be a gap between theory and practice and that Conservation Awareness is not generally achieved through present school curricula.

This writer believes that all these problems are faced in the following broad recommendations:

(b) Broad recommendations.

(i) Administrative recommendations.

(a) The Curriculum.

Because affective development and interests are still at highest levels in the junior phase it is recommended that a broad environmental curriculum design be implemented that embraces the entire spectrum from nursery school to the senior secondary phase.

Colton (7) outlines a possible approach:

(1) Nursery Schools

A respect for all forms of life, care for animals and plants and our responsibility towards them.

(2) Primary Schools

A multidisciplinary, investigatory approach using simple equipment as a sensory extension.

Enquiry/...

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(6) Hurry L.B., Report on Conservation Awareness and Formal Education, (1978)

(7) Colton R.W., Education for the Environment (1974)

Enquiry centred on looking for cause and effect and considering the implications of them upon personal well-being.

(3) Secondary Schools

Critical appraisal of evidence within the disciplinary framework. Objectives should include the ability to find information, to assess and collate it, to consider broad issues and make and defend value judgments. Possibly a multidisciplinary approach is feasible at primary school level and a disciplinary approach would be possible at secondary school level, without straining the structure of existing school organisation.

(B) Examinations.

Clearly a new approach will be needed seeking not only the assessment of the acquisition of factual information but also ethical achievements. Unless the affective domain is examined it is unlikely that it will receive much attention from pragmatically inclined teachers.

Colton (8) has some useful suggestions in this regard.

If/...

(8) Colton R.W., Op. cit. (1974)

> If true ethical objectives are reached the pupils will have sifted out that information, decided on their own attitude and be in a position to defend their values... It seems to be eminently acceptable for the pupils to answer written questions which ask for, not mere recall, but the statement of personal values with the marshalling of evidence and presentation of a case. This could clearly demonstrate a pupil's intellectual ability through his competence in reading environmental situations and the predictive value of such an assessment is as high as, if not higher than, that of recall questions... Field work notes, records, reports and laboratory investigations should all form part of the assessment.

Perhaps such a question could form part of the final Biology paper or a separate paper by itself. In the event of a single examination for all candidates, basic data could be supplied to all candidates with the paper or, in the event of local final examination papers, pupils could be encouraged to make use of their own practical notes incorporating fieldwork and laboratory investigations, thus basing the final assessment on the tangible results of the year's work as well. More investigation is needed in this area.

(c) Equipping the teachers.

As the success of the environmental approach hinges on a study of local ecosystems the Cape Province should be divided into broad ecological zones, each offering a diversity of several ecosystems worthy of intensive investigation and sustained field work. Preference should be given to habitats that also reflect the impact of man on the environment.

As/...

As teachers generally are not equipped to offer applied environmental courses without help it is recommended that capable teachers be seconded to Teachers' Centres for six month periods to prepare resource manuals for each local ecosystem. These resource manuals could be printed in co-operation with the Department of Nature Conservation (who have already expressed interest in such a project) and disseminated by the local Teachers' Centres. Only once the manuals are available should the programme be broadly implemented. There should also be a Provincial Index listing all the manuals available so that teachers who transfer from one area to another are able to adjust to local conditions immediately by obtaining the relevant manuals from the nearest Teachers' Centre. In this regard Appendix A of this thesis could serve as a pilot model of such a resource manual that has already been proved successful in practice.

It is felt that much of the resentment to new methods will be overcome by delaying the implementation of an environmental programme until the necessary manuals are available.

Further orientation of teachers will be discussed in the next section.

(D)/...

(D) Designing new Syllabuses.

Schreuder (9) points out that it will be necessary to:

(1) Appoint a co-ordinating body of experts and educationalists to work together on designing new syllabuses. It is unlikely that many of the present study committee representatives will be qualified to assess the worth of such a programme.

(2) One of their tasks will be the description of specific goals of the programme.

> ...om die program te evalueer is dit ook nodig om die doelstellings spesitiek en baie duidelik af te baken ... (Schreuder)

This report has identified a method of clarifying educational objectives.

The new syllabuses should include adequate opportunities for the realisation of affective as well as cognitive and psychomotor objectives and should be structured in such a manner as to make the realisation of these objectives a practical reality.

(ii)/...

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(9) Schreuder D.R. Op. Cit. (1977)

(ii) Teacher training recommendations.

(A) The role of the Teachers' Centres.

The local Teachers' Centres should be regarded as the base for local research into local eco-systems and capable teachers should be seconded to them to prepare the necessary manuals.

They should also lend the necessary loose-leaf resource manuals to local teachers and be responsible for regular up-dating of these manuals.

They should examine the local resources to assess their educational potential accurately to avoid wasting resources and teachers' time.

e.g. compiling local plant and animal identification keys in conjunction with local universities.

They should run in-service training courses for Biology teachers in practical fieldwork methods; the skills needed in successful small-group teaching and orientation in teaching and examining for affective educational objectives.

(B) The role of the Universities.

University education departments should be requested to ensure students are trained in fieldwork techniques, small-group teaching methods and a greater emphasis on ecological studies of a broad nature to equip students for teaching in all parts of the province.

Teachers/...

Teachers who are candidates for higher degrees should be encouraged to do research in curriculum development to contribute to a suitably adapted indigenous curriculum. (Suggestions as to some possible lines of research are made in Chapter 15 of this report.)

(C) The role of the Teachers' Colleges.

Teachers' Colleges likewise should be encouraged to lay greater emphasis on environmental education and the necessary investigatory techniques employed in field studies. Teachers' Colleges are more particularly concerned with the preparation of primary school teachers and there should be a special emphasis on a multi-disciplinary integrated approach to environmental education at this level. Student teachers should be taught in the manner they are expected to employ once they become members of the teaching core.

It is the belief of this writer and many others whose work has been referred to in this report that the urgency of the times will increasingly thrust educationalists towards an adoption of some system of teaching that promotes positive affective development within an environmental framework.

CHAPTER 15

AREAS FOR FUTURE RESEARCH.

CHAPTER 15 : AREAS FOR FUTURE RESEARCH.

The purpose of this report has been to examine the potential of an environmental approach to Biology teaching for realising positive affective development at Secondary School level. While all the indications suggest that the environmental method was responsible for the early development of positive attitudes towards Science and a persistence of these same affective gains after the programme ended, this writer is well aware that the experiment was conducted with a very small sample indeed and hence the results should be treated with due caution. This in itself suggests that the scales should be readministered to a larger sample of school pupils to confirm the results of this research.

Apart from the foregoing obvious line of research the following possibilities for further basic and developmental research suggested themselves to the writer.

A. BASIC RESEARCH OPPORTUNITIES

Much research has been conducted around cognitive educational objectives. The affective objectives have been by and large ignored as an area of uncertainty and with some suspicion by research workers and administrators alike. At times research in this area has been suppressed or merely discouraged as being too difficult to devote time and funds to this end.

In recent years however there has been a definite tendency for more research papers to appear dealing with affective educational objectives although very few of these papers suggest methods of practical implementation of their ideas. One of the main drawbacks to research in this area is <u>the difficulty of measuring objectives</u>.

1. <u>Basic Research into Measurement Techniques</u>.

   (a) <u>The development of general attitude scales to measure affective development is essential</u>.

   Some research workers have claimed that the attitude-scales are exceedingly specific and must be specially prepared for each individual group; however, the evidence that teaching method is the only variable effecting affective development suggests that there might well be some broad attitude statements which could conceivably be combined into standard scales applicable to a wider group.

   (b) <u>The development of methods of measuring individual pupil attitude profiles</u>.

   At present methods of measuring attitudes are largely confined to group testing and evaluation in terms of group means. This writer has noticed however during the course of his investigation that in one or two instances individual pupils identified themselves despite the anonymous response sheets by their characteristic attitude responses over three tests.

The problem at present is that of getting each pupil to respond to a scale of highly personal interpretation without the results being contaminated by a "guinea-pig" or "halo" effect. Such individual profiles would have immense dianostic value to school counsellors in assisting individuals along the lines of more positive affective development.

(c) <u>The establishment of the rates of group and individual affective development</u>.

The development of techniques such as those suggested above could enable educational research workers to establish accurately the optimal time and rate for the development of particular attitudes and incorporate these principles into modern syllabuses.

(d) <u>The establishment of the mobility of different types of attitudes during the teaching programme</u>.

This writer has suggested four different types of attitudes in terms of their mobility[1] More research is needed to establish how much reinforcement is needed to ensure sustained attitude development; what steps are needed to retard declining attitude development; what stimulation is necessary to mobilise inert attitudes and what the actual trigger techniques are for promoting independent attitude development.

2/...

2. Basic Research into Affective Objectives.

A second major drawback to research into affective development is <u>the uncertainty connected with what attitudes are to be measured</u>. This problem is linked to the educational objectives controversy; behavioural objectives being too specific to be of much value and broad aims being too all embracing to be of value. This writer has suggested a third category of measurable <u>intermediate</u> objectives which are specific enough to base several individual attitude statements on each objective.

(a) <u>The clarification of affective, cognitive and psychomotor intermediate objectives for Science</u>.

The affective intermediate objectives suggested by this writer were the fruits of one mind alone. Clearly it would be advisable to gather objectives from a group of persons rather than any single person alone. Intermediate objectives representing as it were the highest practical common factors of the objectives spectrum are essential starting points from which to construct tests that measure progress in terms of educational objectives rather than arbitrary external standards. These intermediate objectives should be clarified for all three domains.

(b)/...

(b) A survey of affective development in Cape schools.

Once the measuring techniques and the objectives to be measured have been clearly defined it will prove feasible to survey the Cape Schools to assess what affective objectives are being realised in different geographical areas; socio-economic areas and in racial areas. It should be stressed that at present nothing is known about what attitudes are being formed in our schools beyond the subjective evaluation of the teaching corps many of whom are somewhat out-of-step with the youth in their classrooms. Better knowledge of what is happening in the classroom can only result in better education.

(c) A survey of pupil likes and dislikes related to Science teaching.

Many research workers have emphasized the need to identify the factors that cause attitude deterioration with regard to school science teaching in order that steps might be taken to counteract this tendency. This study has identified a few of the factors that stimulate pupils' interests in Biology teaching. More research work is needed to compile a comprehensive list of factors that promote and detract from interest in the Sciences, that syllabus planners might be aware of pitfalls in the basic structure of our modern syllabuses.

B/...

B. DEVELOPMENTAL RESEARCH OPPORTUNITIES

There are several priority projects that could be classed as developmental research based on the basic research findings of the present and proposed research work.

1. Developmental research in Curriculum Development.
   This writer has already referred to the suggestions of research workers with regard to curriculum design along environmental lines in the last Chapter. There is a need to develop an indigenous curriculum that incorporates the principles of the environmental approach which is essentially a multidisciplinary approach at all levels from preschool to the senior secondary phase.

2. Developmental research in syllabus construction.
   There is a real need to base new syllabus contents on the real needs and interests of pupils and students rather than a set of external criteria suited more to university enterance standards than a preparation for life. In this regard syllabus planners should in future take cognizance of the basic research, much of which still remains to be done, and encourage researchers to investigate the basic questions that remain to be answered before truely relevant syllabuses can be constructed.

3/...

3. <u>Developmental research in resource materials</u>.

   The development of adequate resource materials should <u>precede</u> the implementation of a new syllabus, especially in the case of one that incorporates new skills that the teaching corps will be expected to master before communicating these skills to their pupils. Present teachers usually do not have the time or the background to prepare resource manuals based on local conditions by themselves, hence this writer recommended in the previous Chapter that this developmental work be conducted under the auspices of the nearest Teachers' Centres.

4. <u>Developmental research into Formal Evaluation Techniques</u>.

   It has been pointed out in Chapter 14 that if affective teaching is to realise it s true status in our classrooms attention will have to be given to formal evaluation techniques. Research is necessary into examination questions that can realistically measure the degree of affective development of each individual pupil.

Much more could be said with regard to research into the affective domain but this writer regards the foregoing suggestions as basic to the development of a better system of teaching Biology which in turn will result in more interested, highly motivated pupils moving into related career fields and all pupils being better prepared to make a responsible and meaningful contribution in their environment.

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APPENDIX A:

TEACHER'S MANUAL. THE ROCKY SHORE ECOSYSTEM

AN ENVIRONMENTAL EDUCATION PROGRAMME FOR

STD. 8 (FIRST TERM)

TEACHERS' MANUAL

PRODUCED BY
F.W.J. OPIE.
1978

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A. PREFACE

It is unlikely that the environmental approach to the teaching of Biology has been implemented in South Africa prior to this experimental programme.

It is important at the outset to realise why this is so. Fieldwork and outdoor methods are nothing new to Biology teachers. The difference between environmental education and nature study or outdoor education is in the different objectives towards which these programmes proceed.

Outdoor education is primarily concerned in interesting pupils in nature, to teach them in the "outdoor laboratory" the complexities of life. Environmental education goes beyond this goal; "It is concerned with developing informed attitudes of concern for environmental quality." Swan. (1).

Hinton and May (2) elaborate on this definition as follows:

> Environmental education is the process of recognising values and clarifying concepts in order to develop skills and attitudes necessary to understand and appreciate the inter-relationships between men, his culture and his bio-physical surroundings. Environmental education also entails practice in decision-making and formulation of a code of behaviour about issues concerning environmental quality.

Clearly/...

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(1) Swan J.A., "The challenge of environmental education." Phi Delta Kappan, Vol. 51. (1969).

(2) Hinton, K. and May, J., The Place of Science in Environmental Education. (1973).

Clearly we are dealing with an approach that emphasises value clarification and attitude formation.

Information gathered and interpreted serves, not as a goal in it s own right but rather as a necessary step towards informed environmental responsibility.

Positive attitudes cannot be formed until each child has an opportunity to first clarify his/her own values. Thus it becomes necessary to present issues that are actual or potential problems. The children must have practice in decision making and democratic formulation of codes of behaviour. They must explore the methods by which government agencies attack such problems and understand how citizens can help in coping with them.

This problem is much wider than the narrow perspective of nature study. The child may well develop an interest in nature, but will also appreciate man's role in the environment, as he alters it s structure, pollutes it or co-operates in harmony with it. Engineering, Economics, Politics, Local Government, and Social needs all must take their place alongside Biology in this larger study of the environment.

The goal of Environmental Education is responsible citizenship, particularly with regard to the environment.

B/...

B. THE METHOD OF INSTRUCTION.

The teacher's role in environmental èducation is that of..

> a midwife who allows the process of value formation to develop at it s own pace. The teacher makes sure that the pupils learn the correct process of value clarification, but never forces values upon people.
>
> Swan (3).

The experimental group will learn "the process of value clarification" by meansof several different methods:

1. Lectures by the teacher illustrated with films and slides.
2. Two field trips to the sea shore at Glencairn for the purpose of surveying the distribution of plants and animals on the rocky shore and investigating special problems.
3. Small group discussions to arrive by democratic means at solutions to problems.
4. Library research to gather additional information.
5. Participating in class debates.

At all times the prime purpose of the programme is to assist the process of value-clarification.

Stapp (4) has identified this process as consisting of five steps .....

1./...

---

(3) Swan, J.A. and Stapp, W.B., Environmental Education: Strategies towards a more liveable future. (1976).

(4) Swan, J.A. and Stapp, W.B., Op. Cit. (1976).

1. Pupils are presented with an issue.
2. Pupils suggest alternative solutions.
3. Pupils consider the consequences of each alternative.
4. Pupils express their feelings about each alternative.
5. Pupils make a free choice.

This means that the goal of this instruction is to present issues as soon as a sound informational base has been established. Small groups will discuss each issue asking questions such as ...

"1. Who benefits?
2. Who suffers?
3. What are the alternatives?
4. Have we enough information to make a valid judgment?
5. Do we approve of what is happening?
6. What course of action could we take in order to participate?"

Hinton and May. (5)

This is an outline of the proposed experimental programme:

UNIT 1 : – THE ECOLOGY OF THE INTER-TIDAL ZONE OF THE ROCKY SHORE.

An introduction to ecological relationships.

UNIT 2: – FIELD-TRIP ONE : TO INVESTIGATE THE ECOLOGICAL RELATIONSHIPS ON THE ROCKY SHORE.

A survey of the abiotic and biotic factors operating on the rocky shore.

UNIT 3:/...

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(5) Hinton, K. and May, J., Op. Cit. (1973).

UNIT 3: - THE LABORATORY FOLLOW-UP OF THE FIRST FIELD-TRIP.

Small group investigations of:

- Zonation on the Rocky shore.
- Correlations of shell thickness and exposure.
- Molluscan body structure.
- Shore-bird life.
- Plankton, it s role in the food chain.
- Adaptation in Klipfish.
- Identification of animals and plants.
- Adaptation in the Sea Anemone.
- Adaptation in the Bristle Worm.
- Mounting and preserving methods.
- Mappling secondary communities.
- Habitat selection in crustacea.
- Structure of the Shore Crab.
- Adaptation in Barnacles.
- Distribution graphs.
- Wave-action studies.
- Wind effect studies.
- Leveling and profile drawing.
- Micro fauna of Kelp holdfasts.
- Life in the drift line.

UNIT 4: - FIELD-TRIP TWO : TO INVESTIGATE THE EFFECTS OF HUMAN USE OF THE SHORELINE.

The site will be revisited to study the human uses of the shore line with special reference to:

- The litter problem.
- The impact of the railway line on the environment.
- The implications of the sewerage disposal system for the environment as a whole.
- Environmental marring.
- Casual users of the shore and their influence on shore life.
- The oil pollution threat to the rocky shore.

UNIT 5:/...

UNIT 5: THE FOLLOW-UP OF THE SECOND FIELD-TRIP.

- Reports are presented on all the data collected in Unit 4.
- Teacher sums up after each report. The class make decisions on the following issues:
  - Measures to control littering.
  - A code of conduct for beach users.
  - The desirability of maintaining a rail link with Simonstown.
  - Public action to be taken as regards the disposal of sewage in the area.
  - The effects of poisons and the role of vested interests.
  - The cost and desirability of environmental improvement.
  - Conservation and the proper use of marine resources.

Time allocation.

This will depend on the teacher and the abilities of the class. The following is, accordingly, only a rough guide:

Unit 1 - 10 periods.
Unit 2 - 1 school day (Spring low water.)
Unit 3 - 17 periods
 8 periods investigation
 9 periods report-back
Unit 4 - $\frac{1}{2}$ school day (low water)
Unit 5 - 17 periods.
 5 periods investigation.
 12 periods report-back.

Evaluation/...

Evaluation.

This programme holds possibilities for several types of evaluation.

a. Cognitive Evaluation.

In order that the area for testing be clearly defined at the outset so as not to disadvantage the experimental group in comparison with the control group, the dissemination of basic content has been organised into clear units:

Lectures: 1 to 8 on ecological relationships.

Information sheets: 3 to 10 on study animals.

Information sheets: 13 and 14 and any notes which the teacher may supply independently.

Practical Evaluation.

Despite the fact that all work is group orientated, the groups are small enough (4) for the teacher to appreciate the contributions of individuals. They can be evaluated in terms of the assignments given in:-

Task sheets: 1 to 9 on the first field-trip.

Task sheets: 1 to 7 on the second field-trip.

All the written reports are capable of evaluation as are the sketch-maps, data tables and graphs.

b. Affective Evaluation.

Affective evaluation will be based on the Likert-type attitude scales specially devised for this experimental programme.

c./...

G. UNIT ONE:

THE ECOLOGY OF THE INTERTIDAL ZONE OF THE ROCKY SHORE.

METHOD: 8 Lectures illustrated with films, slides and the diagrams provided in these notes.

ESTIMATED TIME REQUIRED: 10 periods.

LECTURE 1/...

LECTURE 1

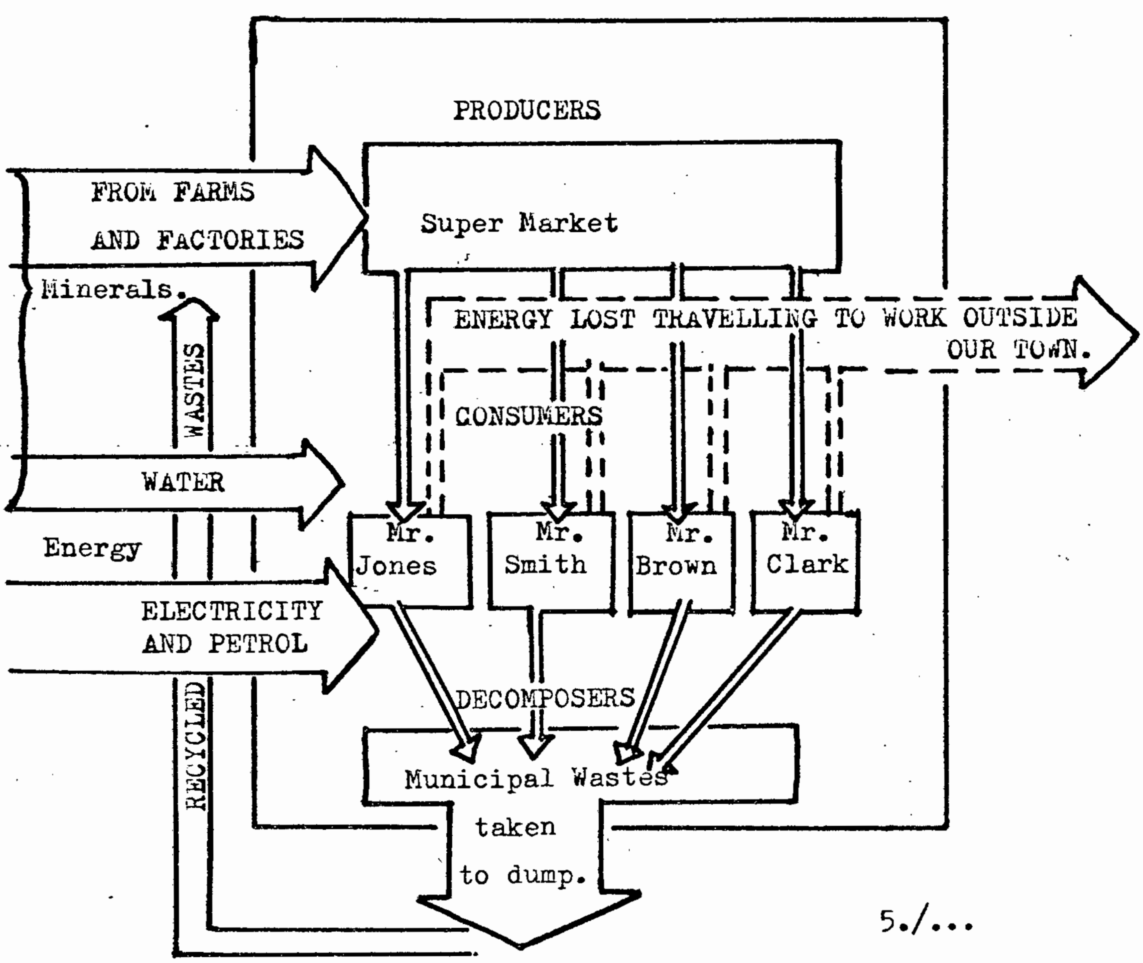
An introduction to Ecology.

1. The film "What is Ecology?" (PS 762) lasting 10 min. is shown as a visual introduction.

2. The teacher elicits a definition of ecology from the class. (ECOLOGY is the study of animal and plant homes.)

3. The teacher initiates a class discussion of the factors involved in buying a house today. These factors are listed on the board as biotic or abiotic factors.

4. The teacher constructs a chalk board model of the local suburban ecosystem helping the class to learn the terminology of the trophic levels in food chains.



5./...

Fig. 1. OUR TOWN (AN ECOSYSTEM)

5. The teacher summarises the components of the ecosystem as follows:

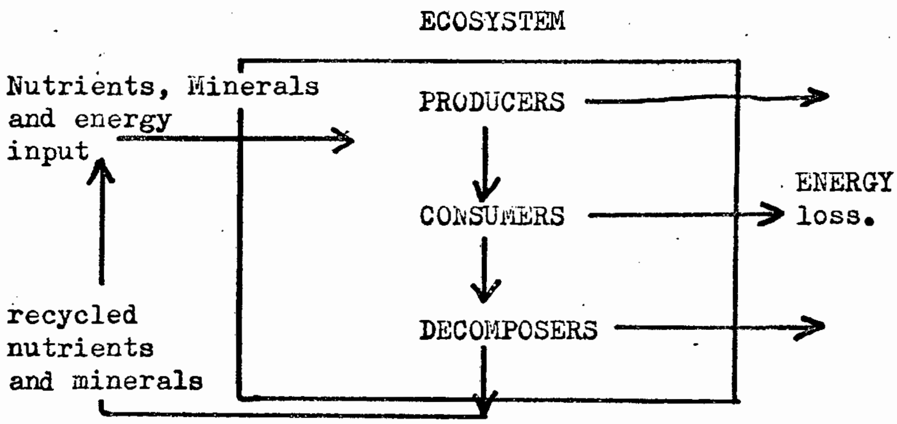


Fig. 2. THE MAIN BIOTIC COMPONENTS of an Ecosystem.

LECTURE 2/...

LECTURE 2

Extending the terminology to the Rocky Shore Ecosystem.

1. Using the simple model learned in the previous lesson the class are required to identify the producers, consumers and decomposers, source of energy and nutrients in this film:
   "Animals of the Rocky Shore" (PS 130) 9 mins.

2. The teacher explains this model.

PRODUCERS:	Sea Weeds and Plankton eaten by
CONSUMERS:	
1. HERBIVORES	Snails and Worms
2. CARNIVORES	Crabs, Fish, Anemones. etc.
DECOMPOSERS:	Bacteria.

Fig. 3. TROPHIC LEVELS IN THE SEA

3. After it has been shown how this very simple food chain operates, the teacher proceeds to elicit the abiotic factors and list them on the board.
   eg. Sunlight, Waves, Tides, Exposure, Minerals, Temperature, Salinity, Rock.

4. Try to get the class to explain the presence of such a variety of life forms in such a potentially harsh environment in terms of energy, food nutrients, adaptation to wave action and exposure.
   (NB: The rocky shore is the most violently changing habitat in the world.)

LECTURE 3/...

LECTURE 3

The Rocky Shore Ecosystem : A general preview.

1. The teacher revises the concepts learned in the last two lessons by means of this model. (The class should receive a copy of this diagram).

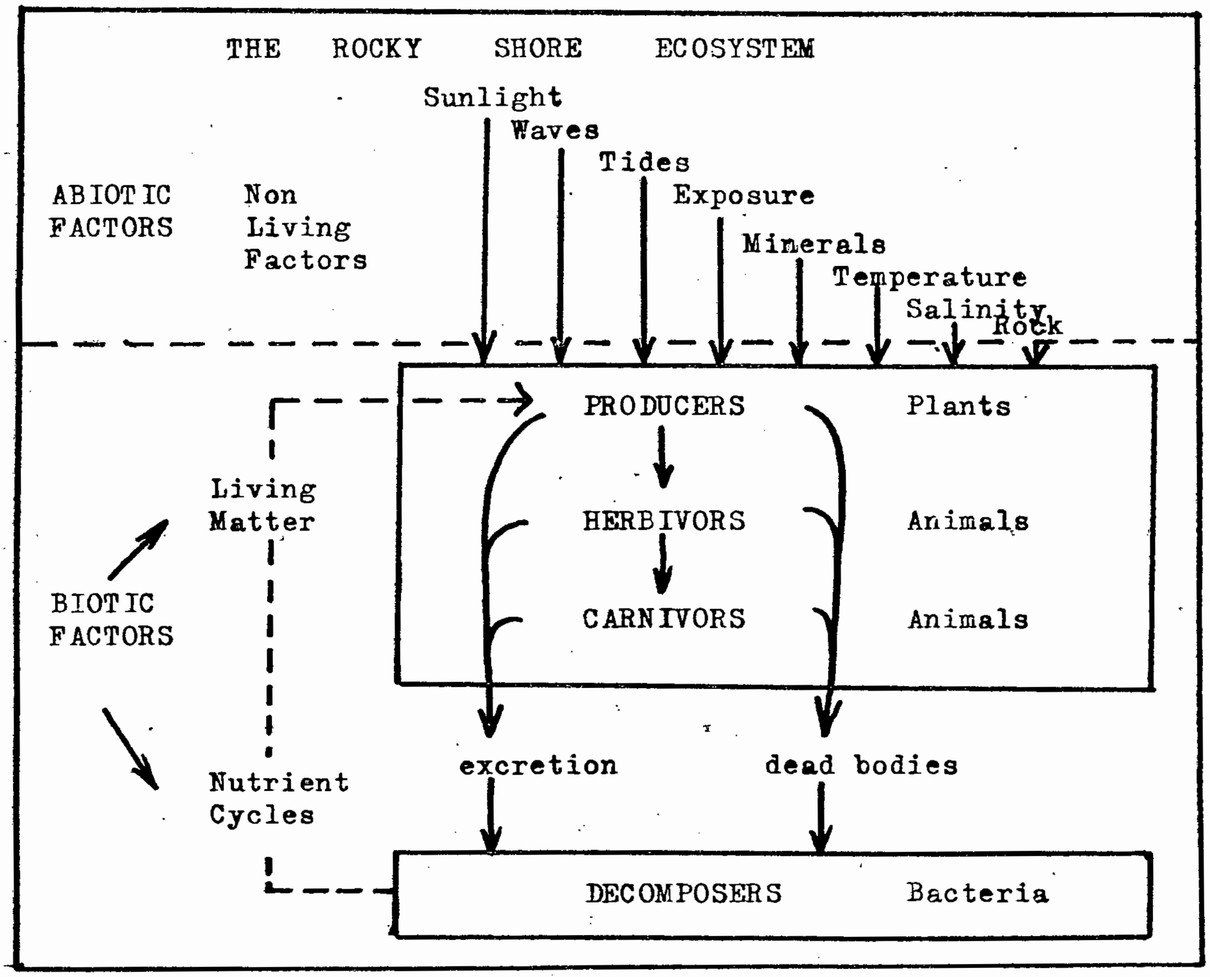


Fig. 4. THE ROCKY SHORE ECOSYSTEM. (6)

2. The film:
"The Community" (PS 773) 10 min.
is shown and the class is asked to identify as many abiotic and biotic factors as possible as a revision of the concept of an ecosystem.

LECTURE 4/...

6) Adapted from: Australian Science Education Project, Sea Shores, (1974).

LECTURE 4

The Abiotic Components: Sunlight Energy

1. The teacher illustrates the energy input to the rocky shore ecosystem using this diagram. (Copies to class.)

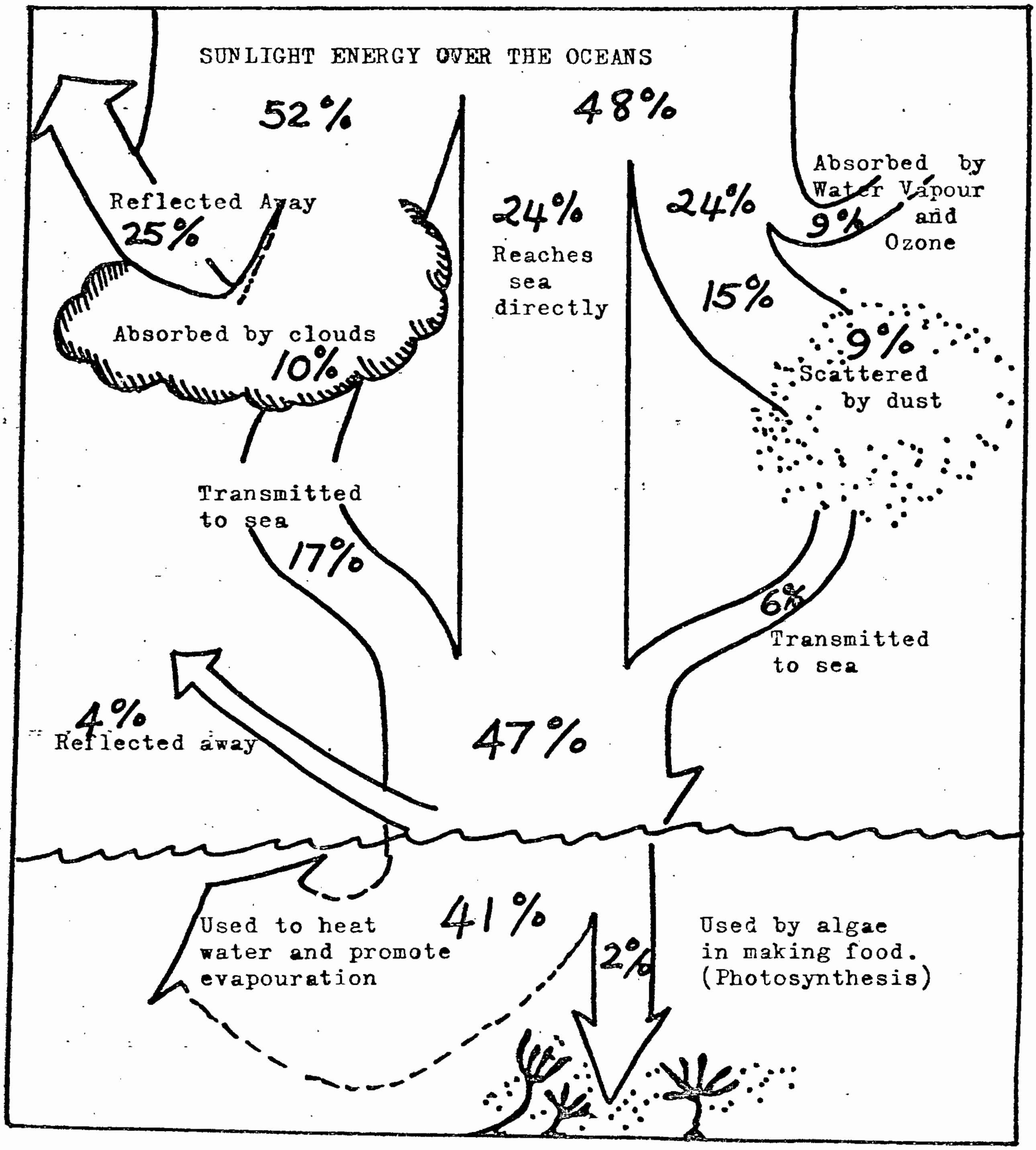


Fig. 5. THE FATE OF SUNLIGHT ENERGY (7,8)

Diagram 7/...

Diagram adapted from:

7. Kimball J.W., Biology (1965)

8. Kormondy E.J., Concepts of Ecology (1976)

2. The teacher points out that:
   (a) More photosynthesis occurs in the oceans than on land. (Rapid absorption of light by water to greater depths.)
   (b) Virtually all of it occurs at the suface.
   (c) Fixed algae (sea weeds) can grow on the rocky shore in fairly distinct zones depending on the amount of light they receive.

Fig. 6. THE DISTRIBUTION OF SEAWEED BY DEPTH

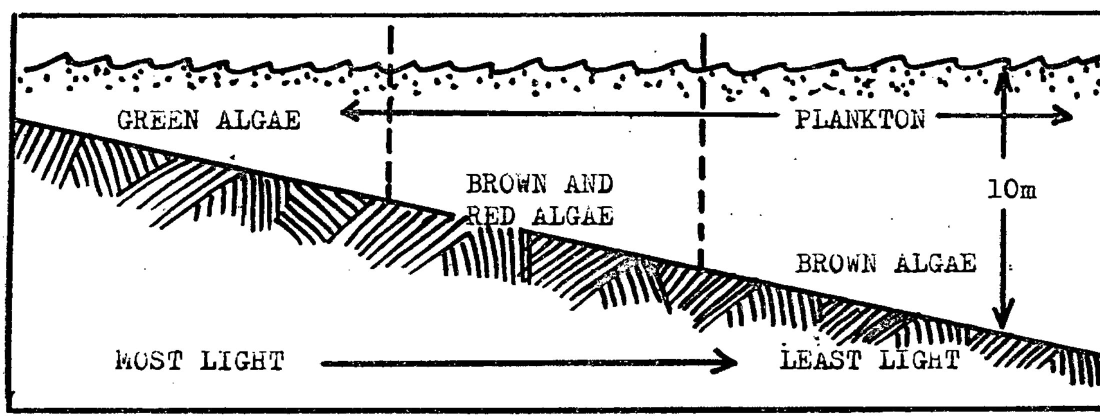


Fig.6. THE DISTRIBUTION OF SEAWEED BY DEPTH

   (d) Floating algae (plankton) can live anywhere on the rocky shore as they float at the surface.
   (e) Deep water (10m) algae have long stalks to lift their photosynthetic organs (straps) to the surface e.g. Kelp.
   (f) The brown and red pigments enable seaweeds to absorb weak light in the deeper water.
   (g) With the exception of plankton most of the producers of the oceanicecosystem live in the shallow waters alongside the rocky coastlines. (Why?)
   (h) Not all the sunlight energy absorbed by the seaweeds is stored in the form of plant tissue. Most is used for the living processes in the seaweed.

Fig. 7/...

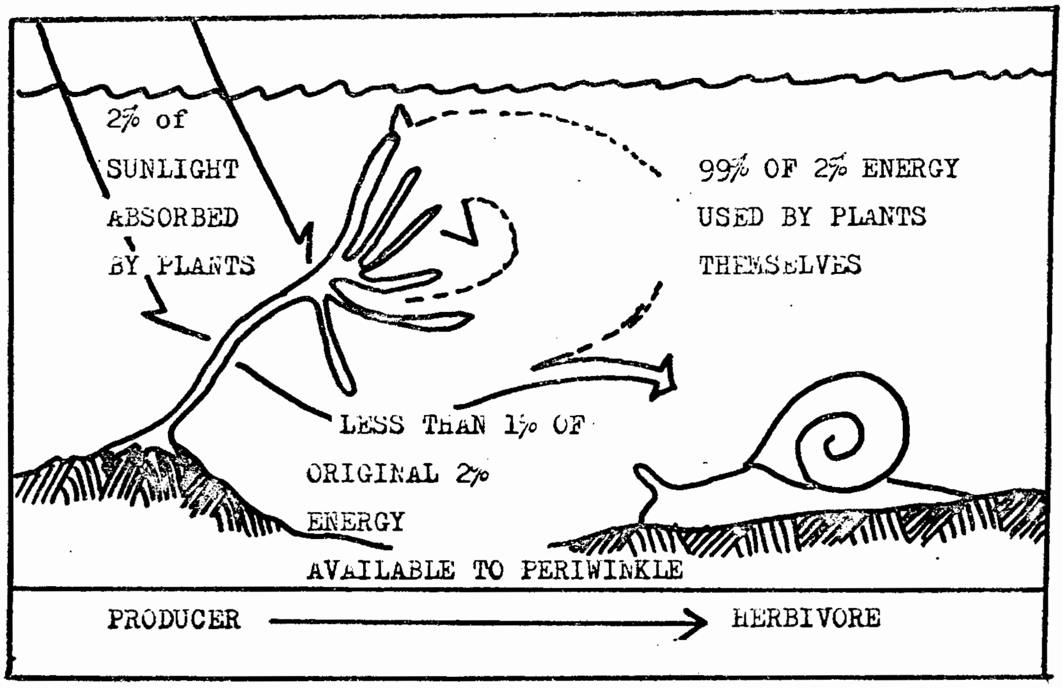


Fig. 7. <u>ENERGY LOSS BETWEEN LEVELS</u>

(i) There is a tremendous loss of energy between the producer and the herbivore.

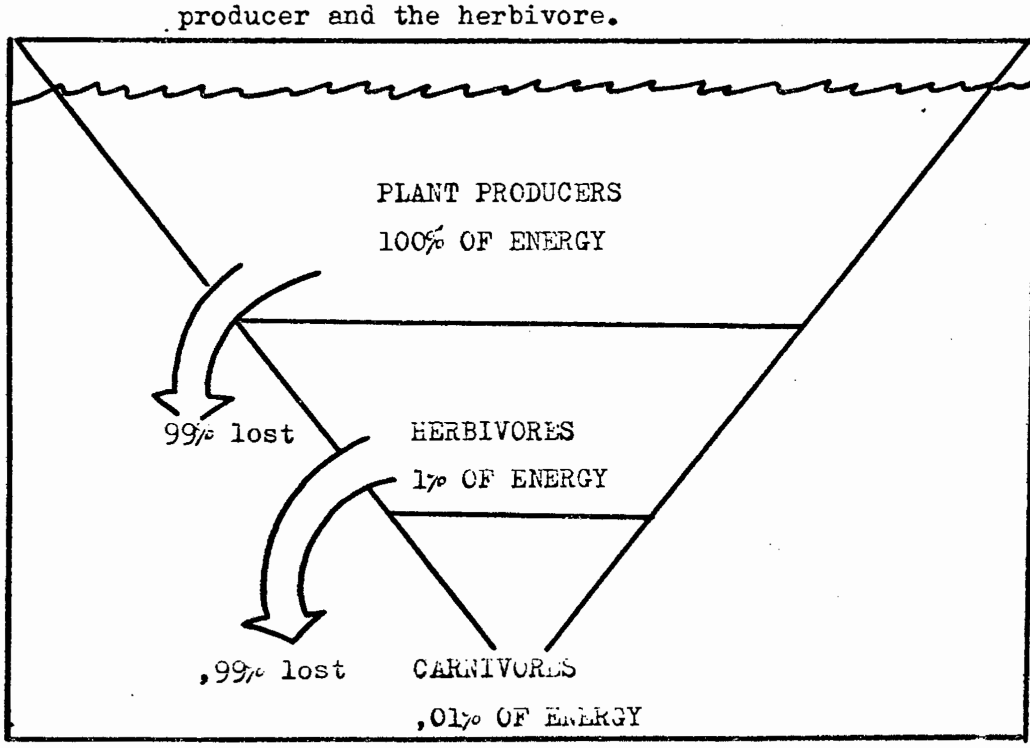


Fig. 8. <u>ENERGY LOSS AT SUCCESSIVE LEVELS</u>

(j)/...

(j) This means many seaweeds support fewer herbivores who in turn support very few carnivores.

(k) This relationship is referred to as an <u>energy pyramid</u>.

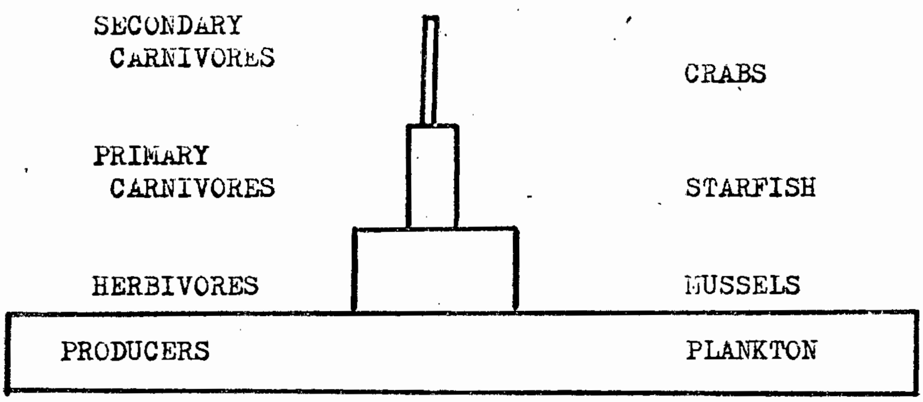


Fig. 9. <u>THE ENERGY PYRAMID</u>

There is a limited amount of energy in the ecosystem. Only a small fraction of it is stored in plant or animal tissue. Thus as we move up the pyramid there is less energy in the form of food available to each new level (energy pyramid). Thus there are fewer animals near the top of the pyramid than the bottom (pyramid of numbers.)

LECTURE 5

The Abiotic Components : The Water.

1. The teacher points out that the abundance of sunlight and hence food is not the only factor to be considered when seeking to colonise a rocky shore.
2. Advantages of the rocky shore to water creatures:
   (a) The strong wave action churns up sediments that contain food and nutrients.
   (b) The strong wave action mixes oxygen into the water so that more life can be supported on the shore.
3. Disadvantages of the rocky shore to water creatures:
   (a) Abrasive action of wave action - always the risk of being torn loose and stranded.
   (b) Rise and fall of the tide may result in isolation in a rock pool or dehydration on an exposed surface.

The teacher illustrates these points using slides taken on a rocky shore-line.

WAVE ACTION (9)

- Gentle swells of 1 metre high develop a pressure of $2\frac{1}{2}$ tons per square metre on the shore. (Barrett)
- Or $6\frac{1}{4}$ kg. of thrust on a 25 cm^2 limpet every few seconds.
- Storm waves increase this pressure to 100 tons per square metre.
- Or 250 kg. of thrust on the same limpet.

(Note the near impossibility of dislodging a secure limpet.)

Animals that cannot withstand these storm waves are washed up on the drift line at high water mark. A storm can result in 100's of tons of kelp and mussels being dislodged and washed up on the beach. Recommended reading: "A wave-swept home" (10)

TIDAL RANGE/...

WAVE ACTION

1. Note how the force of the waves is broken by the rocky shore . Note how much clearer the inshore water is. Account for this in terms of speed of water movement and suspended material. Is this good or bad?

2. Turbid water carries sediments to filter feeders. But it also means rough water. Note the black mussels below and the barnacles above. What does this suggest to you about the needs of the black mussels ?

3. How could wave action possibly increase the amount of oxygen in sea water ?

4. Much of the white colour is the result of light being reflected off air bubbles trapped in the water by the breaking wave. Oxygen is obviously important to animals in the sea, but what special problems would be associated with this white water zone? Comment on the shape and size of the barnacles and green spaghetti weed in this scene.

5. This is a pool in the upper mid-shore . It is isolated from the sea for many hours each day. What animals can you see ? Account for the shortage of animals. Why does the green seaweed survive where the animals can't live?

6. This is an isolated pool right at the top of the shore. Why is there no seaweed growing in this pool ? (pool obviously dries out completely for long periods at a time.

TIDAL RANGE

The tides rise and fall as a function of the gravitational attraction of sun and moon.

JANUARY 1979 - TIDE TABLE					
DAY	HIGH TIDE a.m.	p.m.	LOW TIDE a.m.	p.m.	
6	0951	2234	0325	1630	NEAP TIDE
7	1105	2355	0448	1745	
⋮	⋮	⋮	⋮	⋮	
14	0401	1609	1003	2214	SPRING TIDE
15	0430	1639	1033	2242	

Fig. 10. TIDE TABLES (11)

What is the time lag between 2 consecutive high or low tides?
What is the time lag between a high tide and it s ebbing to low tide?

(The teacher may decide to explain the variation in timing of 2 consecutive high or low tides.)

Highest High tides (Spring tides) occur one day after Full Moon and New Moon.

Lowest High tides (Neap tides) occur one day after first quarter and last quarter moons.

FIG.11/...

Adapted from : 9. Barrett J., Life on the Sea Shore. 1974
10. Farb. P. (Ed.) A wave-swept home in : Ecology (1965)
Tidal data extracted from:
11. Mobil Tide Table 1978 prepared by the South African Navy Hydrographer.

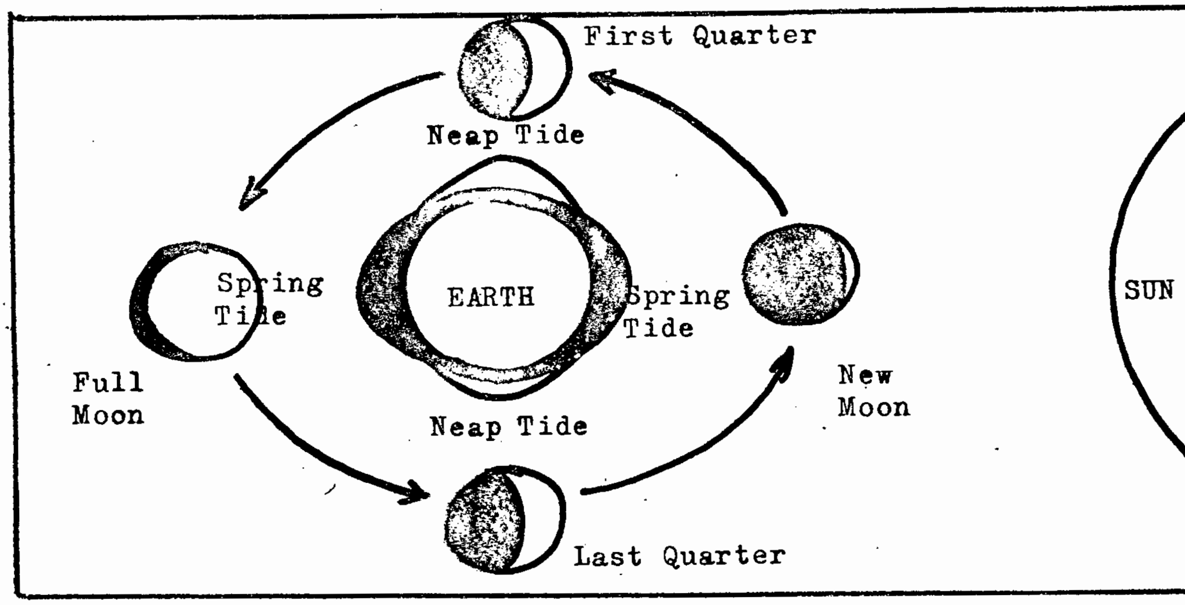


Fig. 11. THE MOON AND THE TIDES.

This means in effect that each month there are 2 very high, high tides (spring tides) and 2 very low high tides (neap tides); all other tides are in between these tides.

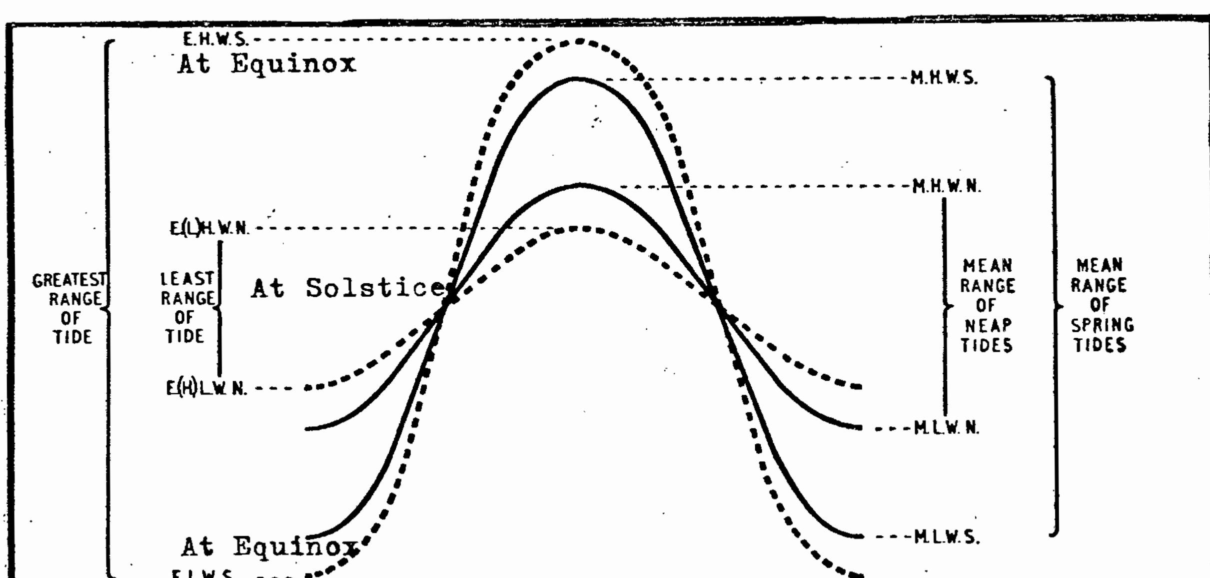


Fig. 12. THE TIDAL RANGE (12)

Thus/...

From: 12. Lewis J.R., The Ecology of the Rocky Shores. (1972)

Thus each day animals and plants are exposed for varying lengths of time according to their position on the shore.

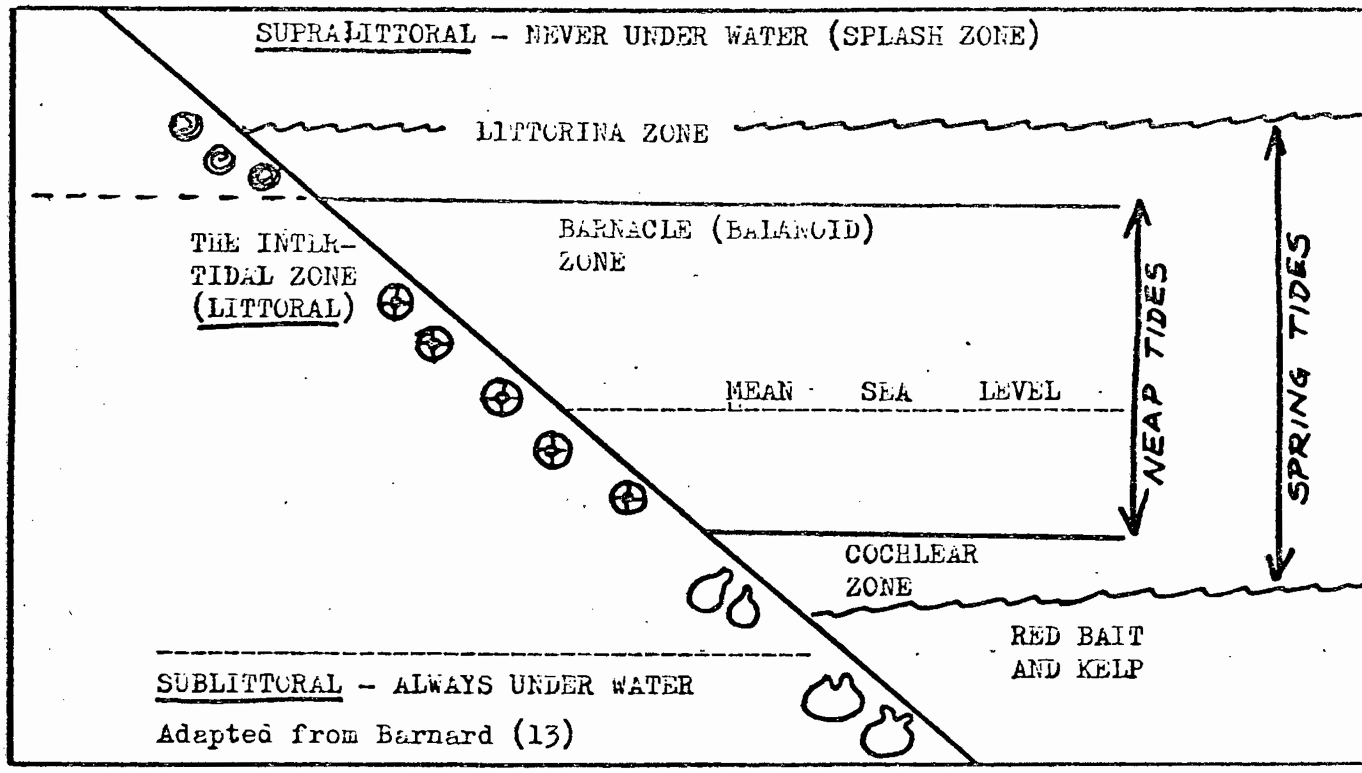


Fig. 13. ZONATION ON THE SHORE (13)

Those in the littorina zone may only be covered briefly twice a month by the spring high tides.

Those in the barnacle zone are covered and exposed at least twice each day.

Those in the cochlear zone may only be exposed briefly twice each month by the spring low tides.

Each species has a fixed tolerance to exposure and drying and thus each species tends to dominate a particular part of the shore.

LECTURE 6/...

Adapted From:

13. Barnard K.H., South African Shore-life (1960)

LECTURE 6

The Abiotic Components : Other physical factors.

THE ROCK

The teacher shows slides that illustrate different rock surfaces.

1. The teacher elicits the facts that some rocks weather smoothly and provide little shelter. Others weather into gullies and cracks that shelter animals.
2. Which type of rock is likely to shelter more animal life - granite or sandstone?

THE TEMPERATURE

3. The teacher points out that sea water temperatures do not vary as much as air temperatures. When the animal is exposed to the air by the receding tide it is generally chilled or heated by the air to a considerable degree.

   How would a limpet survive on a hot rock for a few hours?

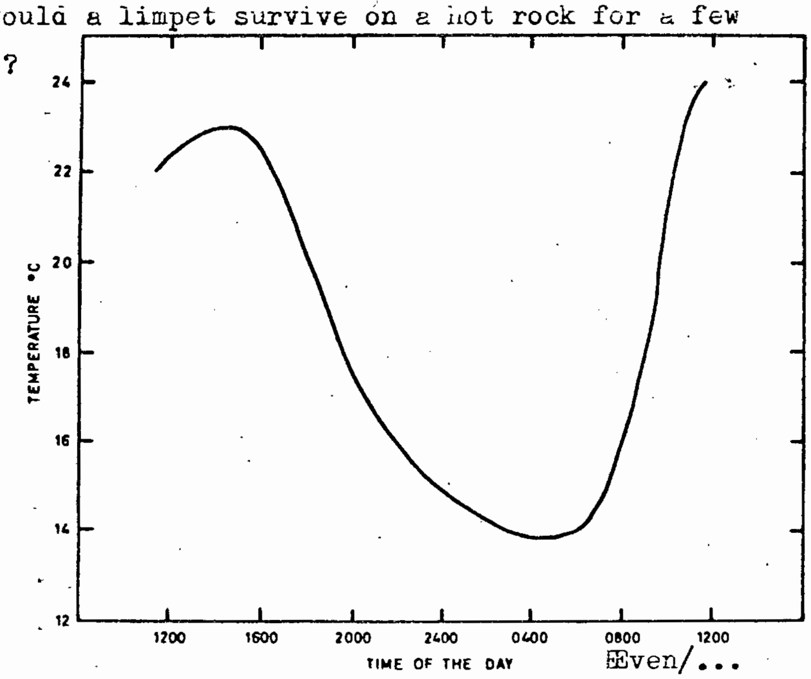


Fig. 14
The temperature range in a pool.
(Newell 14)

Even/...

From: 14. Newell R.C., Biology of Intertidal Animals. (1970)
Answer to 3: By evaporation of water trapped under the shell.

ROCK SURFACES

7. This is a granite shore.
There are few cracks to shelter animals.
The granite weathers to form rounded boulders that produce steep vertical inter-tidal zones.
Comment on the problems of shelter from wave action and predators.

8. Same scene much closer up.

There are three different types of animals living on this shore. Barnacles, black mussels and sea anemones in the cracks. Note how popular the tiniest available shelter is and comment on the lack of seaweeds.
How do these animals obtain their foods ?

9. This is a sandstone surface.
It weathers to form flat benches with many cracks and gullies.
Comment on the abundance of animals.
What could account for the open spaces between the barnacles.
(Predation)

10. Same location facing seawards.

Try to account for the relative abundance of seaweeds.
(Rock bottom for attachment of holdfast)
How will these seaweeds affect the kinds of animals that can live here ?

Even animals that live in rock pools that are temporarily isolated from the sea have to withstand a considerable temperature variation.

THE SALINITY

4. The saltiness of the sea does not change noticeably at all, however the salt concentration of the rock pools, especially those in the Littorina Zone does change considerably. Suggest two causes for these changes.

If the salinity rises too high the animals must abandon the pool or die.

Pools near the top of the shore are dangerous places for marine animal life as they can be isolated from the sea for long periods.

THE ACIDITY OF THE WATER (pH)

5. It has been shown by Newell (15) that there is a close relationship between the number of seaweeds in a rock pool and the acidity of the water.

As photosynthesis proceeds the water becomes less acidic; during the night the acidity rises again.

Only animals that can tolerate these conditions can live in rock pools.

LECTURE 7/...

Answers to 4: (a) Rain. (b) Evaporation (wind and temperature)

15. Newell R.C., Op. Cit. (1970)

LECTURE 7

The Biotic Components : Food Supply.

The biotic components all relate to the living environment as it affects each organism.

1. The teacher establishes that each organism needs certain basic things if it is to survive. Namely: Water, Oxygen, Living space and Food Supply.

   Food supply is probably the most critical biotic factor.

FOOD CHAINS ON THE ROCKY SHORE

2. The teacher revises the pyramid of numbers and the pyramid of energy (Lecture 4) stressing the different trophic levels again.

3. All food chains in the sea start with the producers, that is, the seaweeds and phytoplankton. The teacher discusses the following diagram. All pupils receive a copy.

Fig. 15/...

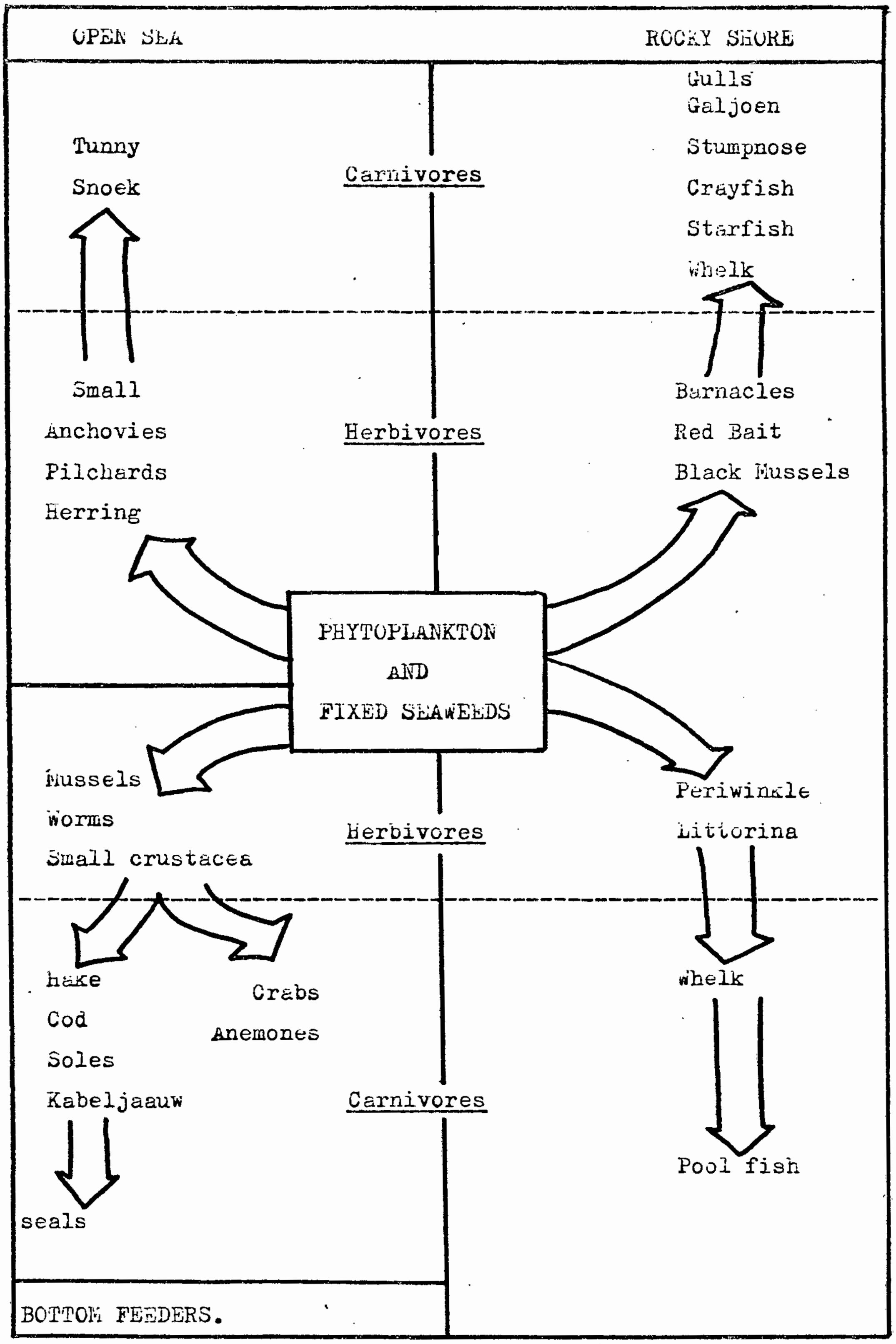
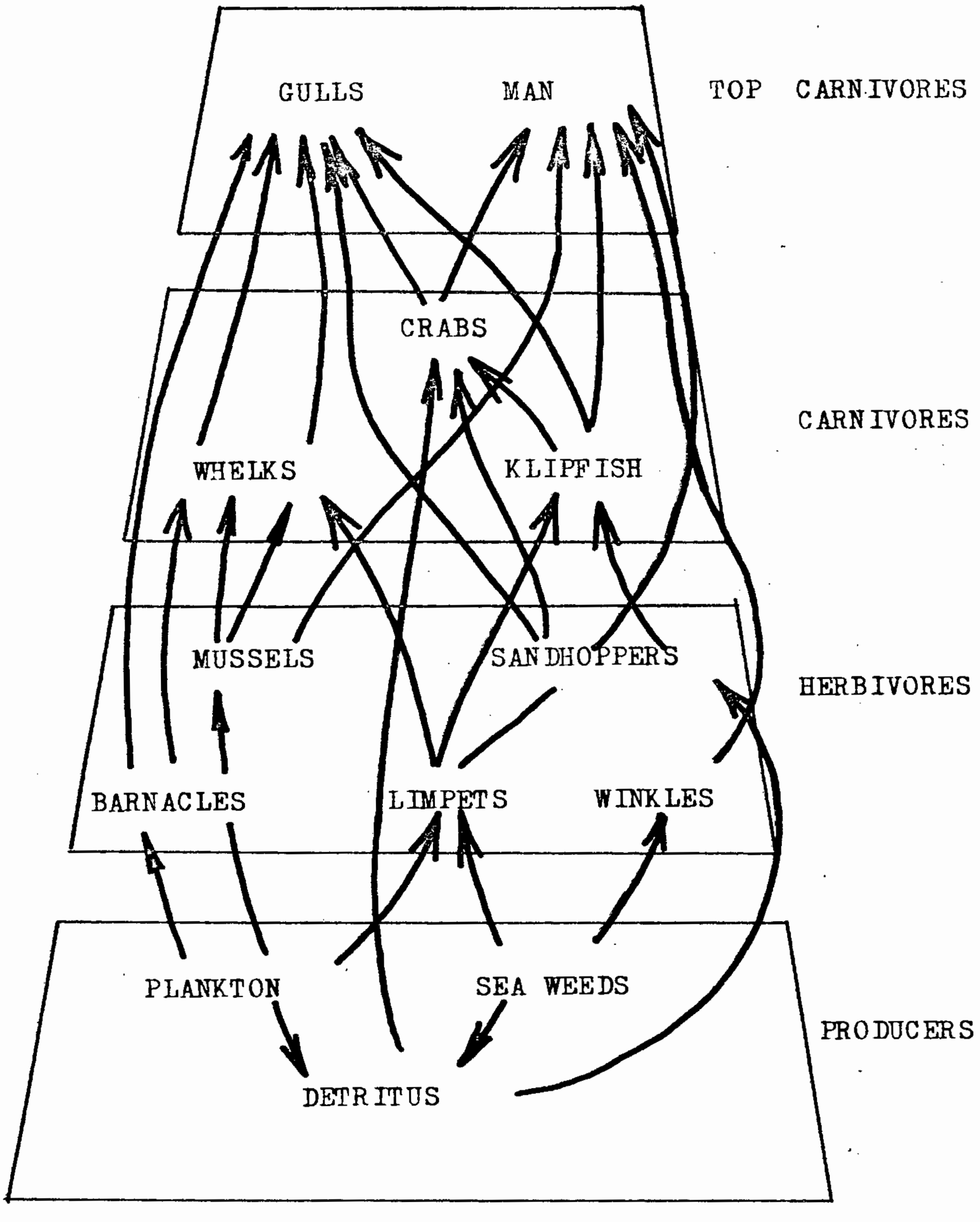


Fig. 15 Food chains in the sea (16 and 17)

4/...

Adapted from 16. Day J.H., Conservation in the Sea (1971)
17. Flatteley F.W., and Walton C.L., The Biology of the Sea-Shore (1922)

4. In reality the situation is more complex. Many food chains are related to each other and mingle to form a food web. All pupils receive a copy.



Follow the arrows to see who eats who.

Fig. 16 A Marine Food Web (Barrett 18)

5./...

Adapted from : 18. Barrett J., (1974) Op. Cit.

5. The teacher shows slides of rocky shore animals and identifies them by common name. The class must examine each slide to see what each animal feeds on. (See also Fig. 20 : Some Common Shore Animals and Plants.)

6. It should be clear by now that there is :

(a) <u>A pyramid of numbers</u> (i.e. fewer animals at higher trophic levels.)

(b) <u>A pyramid of energy</u> (i.e. less accessible energy available to higher trophic levels.)

(c) <u>A pyramid of mass</u>
This follows logically from the pyramid of numbers; fewer animals have a smaller <u>combined mass</u> even though the individuals may be large.

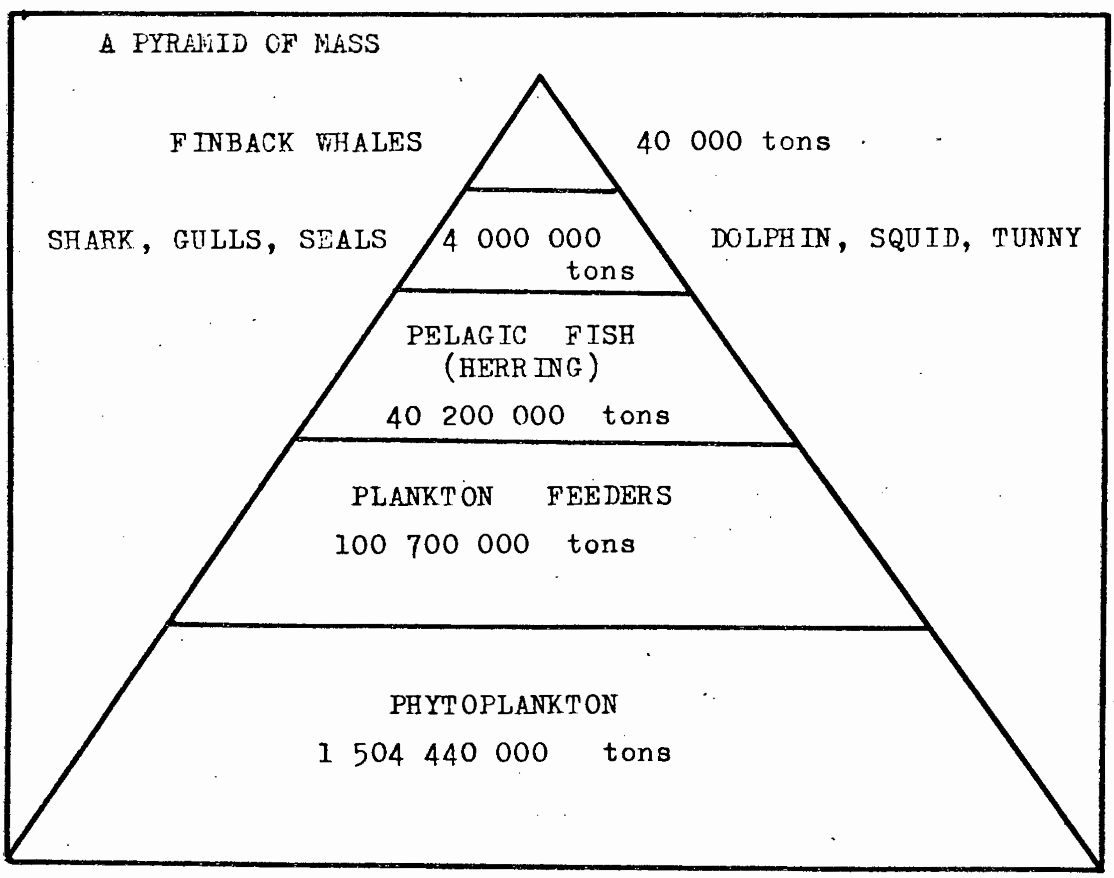


Fig. 17 <u>The Pyramid of Mass</u> (19)

LECTURE 8/...

Adapted from : 19. Kimball. J.W., Op. Cit. (1965)

ANIMALS ON THE ROCKY SHORE

These slides are arranged in a sequence starting at the top of the shore (Littorina Zone) progressing through the mid-shore (Barnacle or Balanoid Zone) and ending in the Low-shore (Cochlear Zone).

THE LITTORINA ZONE (Only covered at spring tides)

11. The shells of dead Whelks, Mussels and Barnacles often give one a good idea of the animals life lower down the shore.

12. The pools on the upper shore look empty but notice the tiny black periwinkles (Littorina).

13. These tiny periwinkles feed on the black lichens that grow on the rock surfaces. Why is it that tiny animals can live so high on the shore where larger ones would die ?

THE BARNACLE ZONE (Covered every twelve hours)

14. The shore crab scavenges amongst the pools and gullies of the mid-shore.

15. Some crabs disguise themselves with sponges. Why ?

16. Green sea lettuce forms a natural food for many periwinkles.

17. Sea anemones shelter in the pools of the mid-shore snatching at drifting food with their paralysing tentacles.

18. At high tide the pools abound with tiny creatures that fall prey to the anemones.

19. Whelks,like this one, bore holes through the shells of Barnacles and Mussels with their drill-like tongues, sucking out their tender insides. The purple crust on the rocks is caused by an algal growth.

20. Brittle stars like this can be found sheltering under stones in the pools.

21. Some whelks are covered with sponge growths. This one seems to be giving a tiny starfish a lift.

22. This is a bristle worm. It is a relative of the earthworm and much sought after as bait. It is found sheltering under stones and in seaweeds.

THE COCHLEAR ZONE (Only exposed briefly at spring tide)

23. The low-shore is the home of the pear limpet (P. cochlear). It feeds on the purple-grey algal crusts on the rocks.

24. Each limpet is surrounded by a tiny garden on which it feeds at high tide.
    Why are the tops of these limpets shells so worn ?

25. Sea urchins are spiny protected creatures. They feed on the algal crusts on the rocks. They are abundant in the sub-shore region.

LECTURE 8

The Biotic Components : Living Space

Fierce competition exists for living space on the rocky shore. In this case it usually means space for attachment in an area where abiotic factors are suitable.

1. The teacher shows some slides of crowded living conditions in the barnacle zone.

THE PROBLEMS OF SURVIVAL FOR BARNACLES

- Young larval stages are easily grazed off the rocks by the radulas of browsing limpets and winkels. Thus crevices and the uneven surface of established barnacle colonies provide shelter.
- Established barnacles are eaten by whelks which can bore through their shells with their radulas or poison them through the opening.
- Seaweed spores and mussel larvae also settle between the barnacle shells and overgrow the barnacles killing them by preventing their feeding. The mass and drag of the seaweeds increases and storms tear masses of weed and barnacles in layers from the rock. This is the reason for bare patches in a densely populated bed of barnacles.
- Barnacles that are attached far up the rock or shore have a better chance of survival as they may be beyond the reach of most whelks. In this case the only gaps that arise are from death caused by an overgrowth of young barnacles. The individuals tend to survive to their maximum age and may be large in size.

Where settlements of larvae are heavy and successful, competition for space can result in mortality just because all barnacles need the same conditions.

As/...

LIFE AMONG THE BARNACLES

26. Barnacles are the predominant form of animal life in the mid-shore. There are two basic types. The volcano-shaped tetraclita and the diamond-shaped octomeris both seen in this picture. Note the drill marks on the large barnacles in the foreground. What animal is responsible for these marks ?

27. Note the difference in size of the barnacles in this picture. Which ones are likely to be the older barnacles ? There are two generations of barnacles in this picture. Comment on this statement and try to account for the death of the older generation.

28. Why are there so few barnacles at the top of the mid-shore?

29. .... and so many by contrast at the bottom of the mid-shore ? What special problems could this crowding cause?

30. Study this picture well. Where are most barnacles found ? What part of the shore is this ? Find the rock in the lower left foreground that has no animals, even barnacles, growing on it. Try to account for its sterility. (Note the presence of kelp that would sweep the larval forms off the rock as they settled)

As pressure from neighbouring barnacles increases they may be forced to elongate. These elongated barnacles form "hummocks". Each barnacle in the "hummock" depends largely on it's neighbours for support as it is only attached to a very tiny portion of the rock. Once a few have died, the wave action may tear masses of living barnacles sharing the same "hummock" from the rock. Paraphrased from : Lewis (1972) (20)

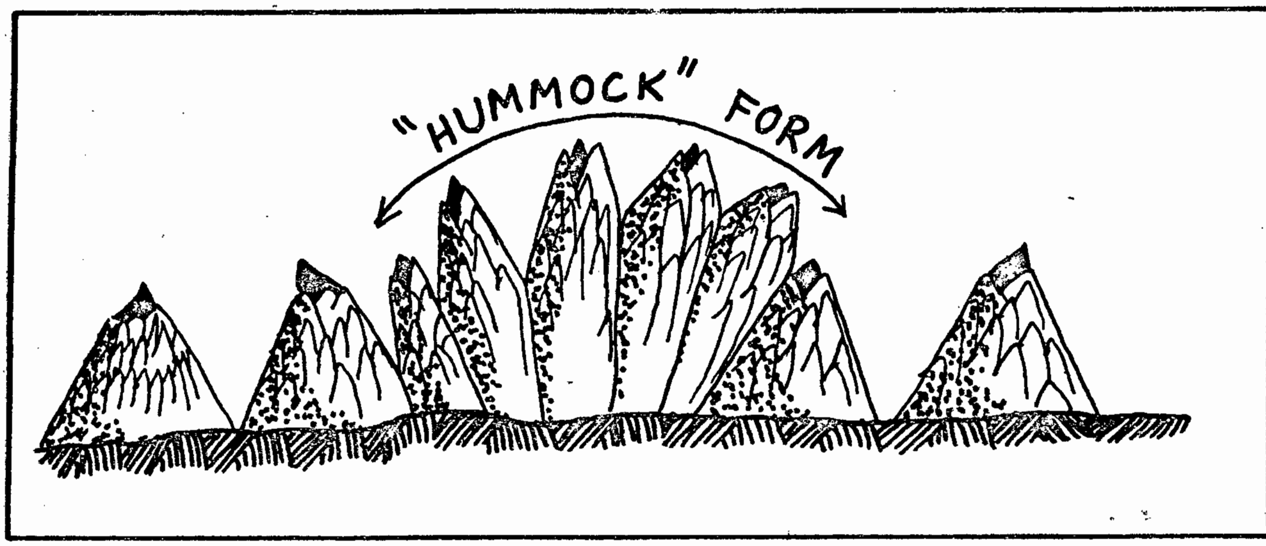


Fig. 18 Competition for space among barnacles

2. The teacher provides the class with copies of the following figure and the children are asked to explain the biotic factors affecting mussels and limpets by evaluating the arrows and preparing a summary.

Fig. 19/...

20. Lewis J.R., The Ecology of Rocky Shores (1972)

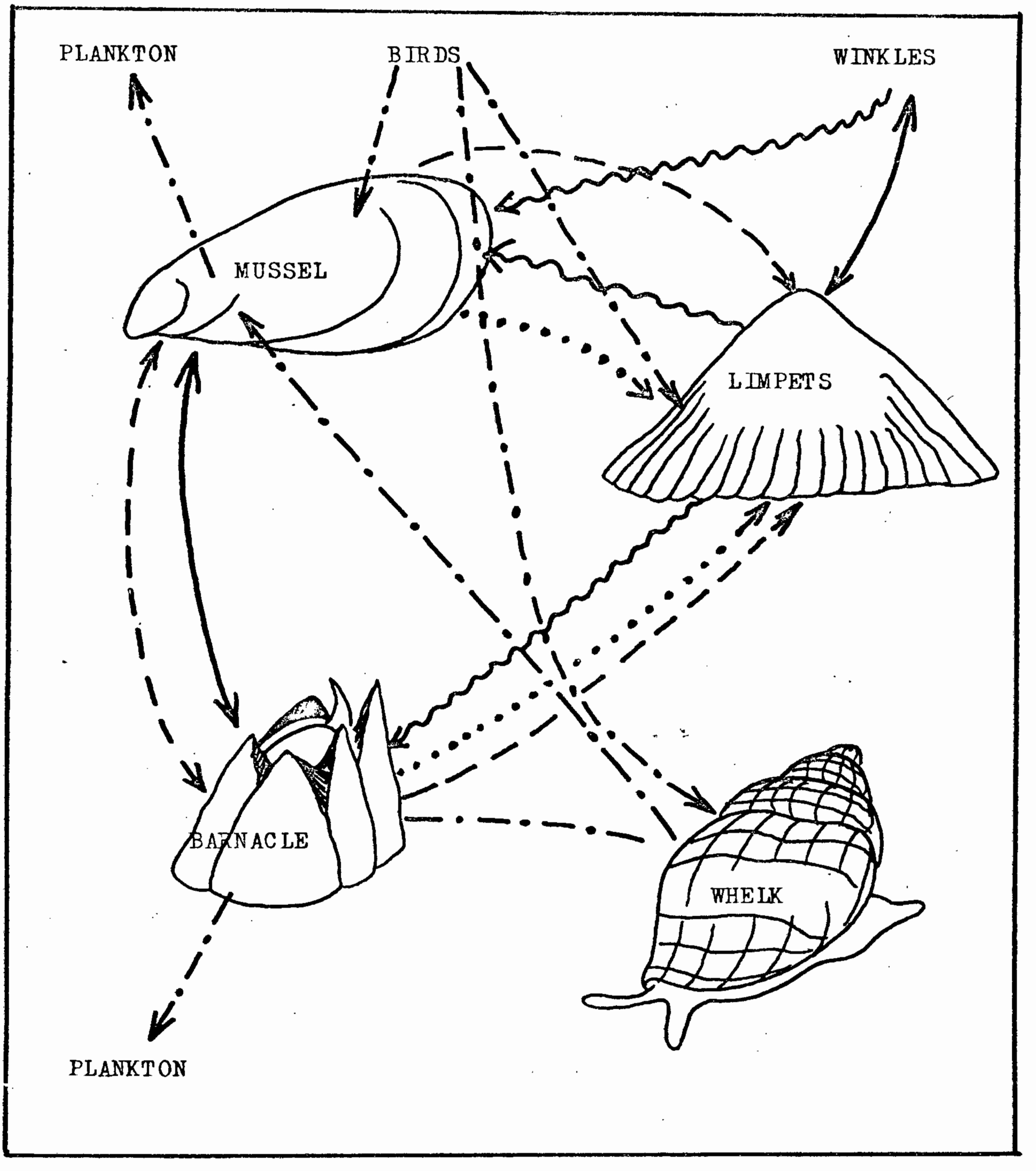


Fig. 19. THE BALANCE OF LIFE (21)

Competition for living space
Competition for food
Predation on organism
Prevention of settlement in juvenile stages
Restriction of movement

Adapted from : 21. Lewis J.R., Op. Cit. (1972)

D. UNIT TWO :

FIELD-TRIP ONE : TO INVESTIGATE THE ECOLOGICAL RELATIONSHIPS ON THE ROCKY SHORE.

METHOD: Field-Trip. Pupils working in small groups.

ESTIMATED TIME REQUIRED: One school day. (± 2 hours at site.)

INFORMATION SHEET 1/...

INFORMATION SHEET 1.

PREPARATION FOR FIELD-TRIP ONE.

This information sheet should be supplied to all groups.

The purpose of this field-trip is to collect data relating to the physical (abiotic) and living (biotic) factors that influence life on a rocky shore.

Each student will form part of a group that will be given special responsibilities on the day of the field trip and in laboratory investigations in the next few weeks. Your group will be expected to produce a report at a later stage that will be evaluated as part of your practical mark for Std. 8.

1. THE STUDY SITE.

   (See map 1. Sketch-map of surroundings near Glencairn Study Site.)

   The portion of rocky shore selected for our special study is situated about 400 metres to the south of Glencairn Station and is easily identified by the presence of a small tidal pool constructed at high water mark by the Simonstown Municipality.

   The special section we will be studying is the portion on the right of the sea-wall of the pool that slopes gently down into the sea (marked with a broken line on the map and an orange arrow at the site.)

   Do not loøse your copy of the map as you will need it for our second field trip later this term.

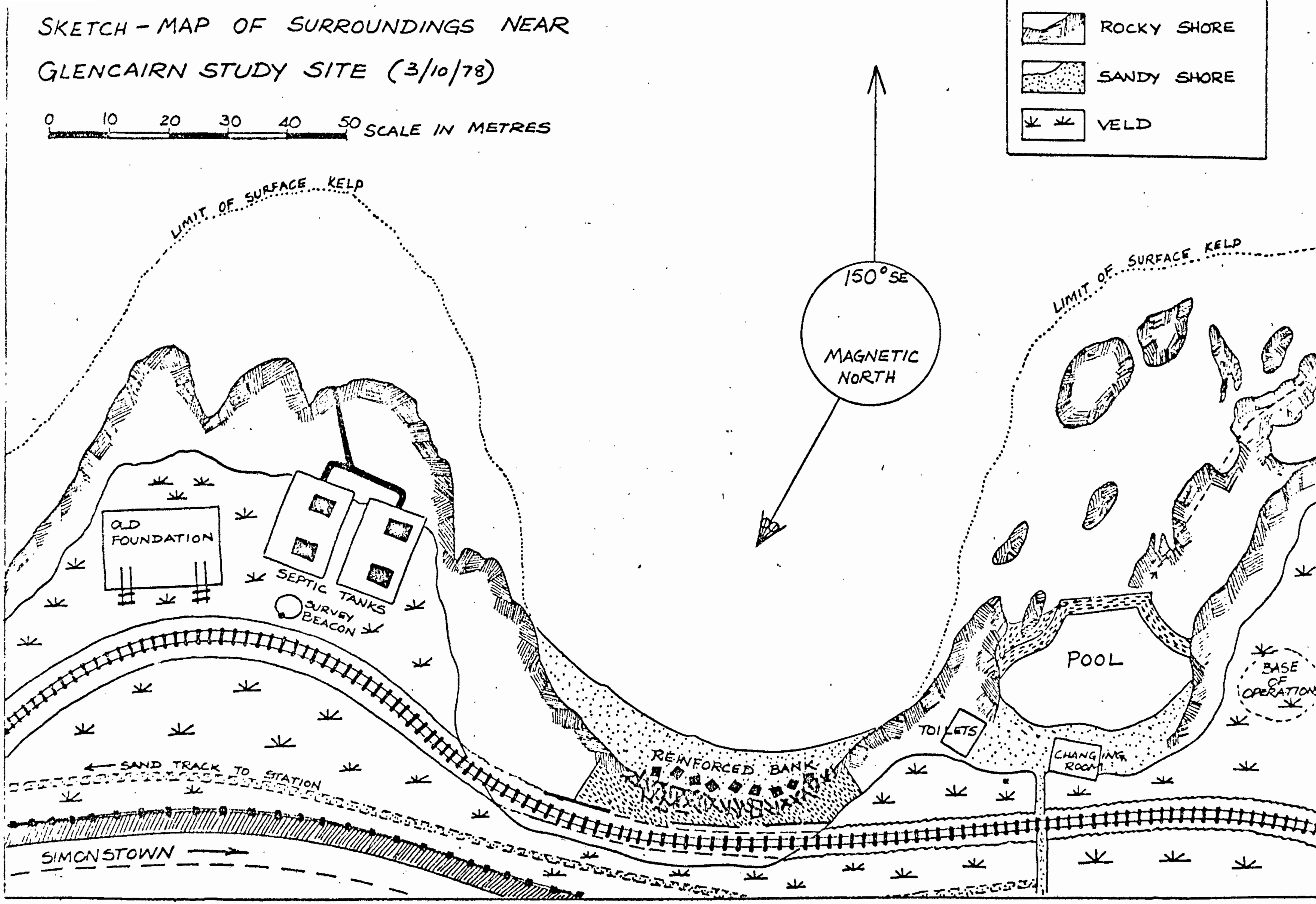
2. THE TIME OF THE FIELD-TRIP

   As the best time to study the rocky shore is when the maximum amount is exposed by the low spring tide, we will arrange to visit the area as close to the new moon date as possible: Spring Low Tide 11.50 a.m. Monday 29th of January.

   We will time our arrival to reach the study site $1\frac{1}{2}$ hours before low tide and will leave as soon as all our tasks are completed.

3/...

A 32


SKETCH - MAP OF SURROUNDINGS NEAR
GLENCAIRN STUDY SITE (3/10/78)
0 10 20 30 40 50 SCALE IN METRES
ROCKY SHORE
SANDY SHORE
VELD
LIMIT OF SURFACE KELP
LIMIT OF SURFACE KELP
150° SE
MAGNETIC NORTH
OLD FOUNDATION
SEPTIC TANKS
SURVEY BEACON
POOL
BASE OF OPERATIONS
TOILETS
CHANGING ROOM
REINFORCED BANK
← SAND TRACK TO STATION
SIMONSTOWN →

3. EQUIPMENT

Old clothes, jersey, change of clothes, tackies and lunch, fare for bus and train. Special equipment lists will be supplied with each groups task sheet, but you will have to complete the lists yourselves.

4. GENERAL INSTRUCTIONS.

On arrival at the site, divide up into groups as arranged; deposit your equipment at the base of operations and start work on your first task immediately. You will have approximately 2 hours for both tasks.

The first task is designed to form part of a survey of biotic and abiotic factors operating on a rocky shore and should take $1\frac{1}{2}$ hours.

The second task is intended to supply you with material and data for laboratory investigations back at school, and should take $\frac{1}{2}$ hour.

Warning: Do not work with your back towards the sea, it may surprise you.

All the collected material and results must be stored in the biology laboratory before you return home after the field-trip.

Fig. 20./...

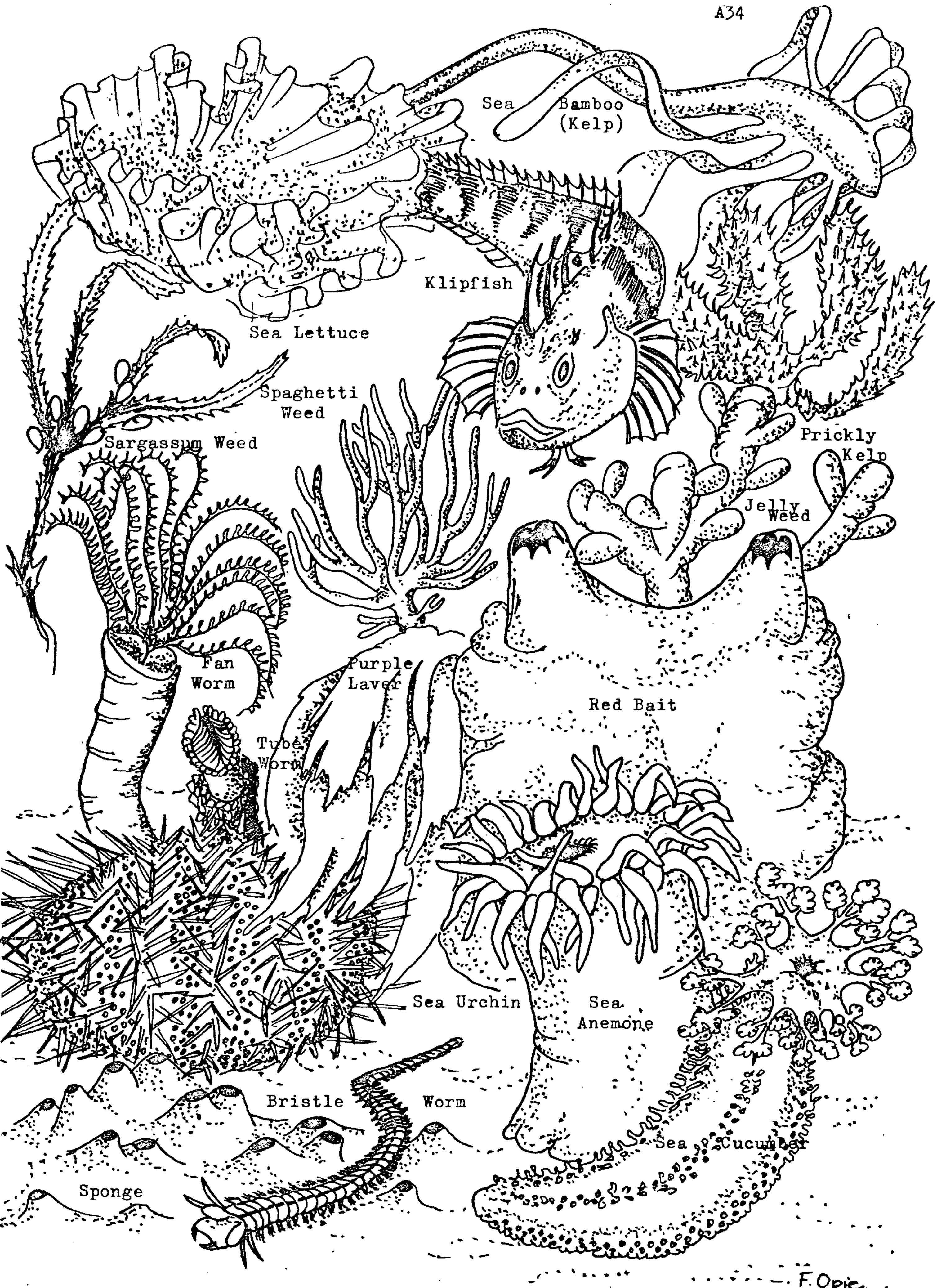
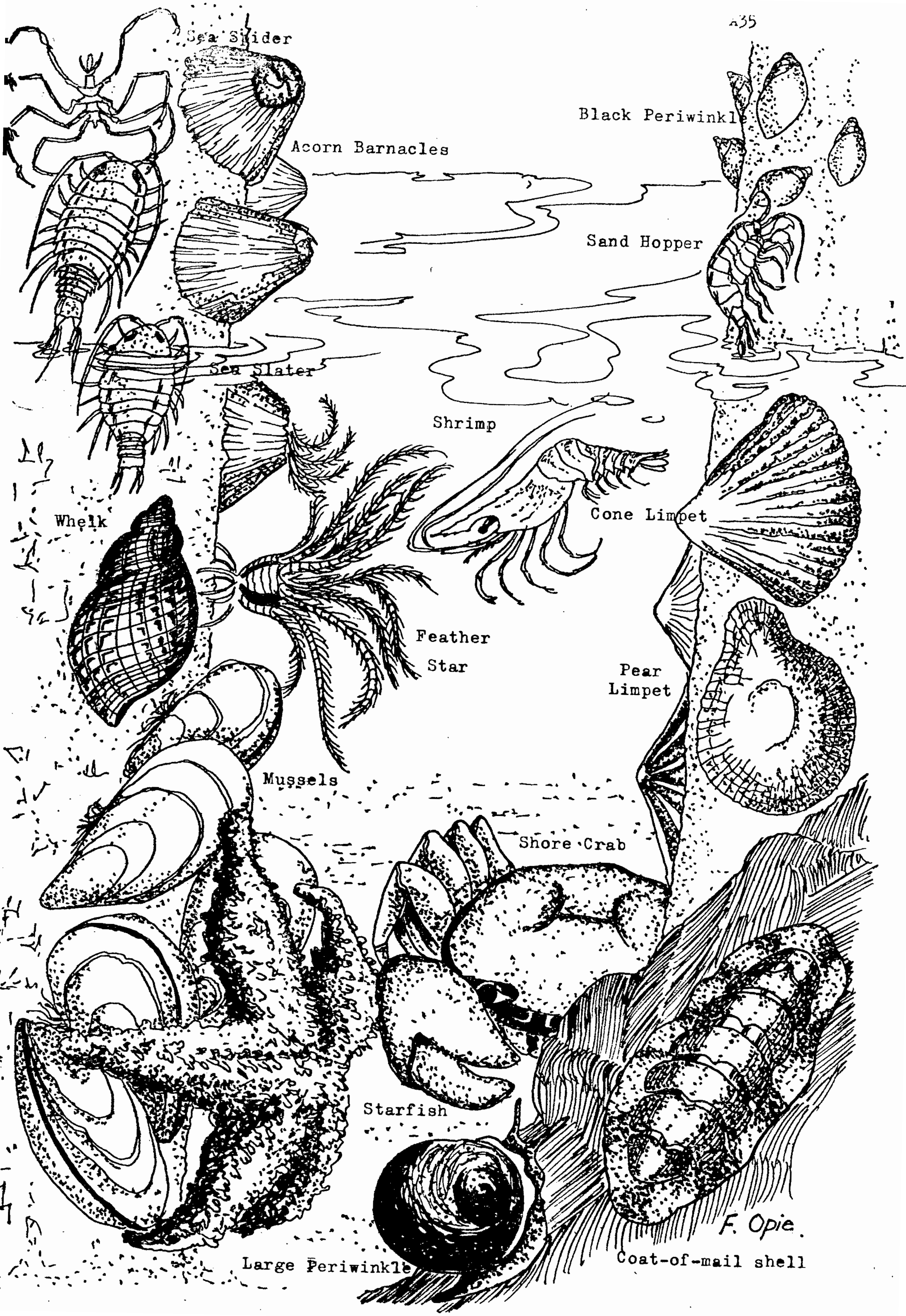


Fig. 20. <u>SOME COMMON SHORE ANIMALS AND PLANTS</u>


Sea Spider
Acorn Barnacles
Black Periwinkle
Sand Hopper
Sea Slater
Shrimp
Cone Limpet
Whelk
Feather
Star
Pear
Limpet
Mussels
Shore Crab
Starfish
Large Periwinkle
Coat-of-mail shell
F. Opie

1	1. 2. 3. 4.	(A) Mapping zonation of animals and seaweeds. (B) Limpet shell study.
2	1. 2. 3. 4.	(A) Shore Birds. (B) Plankton Survey.
3	1. 2. 3. 4.	(A) Recolonisation study. (B) Pyramid of numbers.
4	1. 2. 3. 4.	(A) Animal collection by zones on transect. (B) Identification of animals using keys.
5	1. 2. 3. 4.	(A) Seaweed collection by zones on transect. (B) Identification of seaweeds using keys.
6	1. 2. 3. 4.	(A) Pool and Gully fauna. (B) Drift-line animals survey.
7	1. 2. 3. 4.	(A) Belt-transect survey. (B) Barnacles and wave-action.
8	1. 2. 3. 4.	(A) Photographic record of transect. (B) Wave action studies.
9	1. 2. 3. 4.	(A) Levelling transect slope. (B) Seaweed micro-fauna.

Table 1. SUMMARY OF GROUP TASKS.

SPECIAL NOTE REGARDING GROUPING (Teacher only.)

It is desirable to use the same groupings throughout the experimental programme.

Although it would be very democratic to allow the children to form their own peer groups, it might not necessarily result in the optimal differentiated groupings that these tasks demand.

There is a definite differentiation of tasks from group 1 (simpler tasks) to group 9 (more complex tasks).

The following table may help to guide you in your assignment of pupils to groups.

N.B. Make sure that each group has a natural leader or spokesman before you assign pupils on the basis of ability.

Group 1	Routine collection.
Group 2	Routine survey and microscopic work.
Group 3	Routine counting.
Group 4	Collection and use of keys; artistic.
Group 5	Collection and use of keys.
Group 6	Collection of specialised microfauna.
Group 7	Accuracy, note-taking, mapping.
Group 8	Artistic and photographic skill.
Group 9	Accuracy ; careful observation.

Table 2. DIFFERENTIATED GROUPING.

Table 3/...

ITEM	SOURCE	GROUP
2 Black & White 35mm Films (20 exposures)	Chemist purchase	2,8
Quadrat frame	Construct	3,7
Formalin	Stock	2,4,6
Marked line (45m)	Construct	7
Sketch paper	Stationary	8
Foam balls (tiny)	Stock	8
Magnetic compass	Geography dept.	8
Roll tape measure	Groundsman	9
2 Ranging Rods	Construct	9
2 Cards (small)	Construct	9

Table 3. EQUIPMENT TO BE SUPPLIED BY TEACHER FOR FIELD-TRIP.

TASK SHEET 1/...

TASK SHEET 1 : GROUP ONE

FIRST FIELD-TRIP TO GLENCAIRN.

You will recall that animals and seaweeds on a rocky shore are distributed according to their ability to tolerate exposure to the atmosphere.

The shore is divided up into 5 basic regions or zones. Each zone is characterised by indicator species that indicate the general limits of the zone.

TASK A

1. It is your special task to find these 5 zones shown below and mark their limits in accurately on the large scale map of the transect provided (ignore the broken lines - they only serve as rough guides for other groups.)

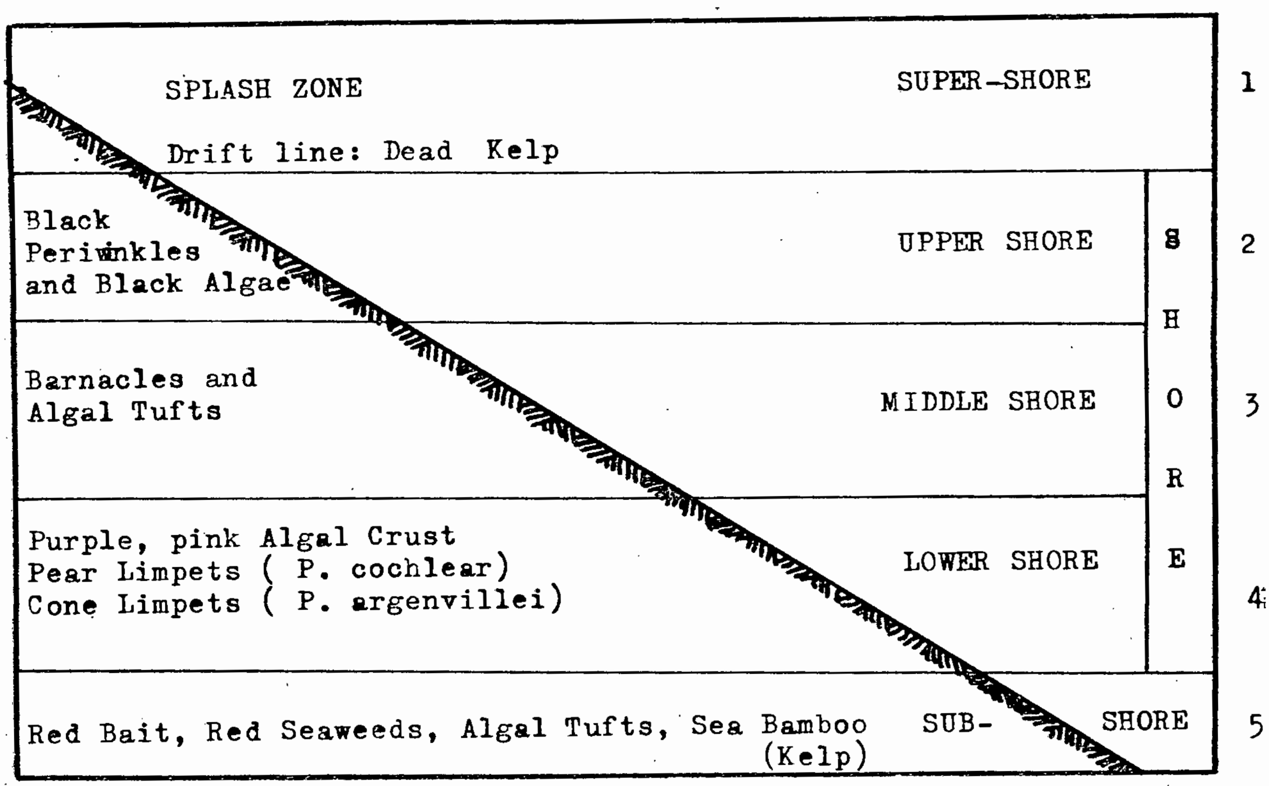
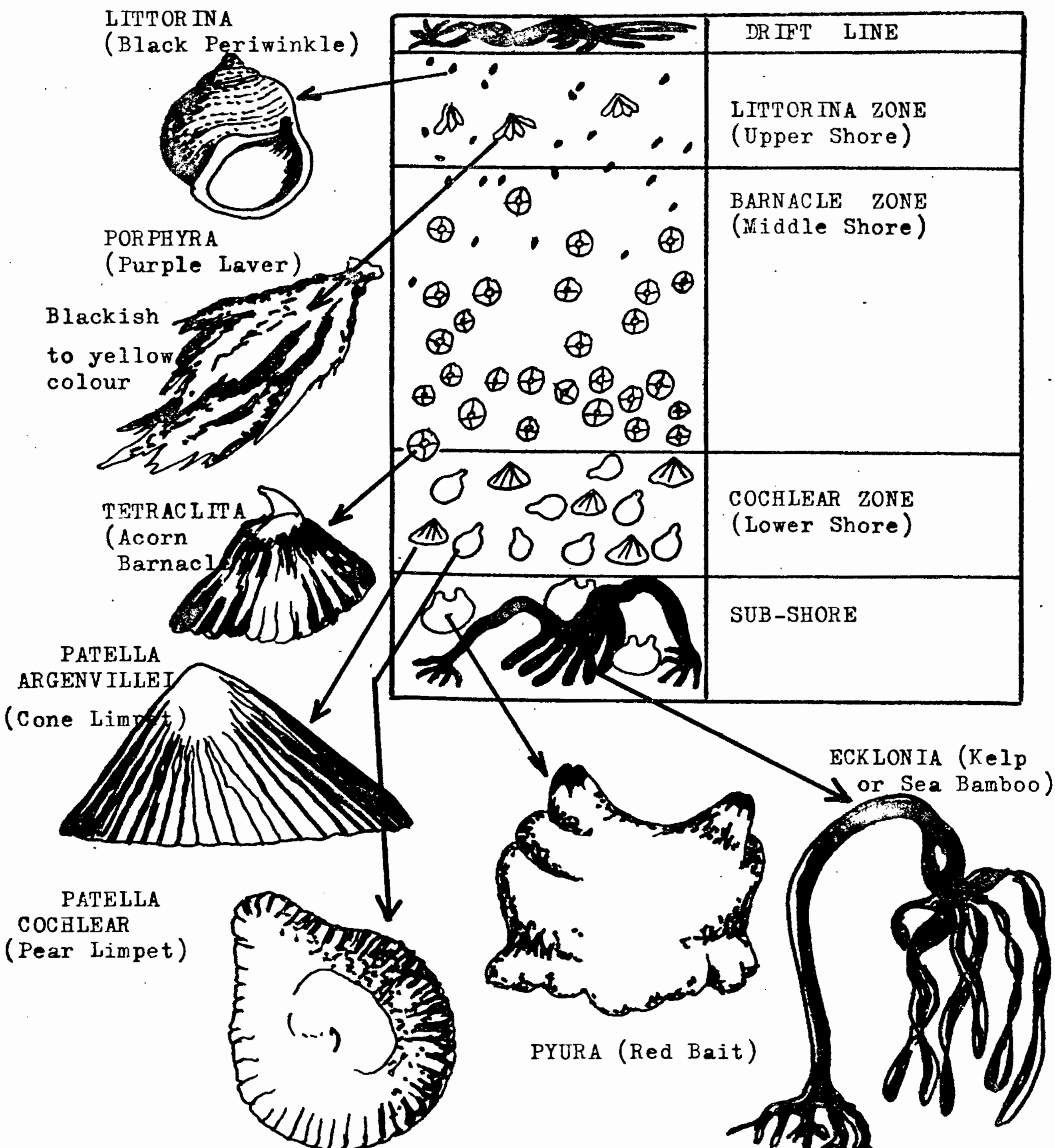


Fig. 21. Distribution of Indicator Species on the Shore.

Fig. 22/...

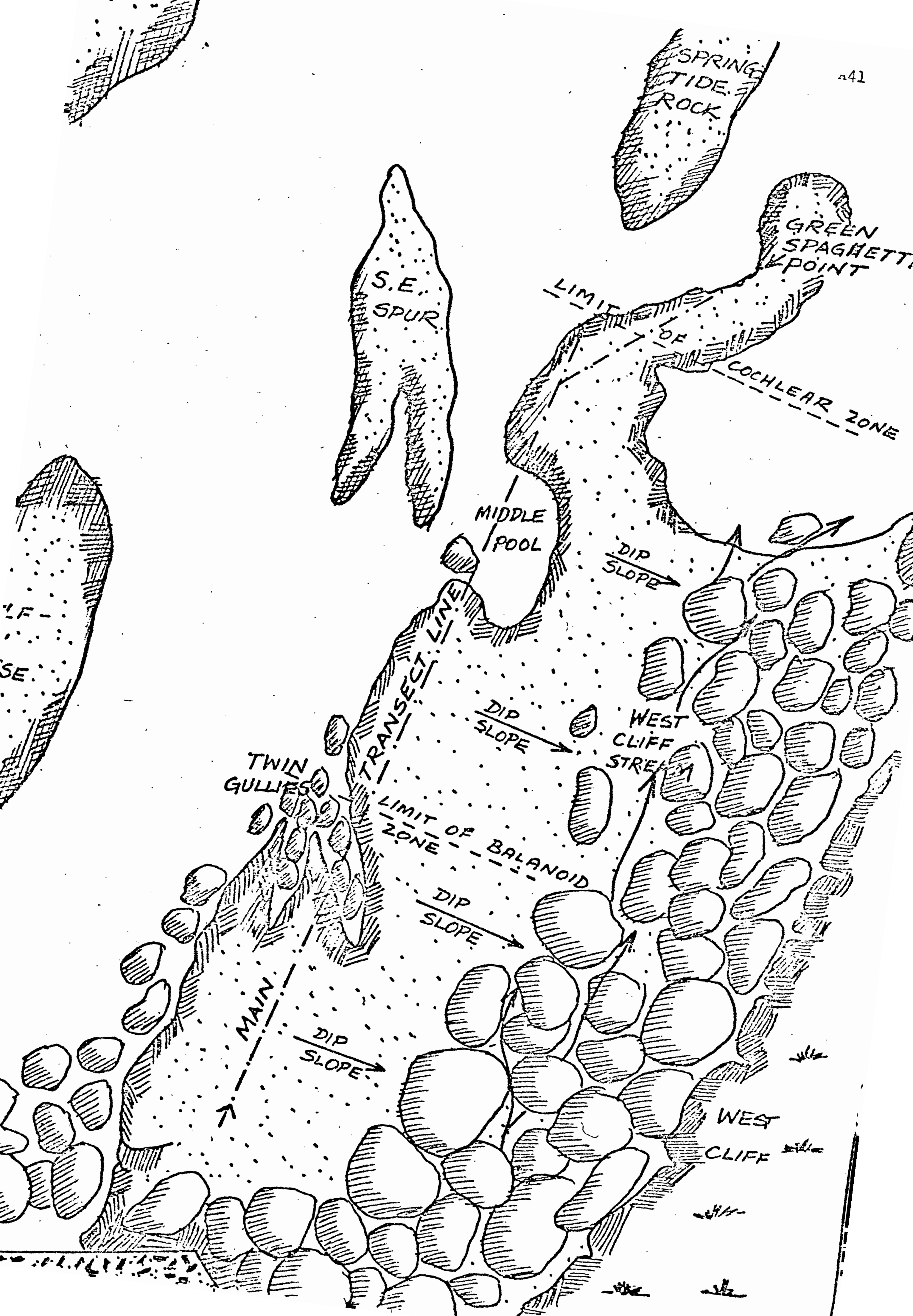
Fig. 22. Recognition Guide to Indicator Species. (23 and 24)



2/...

Adapted from: 23. Barnard K.H., South African Shore-Life (1960)

24. Day J.H., A Guide to Marine Life on South African Shores. (1969).


SPRING TIDE ROCK
GREEN SPAGHETTI POINT
S.E. SPUR
LIMIT OF COCHLEAR ZONE
MIDDLE POOL
DIP SLOPE
TRANSECT LINE
DIP SLOPE
WEST CLIFF STREAM
TWIN GULLIES
LIMIT OF BALANOID ZONE
DIP SLOPE
MAIN
DIP SLOPE
WEST CLIFF

2. Get the photographer in group 8 to take a close up photograph of animals in each of the 4 regions shown above.

3. When you return to class you will be required to enlarge the sketch map and show your boundary lines for each zone on the map, and mount a photograph in each zone to illustrate the indicator animals.

4. Ask your teacher to run off a copy of Fig. 21 for each person in your class, once the field trip is over.

5. As soon as you have completed TASK A, which should take you about 1½ hours, start TASK B.

TASK B. (24)

When you return to the laboratory you will be required to test the truth of this hypothesis:-

"Limpets that are more exposed to wave action have thinner shells than those in more sheltered positions."

1. You will need to collect many large limpets of the same type and size from different locations on the rocky shore.

2. Carefully prise each limpet off the rock with a strong knife and place it in a numbered plastic bag.

3. Keep notes on where the limpets in each bag come from.

4. Try to collect 5 limpets from each collecting point.

   e.g. 1. Top of rock in cochlear zone.
   2. Base of seaward cliff (balanoid zone.)
   3. Landward side of rock in cochlear zone.
   4. Flat sloping rock in balanoid zone.
   5. Bottom of sheltered rock pool (balanoid zone.)

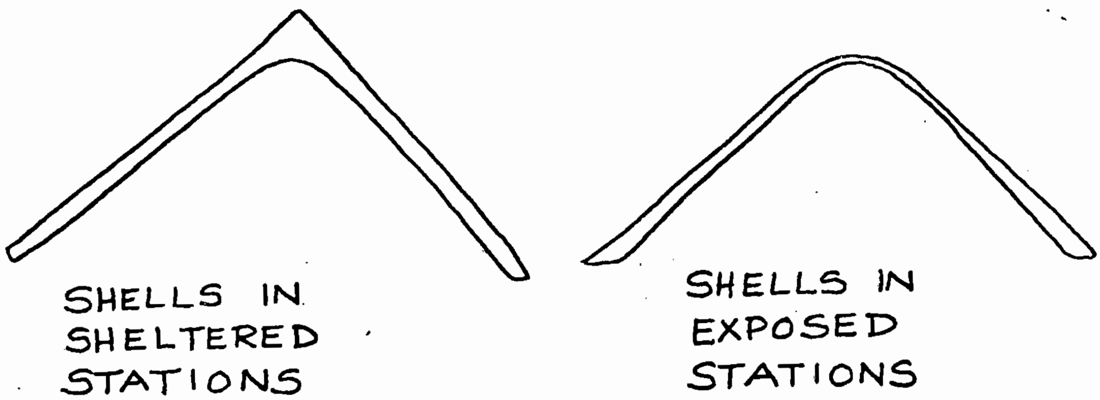
5. When you have collected shells from all levels and all conditions of exposure to wave action, carefully cut out the limpets, making sure you do not cut yourself or mix up your shell specimens.

6./...

Adapted from: 24. Davies A., Ecology. A.S.E. Lab. Book. (1973)

6. When you return to the laboratory bring a tiny hacksaw with you and borrow a pair of calipers from your physical science teacher.

7. Cut the shells in half through the apex and measure the thickness of each shell at this point.



8. Prepare a table in which you enter your results.

e.g.

STATION	SHELL THICKNESS 1	2	3	4	5	AVERAGE THICKNESS
EXPOSED POSITIONS						
1						
2						
SHELTERED POSITIONS						
3						
4						
5						

9. Draw your own conclusions from your results.
Is the hypothesis true or false?

EQUIPMENT LIST:/...

EQUIPMENT LIST: (Complete this yourselves.)

FIELD TRIP

1. Stout knife
2.
3.
4.

LABORATORY INVESTIGATION

1. Calipers
2. Hack saw
3.
4.

TASK SHEET 2:/...

TASK SHEET 2 : GROUP TWO

FIRST FIELD TRIP TO GLENCAIRN.

You will recall that shore birds are the top carnivores in the food chain on the shore, thus in accordance with the pyramid of numbers there will be relatively few of them.

TASK A.

1. It is your special task as a group to count and identify all the seabirds along the coast flanking the pool area.

2. Cover the area above and below the railway line for 400 metres in each direction from the pool.

3. Observe each bird; try to name it; state where it was seen; what it was eating if anything. Present your results in the form of a table.
   Try to photograph the birds if you can get a telephoto lens.

4. These are some of the birds you can expect to see.
   - Antartic Skua.
   - Cape Cormorant (Duiker).
   - South African Black-backed Gull.
   - Hartlanb's Gull.
   - White-fronted Plover.

5. Try to find out what these birds look like before you go to the beach. Your school library should be able to help you.
   Useful reference books:
   Mc Lachlan G.R., and Liversidge R., Robert's Birds of South Africa. (1969)
   Winterbottom J.M.; and Uys C.J., Some Birds of the Cape. (1969)

6. Make descriptive notes about any birds you do not recognise and identify them once you get back to school.

7. Proceed with TASK B as soon as you are finished.

TASK B.

When you return to the laboratory you will be required to prepare a report on birds of the shore at Glencairn and also a series of diagrams of animals and plants that form part of the plankton.

1. Take a plankton net and find a safe place to stand where the sea runs quickly past a rock.
2. Scoop samples of microscopic plankton from the water from as near the bottom as possible. Include any small floating animals you can catch in the tube.
3. Take all samples back to the laboratory in a sealed thermos flask.
4. During the time that will be devoted to laboratory work you will be required to stain your catch blue with methylene blue animal stain. (Remember to be careful of your clothes as it is a permanent stain.) Examine your specimens under the microscope and draw them as carefully as possible.
5. Try to identify each specimen if you can. (See Newell and Newell. 25)
6. Find out as much as you can about plankton. Make use of encyclopaedias in the school and public libraries.

EQUIPMENT LIST: (Complete this yourselves.)

FIELD TRIP

1. Binoculars
2. Thermos Flask
3. Plankton net
4.

LABORATORY /...

25. Newell R.C. and Newell G.E., Marine Plankton (1973)

LABORATORY INVESTIGATION

1. Microscope
2. Methylene Blue.
3.
4.

TASK SHEET 3/...

TASK SHEET 3 : GROUP THREE

FIRST FIELD TRIP TO GLENCAIRN

You will recall that living space is at a premium on the rocky shore. A space that is cleared is soon recolonised by other animals and plants.

TASK A.

Your special task is to establish how quickly a cleared space is recolonised.

THE RECOLONISATION EXPERIMENT.

1. A $\frac{1}{2}$ metre square in the cochlear zone and a similar square in the lower balanoid zone were cleared of all life four months prior to the field trip.

2. These two test squares were marked in paint at their corners and labelled:
   1. (Station in balanoid zone)
   2. (Station in cochlear zone)

   respectively.

3. Find the two squares and make a careful diagram of the animal life in each square.

4. Make detailed notes of the animals and plants present and try to identify them using the classification keys back at school.
   Useful Reference :

   Day J.H., A Guide to Marine Life on South African Shores. (1969)

5. Try to suggest reasons why these animals and plants were the first to recolonise this open space.

6. As soon as you are finished proceed with TASK B.

TASK B/...

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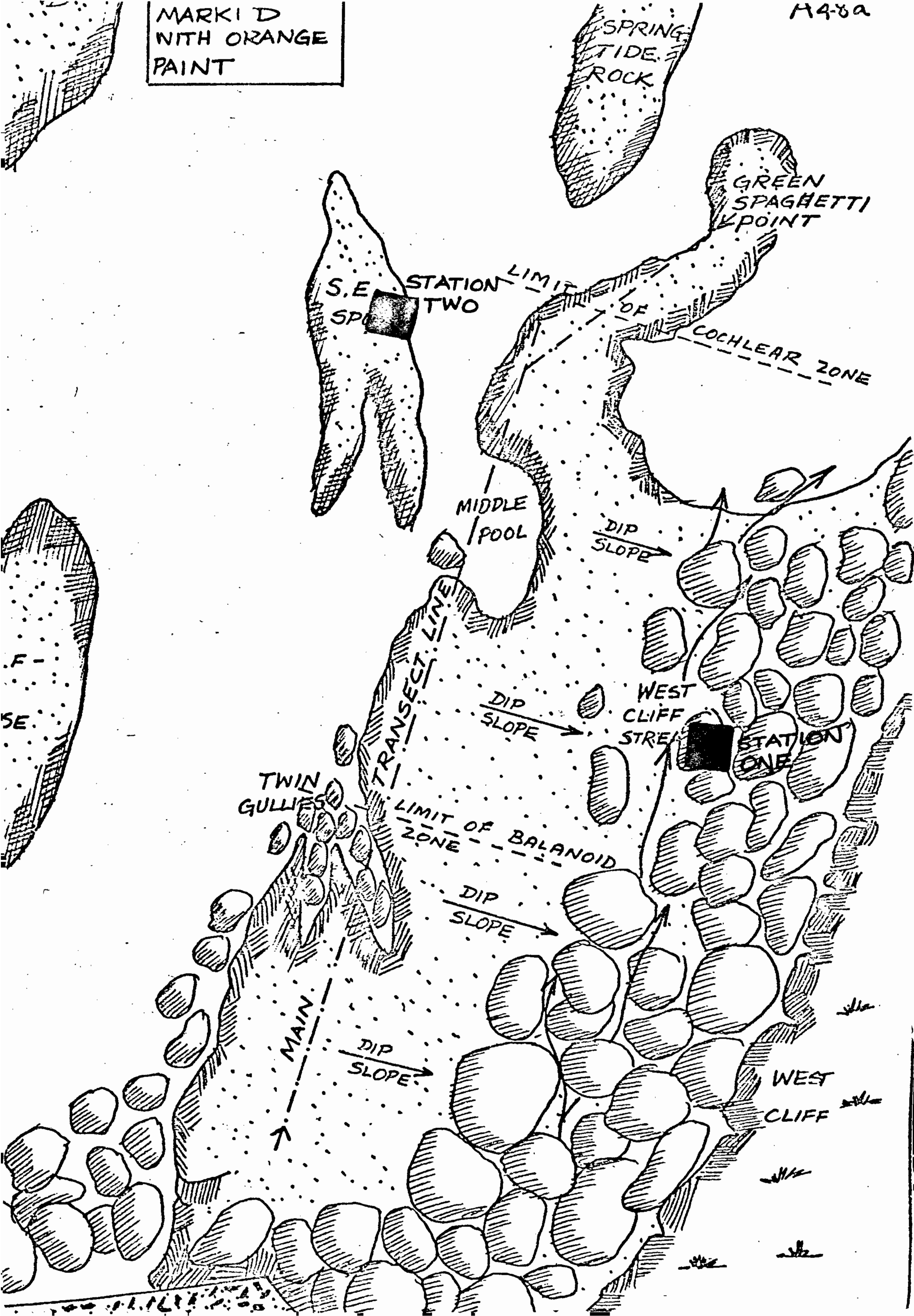

MARKI D WITH ORANGE PAINT
SPRING TIDE ROCK
GREEN SPAGHETTI POINT
S.E. SP
STATION TWO
LIMIT OF COCHLEAR ZONE
MIDDLE POOL
DIP SLOPE
TRANSECT LINE
DIP SLOPE
WEST CLIFF STRE
STATION ONE
TWIN GULLIES
LIMIT OF BALANOID ZONE
DIP SLOPE
MAIN
DIP SLOPE
WEST CLIFF
F
SE

TASK B.

You will be required to provide proof of the existence of the pyramid of numbers as it relates to food chains on the shore.

1. Select a densely populated area of the barnacle belt of the rocky shore.
2. Place the quadrat frame of 1 square metre and count all the barnacles in the area.
3. Now using this figure estimate the number of barnacles in the study area.
4. Now search for and count all the whelks that you find.
5. What is the proportion of barnacles to whelks?
6. Is this figure in keeping with what you expected in terms of the pyramid of numbers?
7. Collect 5 whelks and preserve them in 8% formalin.
8. When you get back to the laboratory, crush each shell with a hammer, extracting the whelk.
9. Cut out the snail's tongue (radula), stain it for 2 minutes in Methylene Blue, wash it off in alcohol and examine it under the microscope. (Take care, it stains clothes badly.)
10. Make a careful drawing of 3 radulas from three different whelks.
11. Find out how this snail manages to eat barnacles.

EQUIPMENT LIST: (Complete this yourselves.)

1. Note book
2. Quadrat frame
3.
4.

LABORATORY INVESTIGATION

1. Microscope
2. Methylene Blue
3.
4.

TASK SHEET 4 : GROUP FOUR

FIRST FIELD TRIP TO GLENCAIRN

There is a great range of animal life on the rocky shore. Many animals are restricted by intolerance to prolonged exposure to the lower shore (cochlear zone). Others that are more resistant to drying can occupy the middle (barnacle zone) and upper (littorina - black periwinkle zone) shores more successfully.

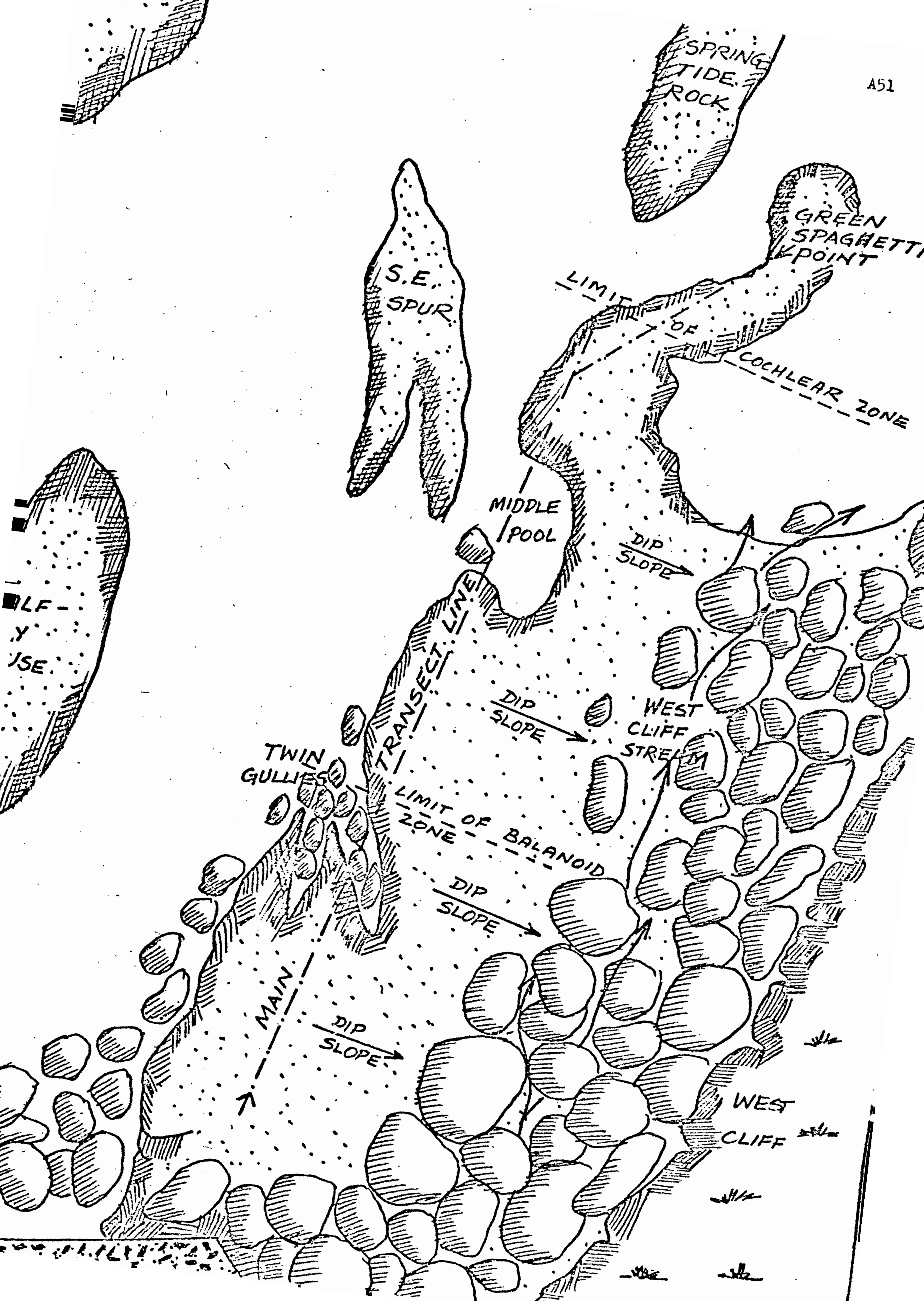
TASK A

1. Your special task is to make 4 animal collections from the four main regions on the shore. Consult your large scale map of the transect area to determine where you should be collecting from:-

   A collection of animals from the :

   1. Upper Shore - Littorina Zone.
   2. Middle Shore - Barnacle Zone.
   3. Lower Shore - Cochlear Zone.
   4. The Sub-Shore - Sub-Littoral Zone.

2. Put one specimen of each animal found in each zone into a specially labelled, strong plastic bag.


SPRING TIDE ROCK
GREEN SPAGHETTI POINT
S.E. SPUR
LIMIT OF COCHLEAR ZONE
MIDDLE POOL
DIP SLOPE
TRANSECT LINE
DIP SLOPE
WEST CLIFF STREAM
TWIN GULLIES
LIMIT OF BALANOID ZONE
DIP SLOPE
MAIN
DIP SLOPE
WEST CLIFF

3. Make each collection as complete as possible but do not take more specimens than you need to.

4. If you turn over any rocks, make sure you turn them back again once you are finished.

5. Take your labelled bags up to the base of operations and close them so that they cannot leak and carefully immerse the whole packet in a plastic bucket of sea water.

6. Proceed to TASK B.

TASK B

1. You must now begin a preliminary classification of animals into groups.

2. Keep careful notes at each stage of the animals in each plastic bag. Keep your labels inside the bag in the water, so that they are not lost.

3. This is a rough key that will help you to identify the group to which your animal belongs. The pages indicated next to each phylum are your reference pages in :
   Day J.H., A Guide to Marine Life on South African Shore.(1969)

   When you get back to the laboratory you will be using this book to identify the animal's full name.

Table 4./...

Table 4. A Quick Identification Key.

A ROUGH GUIDE TO COMMON SHORE ANIMALS	
1. Specimen has a backbone – Fish, Red Bait (Chordata)	196
2. Specimen has no backbone –	
A. Specimen has jointed legs – Crab (Arthropoda), Barnacle	68
B. Specimen doesn't have jointed legs.	
I. Specimen has worm-like body	
(a) Body divided into segments – Bristle Worm (Annelida)	51
(b) Body not segmented obviously	
Worm lives in tube, has ring of tentacles on head – Tube Worm (Annelida)	46
II. Specimen is not worm-like	
(a) Soft body, lives in shell – Mollusc	134
(b) Soft body, fixed to rock, ring of tentacles around mouth. – Anemone (Coelenterata)	22
(c) Soft body, fixed to rock pores on surface. – Sponge (Porifera)	16
(d) Body covered with hard-plates or spines. Sea Urchin, Starfish (Echinodermata)	180

4/...

4. Add some formalin to each bag (8% solution preserves animals); knot each bag tightly. Place in empty plastic buckets and take back to school.

5. When you get a chance back at school identify the animals in as much detail as possible.

6. Prepare a wall chart showing the 4 regions of the beach and draw copies of the animals you found in each zone with their genus names under each of them on the chart in the correct regions.

7. Set up a display of the animals you found in old jam jars with screw-top lids.

EQUIPMENT LIST: (Complete this yourselves)

FIELD TRIP.

1. Plastic Buckets (3)
2. Strong plastic bags (10)
3. Stout knife.
4.

LABORATORY INVESTIGATION

1. White enamel dishes.
2. Classification Book.
3. Jam Jars.
4.

TASK SHEET 5 : GROUP 5

FIRST FIELD TRIP TO GLENCAIRN

Seaweeds are the primary food producers in all food chains on the rocky shore. You will recall that they range from green in shallow water to reds and browns in deeper water.

TASK A

1. Your special task is to make 4 seaweed collections from the four main regions on the shore. Consult your large scale map of the transect area to determine where you should be collecting from:-

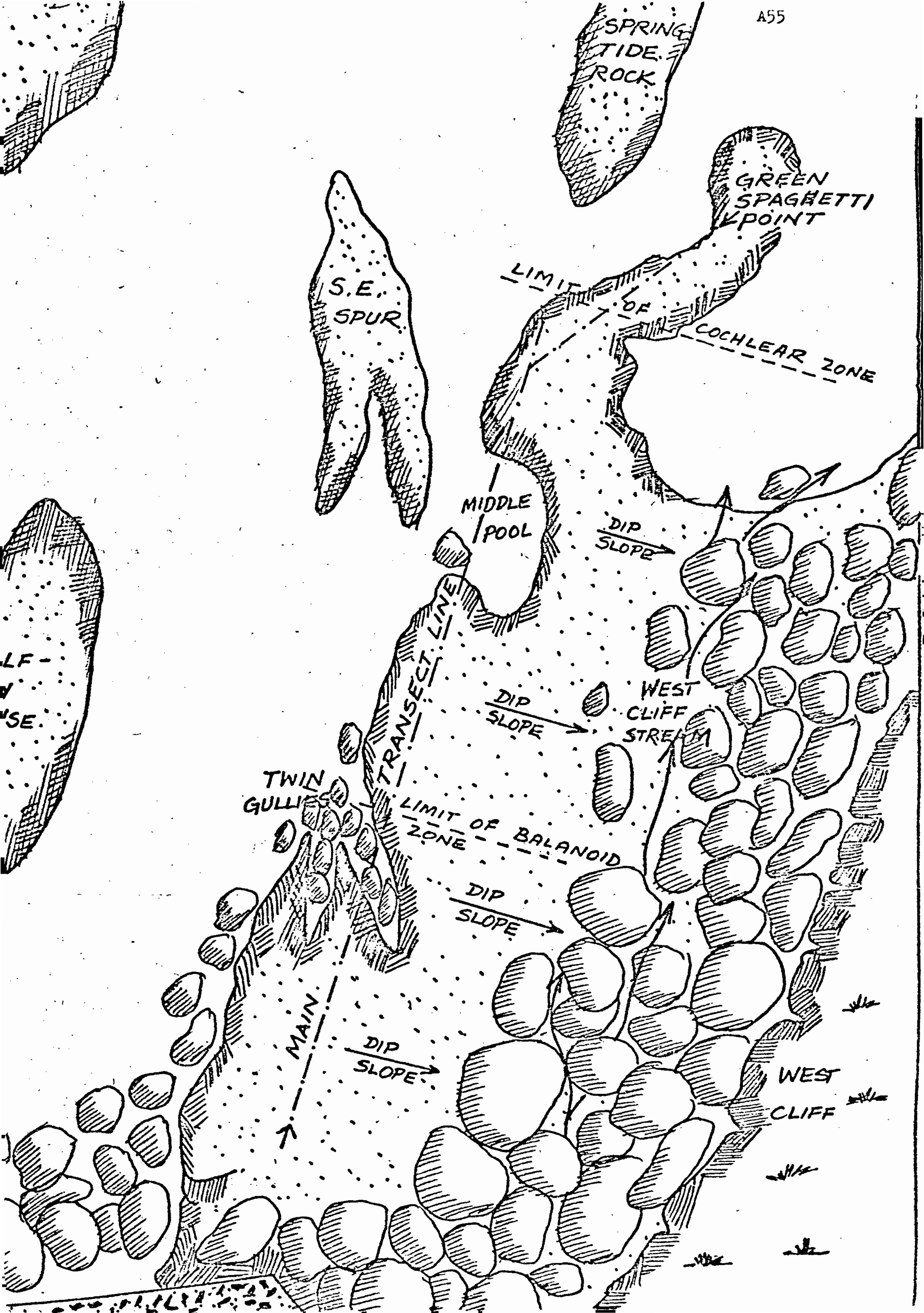
   A. collection of seaweeds from the:

   1. Upper Shore - Littorina Zone.
   2. Middle Shore - Barnacle Zone.
   3. Lower Shore - Cochlear Zone.
   4. The Sub-Shore - Sub-Littoral Zone.

2. Put one small specimen of each type of seaweed found in each zone into a specially labelled black, plastic garbage bag.

3. Take your 4 labelled bags up to the base of operations and proceed with task B.

TASK B/...


SPRING TIDE ROCK
GREEN SPAGHETTI POINT
S.E. SPUR
LIMIT OF COCHLEAR ZONE
MIDDLE POOL
DIP SLOPE
TRANSECT LINE
WEST CLIFF STREAM
DIP SLOPE
TWIN GULLIES
LIMIT OF BALANOID ZONE
DIP SLOPE
MAIN
DIP SLOPE
WEST CLIFF

TASK B (26)

1. You must now attempt a preliminary classification of your seaweeds.

2. Take your seaweeds to the fresh water tap near the changing block. Soak and rinse each weed in fresh water and replace it in it s bag.

3. If you still have time to spare offer to assist group 4 at this stage.

4. When you return to school store your damp weeds in their bags in a lab. sink overnight.

5. Next day, wash each weed carefully and float it out of the sink on a piece of stiff white drawing paper (such as is used for woodwork drawings.)

6. Arrange the seaweed carefully with a brush and place the paper on a shelf in the sun where it can dry.

7. The seaweed should stick to the paper as it dries, but if it doesn't use sellotape to fasten it down.

8. While you are waiting for your weeds to dry, start classifying them using the reference book:

   Day J.H. A Guide to Marine Life on South African Shores. (1969)

9. Finally display your 4 classified seaweed collections on a pin board in the laboratory, arranging them in the same order that they occur in and on the rocky sea shore.

10. If you finish ahead of others assist group 4.

EQUIPMENT LIST : (Complete this yourselves.)

FIELD TRIP

1. Sharp knife
2. Black Plastic Bags (4)
3.
4.

LABORATORY INVESTIGATION.

1. Sheets of stiff, white drawing paper (30)
2. Classification Book
3. Sellotape
4.

TASK SHEET 6/..

Adapted from: 26. Australian Science Education Project, Sea Shores.

TASK SHEET 6 : GROUP 6

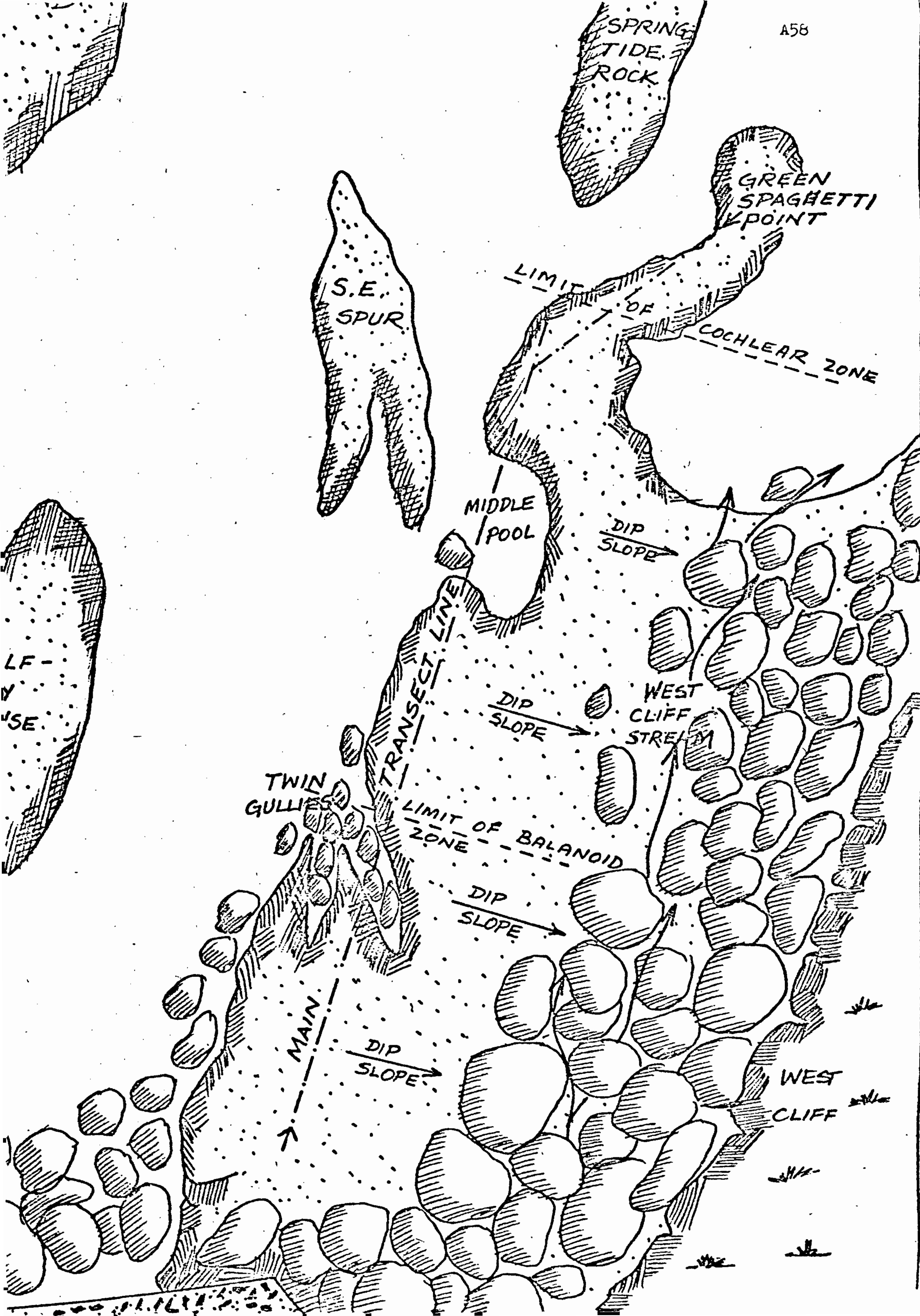
FIRST FIELD TRIP TO GLENCAIRN

While most shore animals conform to basic distribution patterns related to the degree of slope and hence exposure to the atmosphere by the receding tide, occasionally local conditions vary and these different conditions give rise to different communities.

TASK A.

There are two of these secondary communities on the line of the transect. One in the upper balanoid zone (twin gullies) and one in the lower balanoid zone (middle pool). It will be your special task to map the distribution of animal life in these two communities.

1. Locate the two communities with the aid of the large scale map supplied.
2. Divide into two teams, one team to study each community.
3. Draw a large sketch-map of each community.
4. Mark in the correct position where each animal or plant is found in the pool or gully.
5. Find out the height of your community above low tide level Group 9 will be able to supply the information at a later stage this morning.


SPRING TIDE ROCK
GREEN SPAGHETTI POINT
S.E. SPUR
LIMIT OF COCHLEAR ZONE
MIDDLE POOL
DIP SLOPE
TRANSECT LINE
DIP SLOPE
WEST CLIFF STREAM
TWIN GULLIES
LIMIT OF BALANOID ZONE
DIP SLOPE
MAIN
DIP SLOPE
WEST CLIFF

6. Are the animals distributed in special areas or zones? (Check with group 1 which animals are indicators of special zones.)

7. Try to account for any pattern you observe.

8. Get the photographer in group 8 to take a photograph which illustrates your community. Try to take the photograph from the same position that your map was drawn from.

9. Try to explain why mussels and barnacles can live closely packed together while limpets need more space.

10. Why are sea anemones found only lower down the shore?

11. Draw a cross-sectional diagram through your community along the line of the transect to show the depth of the water and how the animals are distributed in it.

12. Don't forget to look for life under stones and replace them once you have looked.

13. Compare notes on the animals in your two communities. Account for any differences you found. You will have to present a report to the class on this study at a later stage.

14. Draw rough sketches of all the animals whose names you don't know and find out their names from group 4 once you get back to the laboratory.

15. Proceed to TASK B.

TASK B/...

Adapted from:

Clark E., Fieldwork in Biology. (1973)

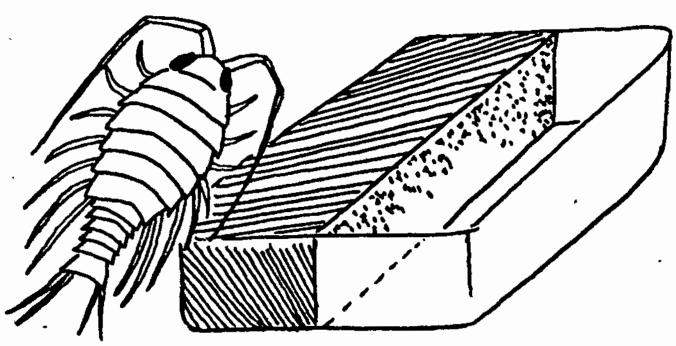
TASK B

Now that you have had some practice with special secondary communities in the middle and lower shore, you are well equipped to study the fauna of the drift line:

1. Find a mass of dead kelp lying on the drift line.
2. Lift back the surface layers and collect as many different types of animals as you can. Empty pill-bottles and plastic tubes are very suitable for keeping these animals in.
3. Where do the animals that escape go to?
4. Can they swim?
5. How do they differ from the animals you found lower down the shore?
6. How do these animals ensure that they survive so far up the shore?
7. What would their main predator be?
8. Take specimens back to the laboratory, in bottles with an 8% formalin/seawater solution.
9. Identify each animal as best you can using:

   Day J.H. A Guide to Marine Life on South African Shores. (1969)

   Start at page 87.
10. Bring back about 30 live specimens of the (Ligia) Sea Slater found hiding under the kelp and bring them back to school in a sealed tupperware container.
11. Place them in a glass oven dish covered with a sheet of glass with one half masked black. Which side do they prefer? Does this reaction have survival value? Why? (27)



EQUIPMENT LIST/...

EQUIPMENT LIST : (Complete this yourselves)

FIELD TRIP

1. Notebooks and pencils
2. Pill bottles
3. Formalin
4.

LABORATORY INVESTIGATION.

1. Classification book.
2. Glass sheet, oven dish, black paper.
3.
4.

TASK SHEET 7/...

Adapted from:

27. Andrews W.A., A Guide to the Study of Freshwater Ecology. (1972)

TASK SHEET 7 : GROUP 7

FIRST FIELD TRIP TO GLENCAIRN.

The basic skill upon which all scientific theory depends is the ability to measure accurately.

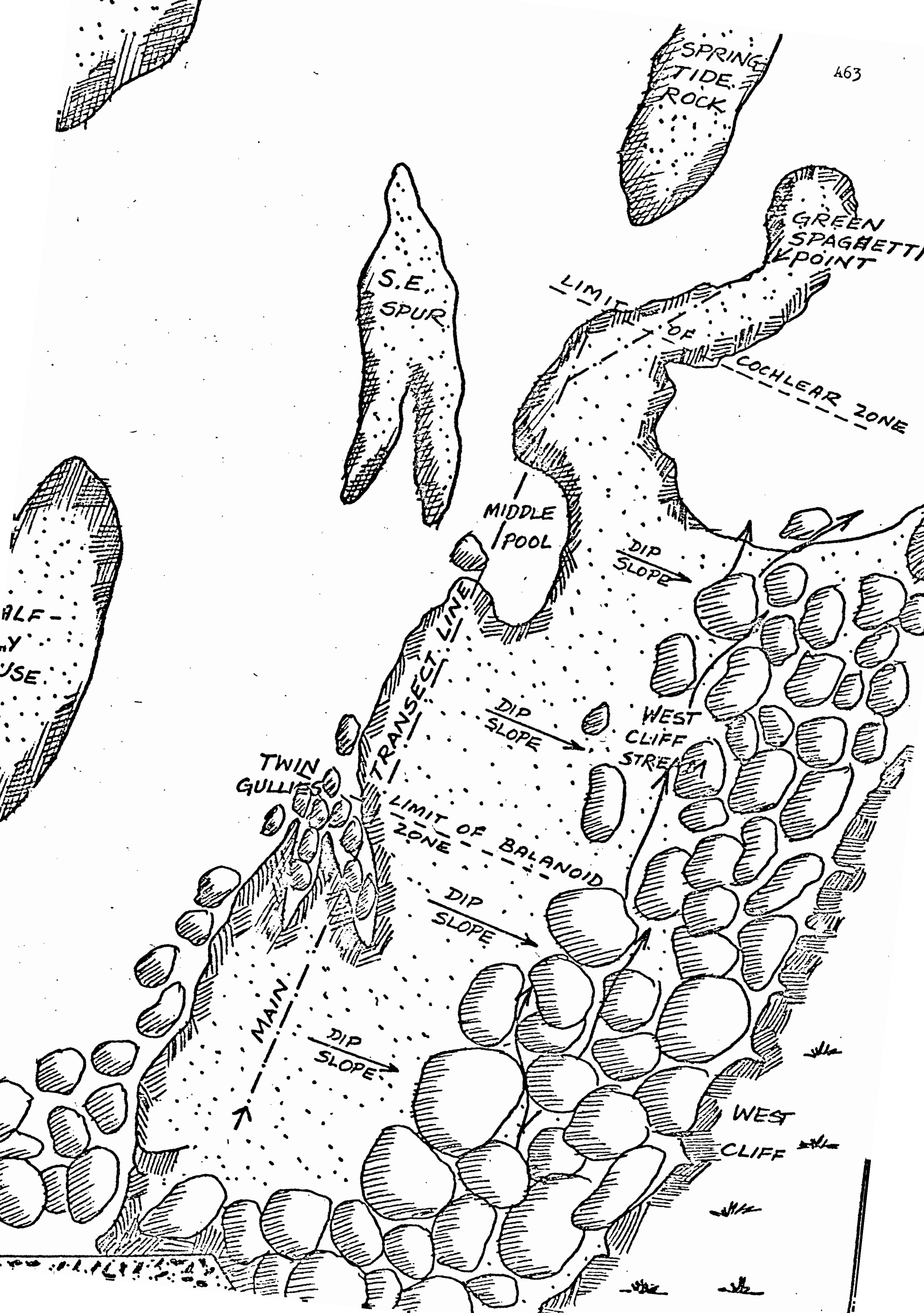
Today we are to measure by samplingthe distribution of the seaweeds and animals along the transect line.

TASK A.

1. Find the orange marks on the rocks along the transect.
2. Stretch the line marked off in metres from the top of the transect to the water's edge.
3. Place the one metre quadrat frame next to the line at the top of the transect.
4. Mark in this position on your sketch map supplied.
5. Use Fig. 22 to decide if the specimens in your sample are:

A - Abundant
C - Common
F - Frequent
O - Occasional
R - Rare

Fig 22./...



SPRING TIDE ROCK
GREEN SPAGHETTI POINT
S.E. SPUR
LIMIT OF COCHLEAR ZONE
MIDDLE POOL
DIP SLOPE
TRANSECT LINE
DIP SLOPE
WEST CLIFF STREAM
TWIN GULLIES
LIMIT OF BALANOID ZONE
DIP SLOPE
MAIN
DIP SLOPE
WEST CLIFF

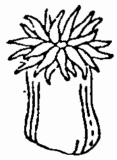
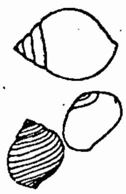
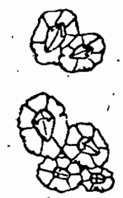
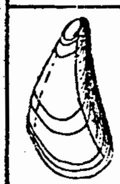
 **anemones** A many in almost every pool and damp place C groups in pools and damp places F isolated specimens in few pools O more than 10 found in 30 minutes R under 10 found after 30 minutes' search	 **limpets** A over 50 per sq. metre C 10 to 50 per sq. metre F 1 to 10 per sq. metre O less than 1 per sq. metre R only a few found in 30 minutes' search
 **very small periwinkles** A over 1 per sq. cm C 10 to 100 per sq. decimetre F less than 10 per sq. decimetre O a few individuals in most deep crevices R only one or two found in 30 minutes' search	 **other periwinkles** A more than 50 per sq. metre C 10 to 50 per sq. metre F 1 to 10 per sq. metre O less than 1 per sq. metre R only one or two found in 30 minutes' search
 **barnacles** A rocks well covered C up to one-third of the rock covered F individuals never more than 10 cm apart O 10 to 100 per sq. metre, few within 10 cm of each other R only a few found in 30 minutes' search	 **common brown seaweeds forming major zones** A more than 30% cover C 5 to 30% cover F less than 5% cover, but zone still apparent O scattered individuals, zone indistinct R a few plants found in 30 minutes' search
 **topshells and dog whelks** A exceeding 10 per sq. metre generally C 1 to 10 per sq. metre, locally sometimes more F less than 1 per sq. metre O always less than 1 per sq. metre R only one or two found in 30 minutes' search	 **lichens** A more than 20% cover C 1 to 20% cover, zone well-defined F large scattered patches, zone ill-defined O Widely scattered patches, all small R a few small patches seen in 30 minutes' search
 **mussels** A More than 20% cover to surface C Large patches F many scattered individuals, small patches O scattered individuals, no patches R a few seen in 30 minutes' search	

Fig. 23. <u>Accessing the number of specimens.</u>
(Clark 28)

6. Enter your findings for Qudrat 1 in the list on the following page.

7. Proceed on down the transect repeating this process (steps 3 to 6) every 3rd metre of the line, working towards the sea.

8. Proceed to TASK B.

Table 5/...

From :
28. Clark E., <u>Fieldwork in Biology</u> (1973)

ANIMALS	QUADRAT SAMPLES 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ANEMONES															
BARNACLES															
BRISTLE WORMS															
COAT OF MAIL SHELLS															
CRABS															
HERMIT CRABS															
FISHES															
MUSSELS															
QUAY LOUSE															
SAND HOPPERS															
SHRIMPS															
SPONGES															
STARFISH															
SEA URCHINS															
SEA CUCUMBERS															
TOP SHELLS															
TUBE WORMS															
WHELKS (ALL TYPES)															
BLACK PERIWINKLES															
LIMPETS CONE															
LIMPETS PEAR															
LIMPETS OTHER															
RED BAIT															
FEATHER STARS															
SEA SPIDERS															

SEA WEEDS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
GREEN WEEDS															
SEA LETTUCE															
JELLY WEED															
SPAGHETTI WEED															
BROWN WEEDS															
SEA BAMBOO/KELP															
SARGASSUM WEED															
PRICKY KELP															
RED WEEDS															
PURPLE LAVER															
UNKNOWN TUFTS															

Table 5. Frequency Distribution of Shore-Life (29)

9/...

Adapted from:
29. Miles P.M., and Miles H.B., Sea Shore Ecology. (1966)

9. When you return to the laboratory you will be required to graph your results in conjunction with the shore profile being prepared by group 9 at present. Here is an example of such a graph to help you.

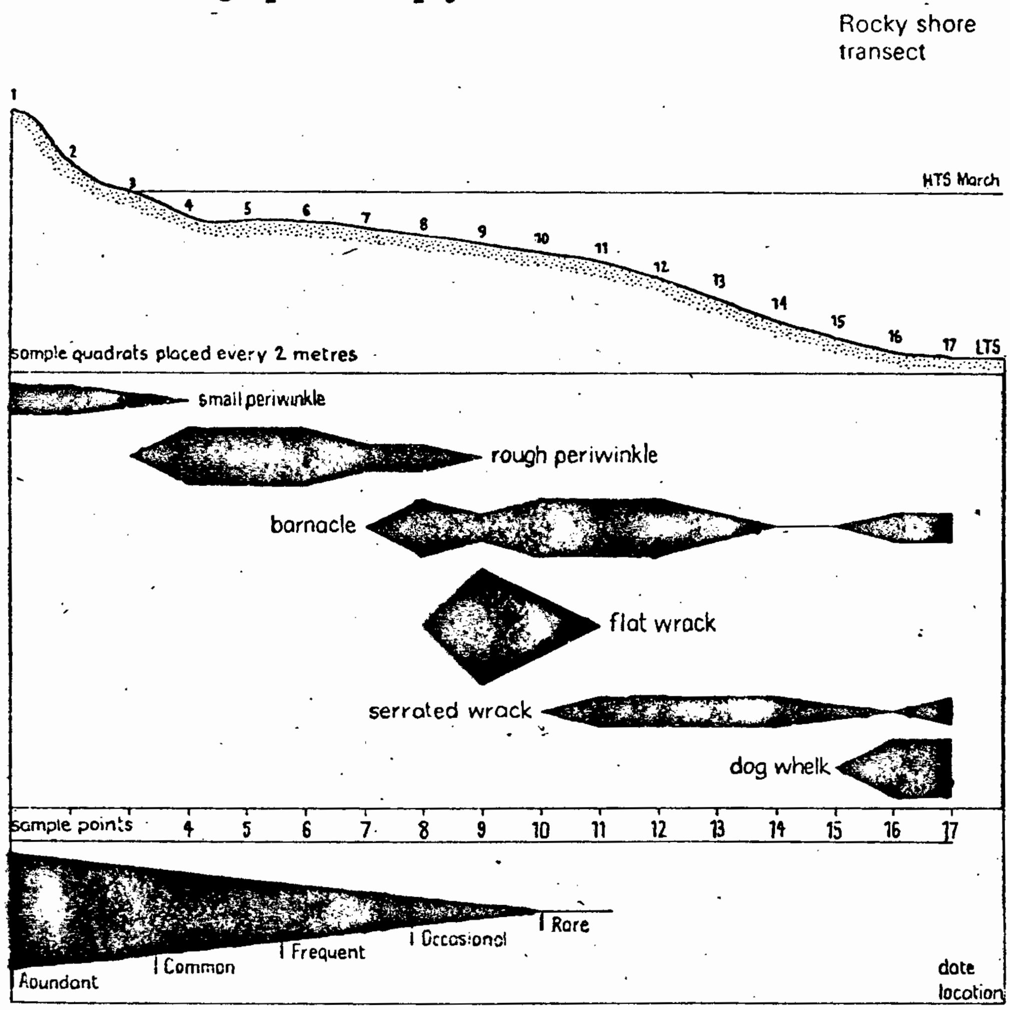


Fig. 24. A graph of animal distribution on the rocky shore.(30)

10. When you have completed your graph try to account for the varied distribution. Group 1 should be able to help you by identifying indicator species.

TASK B/...

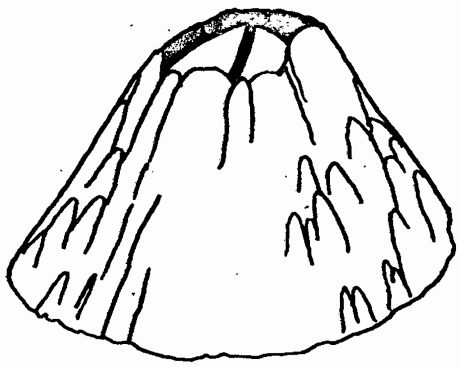
From:

30. Clark E., Op. Cit. (1973)

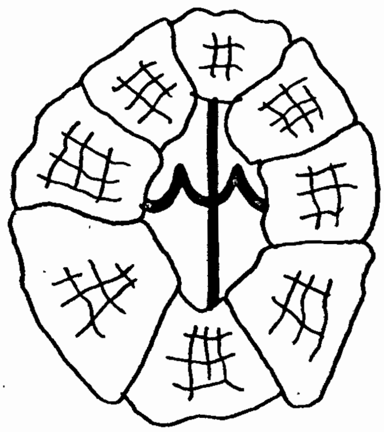
TASK B.

1. Move across off the transect line to the seaward end of the west cliff where there is a heavy barnacle colonisation on the exposed rocks.

2. There are two types of barnacles on this shore.



Volcano - shaped TETRACLITA (Side view)



Eight - plated OCTOMERIS (Plan view)

Fig. 25. Two different types of shore barnacles.

3. Note carefully all the places where Tetraclita occur and all the places where Octomeris occur.

4. Formulate a theory (hypothesis) about the distribution of these two different types.

5. Test your hypothesis by seeing if this is borne out by their distribution on the shore.

6. Get the photographer in group 8 to take a close up photograph of each type of barnacle.

EQUIPMENT LIST; (Complete this yourselves.)

FIELD TRIP.

1. Quadrat Frame
2. Line
3. Note books
4.

LABORATORY INVESTIGATION

1. Sheet of white paper for diagram.
2.
3.
4.

TASK SHEET 8 : GROUP 8

FIRST FIELD TRIP TO GLENCAIRN

The structure of the shore-line is partly determined by wave action and partly by the nature of the shore itself. Either way the places where animals are found are determined by these abiotic (physical) factors.

TASK A

Your special task is to accurately determine wave action in the field and reconstruct a working model in the laboratory when you return.

1. Appoint one member of your group to make a photographic record of the surroundings of the transect area. (You will have to share your photographer with several other groups as well.)

2. The photographic record should be taken from the right-hand side and base of the map on the following page, in such a way as to enable you to make careful models from the photographs. (NB. Hand the film in for developing TODAY!)

3. In addition an artist should make several field sketches of the area from the west cliff, east cliff and changing block to supplement the photographic record.

4. This map should be a help as the location of the main points have been accurately surveyed.

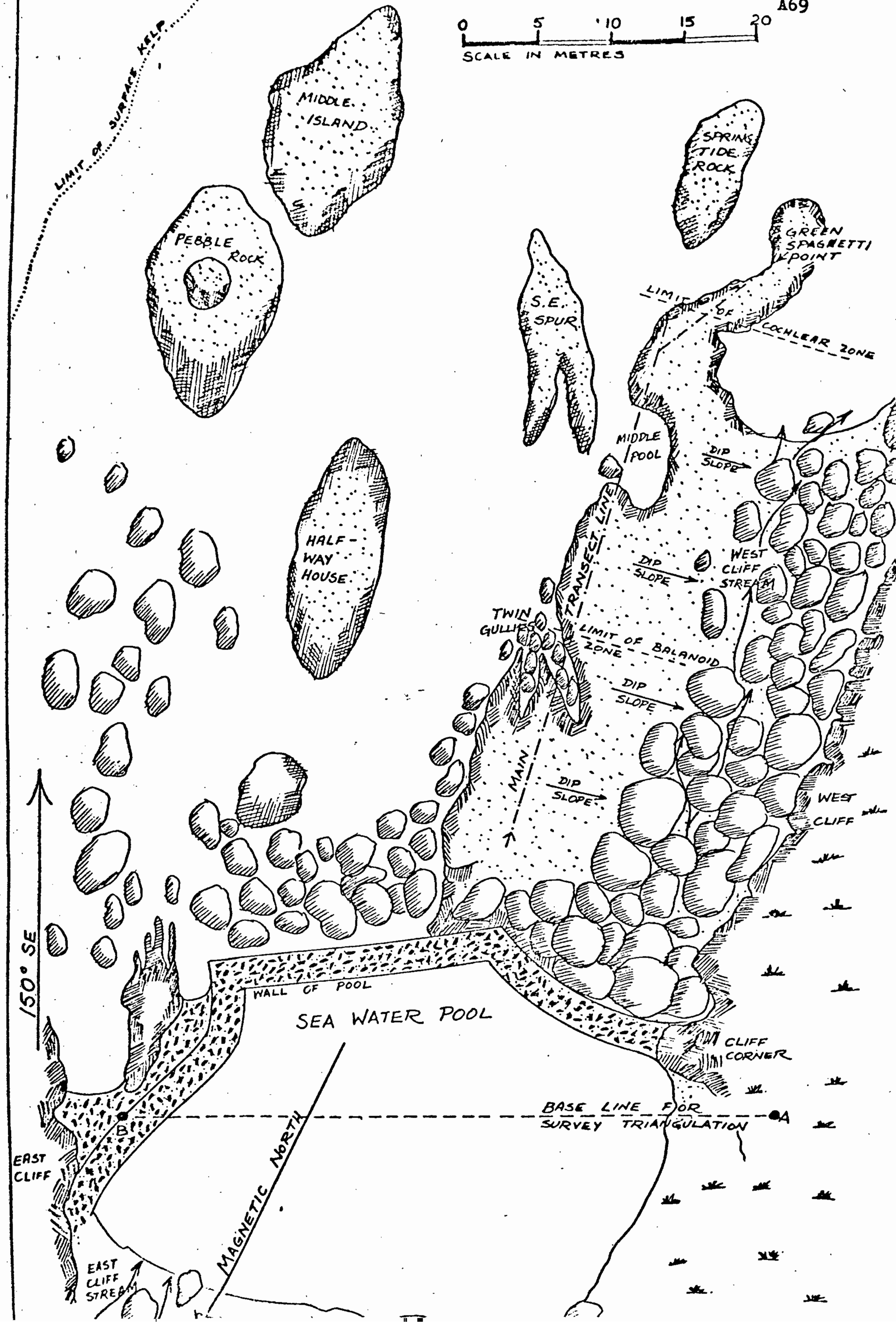
5. The other two members of the group should determine the direction of water movement at Spring Tide Rock, South East Spur, Half Way House, and the end of West Cliff.

6. This is best done by throwing a handful of tiny foam balls onto the water and using a compass to determine the direction they move.

7. These directions are plotted on the map.

TASK B/...

SPRING LOW WATER (3/10/78 09-00 h)



TASK B.

If you have any time to spare attach yourselves to groups needing help at this stage. Your teacher will be able to advise you in this regard.

8. Back in the laboratory you will be required to set up a ripple tank into which you model a facsimile coast-line so that the waves generated strike it at just the correct angle as determined from the map compass bearings and map provided.

9. The coastline is to be modelled out of a mixture of clay and builders sand. (One part of clay to eight parts of sand.) Add just sufficient water to make a putty-like mixture. (31.)

10. Model the coastline on a thin sheet of glass so that you can adjust it's angle in the ripple tank. Work as accurately as you can.

11. Generate waves in the tank and make a careful drawing of the reflection patterns around your model.

12. Take 3 photographs: one at the start of the experiment, one after 10 minutes, one after 30 minutes.

13. Prepare a report on wave action at the Glencairn site as regards; the most exposed places for animals. Where the currents are moving more quickly. Where the currents move slowly. Where shelter-loving animals are most protected. What is likely to happen to the shape of this coast in a few thousand years time.

14. Place a large fan behind the wave generator and see what difference wind speed makes to the waves, at different velocities.

EQUIPMENT LIST: /...

Adapted from:

31. Australian Science Education Project. Sea Shores.

EQUIPMENT LIST: (Complete this yourselves)

FIELD TRIP

1. Camera and black and white film.
2. Foam Balls
3. Sketch book
4.

LABORATORY INVESTIGATION

1. Ripple tank
2. Clay and Sand
3. Fan
4.

TASK SHEET 9/...

TASK SHEET 9 : GROUP 9

FIRST FIELD TRIP TO GLENCAIRN

The basic skill upon which all scientific theory depends is the ability to measure accurately. We are already in possession of an accurately surveyed map of the area but there is no accurate measure of the slope of the land as it falls towards the sea. As this slope factor is of extreme importance to the animals depending on periodical tidal immersion it is necessary to plot it accurately.

TASK A

1. You will need a long metric measuring tape of the roll type, or a cord marked off in one metre lengths.
2. Find the high water mark above the pool and use this as the starting point of your profile.
3. Take the two ranging rods provided and cut two cards so that one can be pushed down each pole.
4. Place one pole on the high water mark, move the card down to a suitable point, say 50 cm, and sight across to the 2nd pole and card being held on the top of the pool wall.
5. Sight along the top of your card (50cm) across to the other pole and beyond to the horizon.
6. Shift the far card up or down until it touches the horizon, and read off the measurement in centimetres. This new reading is the rise or fall between the two points.

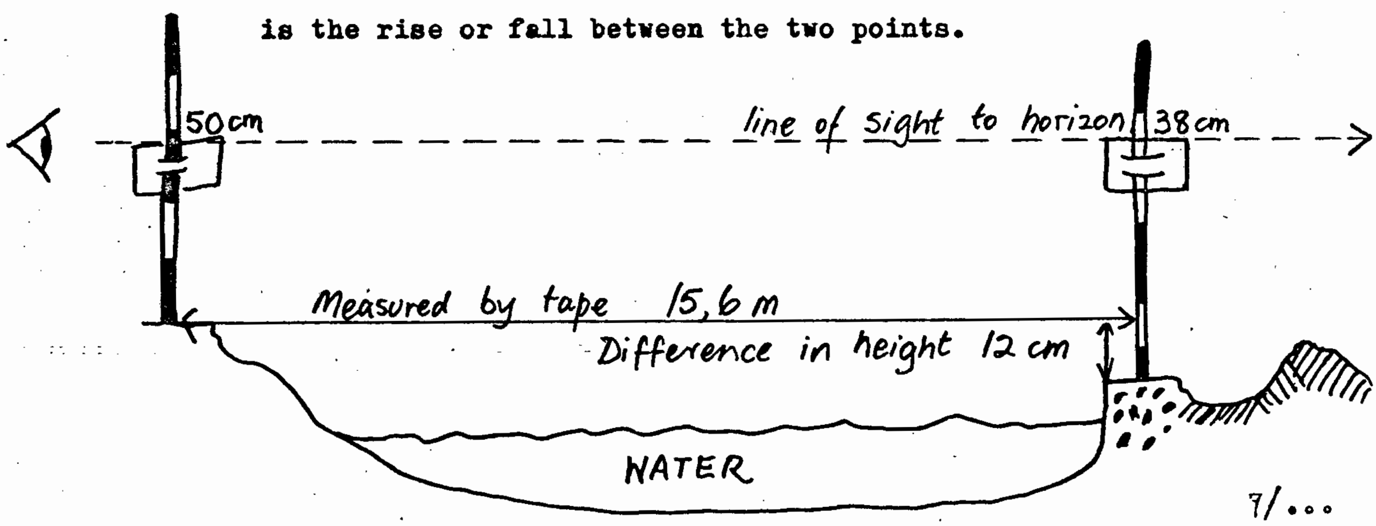


Fig. 26 The method of levelling the transect. (32)

7. Measure the straight line distance between the two ranging rods.

8. Record the details in this table. (33)

Stations	Drop in cm or	Rise in cm
1. High Water Mark. 0m		
2. m		
3. m		
4. m		
5. m		
6. m		
7. m		
8. m		
9. m		
10. m		
11. m		
12. m		
13. m		
14. m		
15. m		

Table 6. The leveling results.

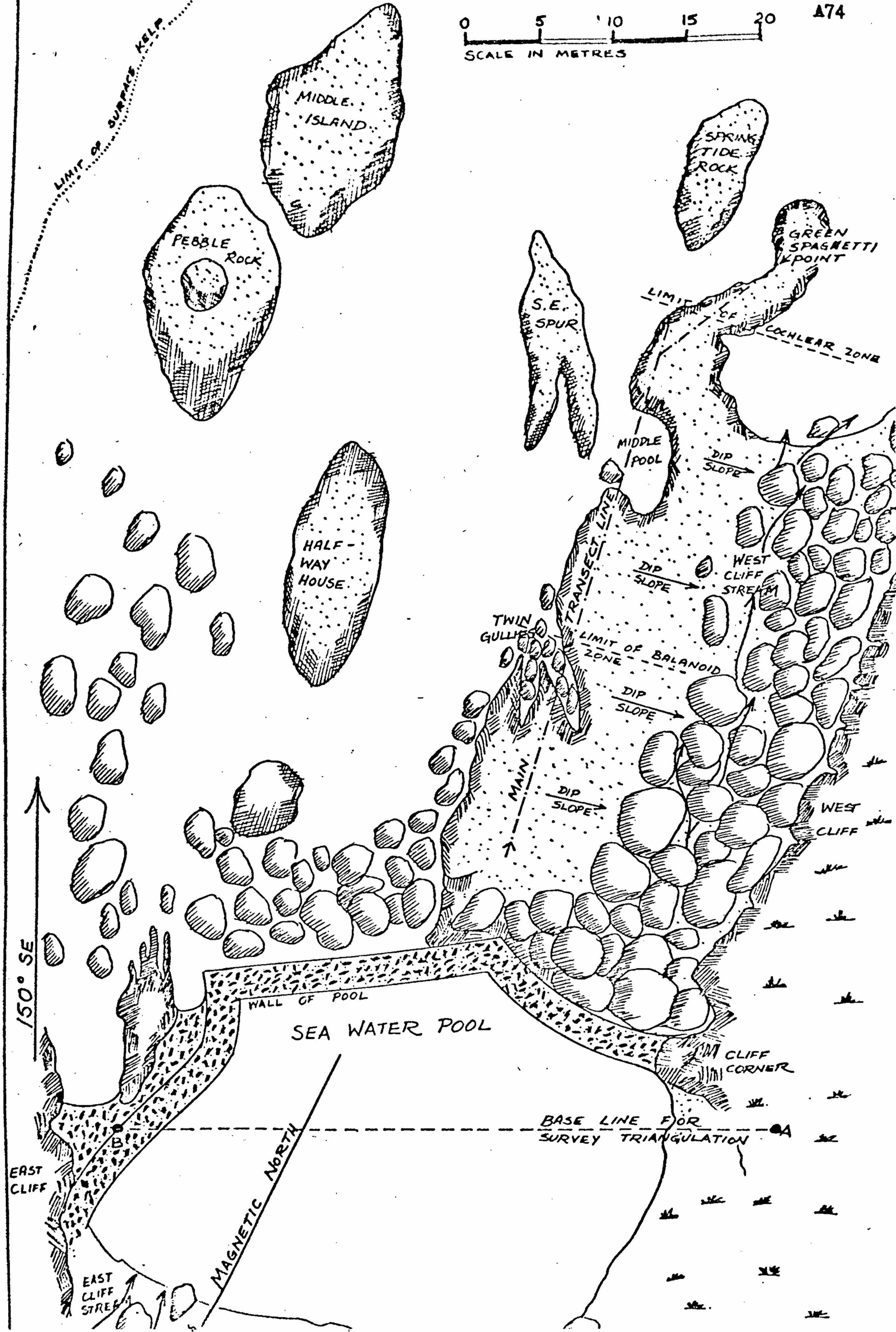
9/...

Adapted from; 32. Day J.H., A Guide to Marine Life on South African Shores (1969)

33. Miles P.M., and Miles H.B., Sea Shore Ecology (1966).

SPRING LOW WATER (3/10/78 09-00 h)

A74



9. Now proceed with TASK B.

10. When you return to the laboratory you will be required to prepare a scaled down profile of the slope using your measurements.

    e.g. Horizontal Scale : 1 metre = $\frac{1}{2}$ cm.

    Vertical Scale : 1 metre = 3 cm.

11. You will need a piece of paper just over 40 cm long to fit the whole profile onto it.

TASK B

Many small animals are abundant in the shelter of the holdfast of the sea bamboo/kelp. They find shelter from wave action, predators and desiccation.

1. Move down to the low water level and pull up or cut off 4 large kelp holdfasts.

2. Place each holdfast in a separate plastic bag with a bit of water and bring it back to school for further study.

3. Place each holdfast in a white enamel dish of sea water and leave them overnight to stand.

4. Collect the animals that you find in the holdfast. Break it up to reach those that are inside.

5. Make up a separate list of all the animals that you found in each holdfast. Use the list of common names provided to group 7 (Table 5.) and the rough guide to common shore animals provided to group 4 (Table 4.)

6. Are any types of animals particularly abundant? If so suggest a reason.

7. Were any animals found in more than one or all the holdfasts? If so which ones?

8. You will be required to report your findings to the class.

EQUIPMENT LIST/...

EQUIPMENT LIST: (Complete this yourselves)

FIELD TRIP

1. Ranging Rods and Cards
2. Tape (metric)
3. Notebook
4. 4 Plastic Bags
5.

LABORATORY INVESTIGATION.

1. 4 White enamel dishes.
2. Large sheet of paper.
3.
4.

E. UNIT THREE:

THE LABORATORY FOLLOW-UP OF THE FIRST FIELD-TRIP

METHOD: Groups investigate data and materials gathered on shore during field-trip and present reports. The teacher sums up using information sheets.

ESTIMATED TIME: 17 periods.
(8 periods for investigation.)
(9 periods for reporting and summarising.)

INFORMATION SHEET 2/...

INFORMATION SHEET 2

LABORATORY FOLLOW-UP TO FIELD-TRIP ONE

This information sheet should be supplied to all groups.

Yesterday we collected specimens and scientific data relating to the rocky shore. Questions were posed and assignments set which you must now begin to complete in your groups.

The next few biology periods will be devoted to completing the tasks assigned on the field-trip and preparing class reports.

THINGS TO DO:

1. Appoint a leader for your group who will also deliver some or all of your findings to the class during the report-back session next week.
2. Read over your Task Sheet again and make a list of the things you have to do.
3. Some groups will need more time than others to prepare. Some groups already know what their report is to be about. Some groups were not given a special report to prepare for on the field trip because their report only involves library research.
4. Here is a full list of all the work to be prepared for next week's report-back sessions:

Table 7/...

GROUP	LAB. WORK	REPORT-BACK
1	Measuring relative thickness of limpet shells.	(1) Zonation on the Rocky Shore. (2) Shell thickness and exposure in limpets. (3) Molluscs. Their body structure and feeding as an adaptation to the habitat. (4) Group 3 will assist with radula structure in whelks.
2	Microscope studies of plankton.	(1) Shore Birds at Glencairn. Their diet and role in the food chain. (2) The nature of the plankton. It s role in the food chains.
3	Radula studies in whelks.	(1) Assist group 1 with feeding of whelks. (2) Pool fish; their structure and colour as a response to survival pressures. Their role in the food-chain.
4	Identification of Animals; preparation of a wall chart and display of sample specimens.	The Sea Anemone It s structure as an adaptation to the inter-tidal environment.
5	Identification and mounting of seaweeds.	The Bristle Worm It s structure and movement. It s place in the food chain.

GROUP	LAB. WORK	REPORT-BACK
6	Maps and cross - section drawings of secondary communities. Illustrated with photographs. Identification of animals. Experiments on habitat selection in the Sea Slater (Ligia)	(1) A comparison of two rocky shore communities. (2) Experiments on habitat-selection in the quay louse. (3) Rocky shore crabs; their body structure and manner of feeding.
7	Graph of distribution of animals and seaweeds.	Barnacles: heir body structure and manner of feeding. Barnacles and their distribution as a response to wave - action.
8	Display of photographs and field sketches. Map of water movements. Construction of model and mapping of wave reflection and refraction patterns	Report on wave and wind action at Glencairn.
9	Preparation of transect profile. Study of micro-fauna of Kelp holdfasts.	Report on micro-fauna sheltering in Kelp Holdfasts.

Table 7. SUMMARY OF GROUP ACTIVITIES

5. All reports and investigations must be completed by ....
   ....

6. Those groups who do not find enough time in class to complete their reading must work in the school and public libraries in their own time.

7. The reports must be written-up and handed in after each report back with the names of the group members on each report.

8./...

8. **Divide up your tasks among group members and start immediately.**

A GUIDE/...

A GUIDE TO THE TEACHER ON HANDLING GROUP WORK IN THE FOLLOW-UP

The method being followed in this manual should ensure immediately successful group work:

1. The groups are small.
2. The groups are well-prepared and have a basis of common experience.
3. The groups have a task to perform.
4. The groups have reports to prepare.

The role of the teacher is to circulate to all groups stimulating discussion, helping to solve problems and ensuring that meaningful progress is being made. Once the report-back sessions begin the teacher adopts the role of chairman and introduces and summarises each report. A series of pupil information sheets, supplied in this unit, are circulated to the class at the con - clusion of the teacher's summary to act as a basis for later testing.

Time allocation has intentionally been kept very flexible. It is anticipated that if the assignment of pupils to groups has been made in accordance with their varying abilities, all groups should need about the same length of time to complete their tasks.

Here is a proposed time-table, but flexibility is important:

Unit One:	Introduction ...	10 periods
Unit Two:	Field-trip	1 day
Unit Three:	Follow up	
	Preparation	8 periods
	Reports and summaries	9 periods.

The teacher's preparation will revolve largely around two aspects:
1. Supply copies of selected portions of this manual to the groups or class as a whole. 2. Help the groups to assemble the necessary equipment.

Table 8./...

ITEM	SOURCE	GROUP
Hack Saw (small)	Borrow	1
Calipers (fine)	Physical Science Store	1
Microscopes (two)	Stock	2,3
Slides and Coverslips	Stock	2,3
Dropper	Stock	2
Methylene Blue	Requisition	2,3
Absolute Alcohol	Stock	3
Tweezers (fine)	Stock	3
Hammer	Woodwork	3
A Guide to Marine Life on S.A. Shores - Day	C.E.D. library	3,4,5,6.
Poster Card (large)	Stationary purchase	4
White dishes (8)	Requisition	4,9
Stiff white drawing paper (20)	Woodwork?	5,9
Brushes (2)	Art	5
Sellotape (1)	Office	5
Glass oven dish	Borrow	6
Sheet of Glass (1)	Stock	6
Photographic black paper	Stationary purchase	6
Sheet of graph paper	Mathematics	7
Ripple tank	Physical Science store	8
Clay	Art	8
Sand (½ bucket)	Builders' yard	8
Fan	Office	8

Table 8. Equipment to be supplied by teacher for laboratory investigations.

N.B. Arrange with office to reimburse for the cost and developing of 2 films used on field trip, out of school funds.

INFORMATION SHEET 3.

SEA SHELL ANIMALS (MOLLUSC S)

Film : Sea Shell Animals PS 183	9 minutes
or Mollusc s PS 461 B	14 minutes

LIMPETS

These rock snails are covered with a cone-shaped shell that offers maximum protection and coverage for the whole body. The snail's foot is as large as it s shell. It is tremendously powerful and can resist the wildest storm waves.

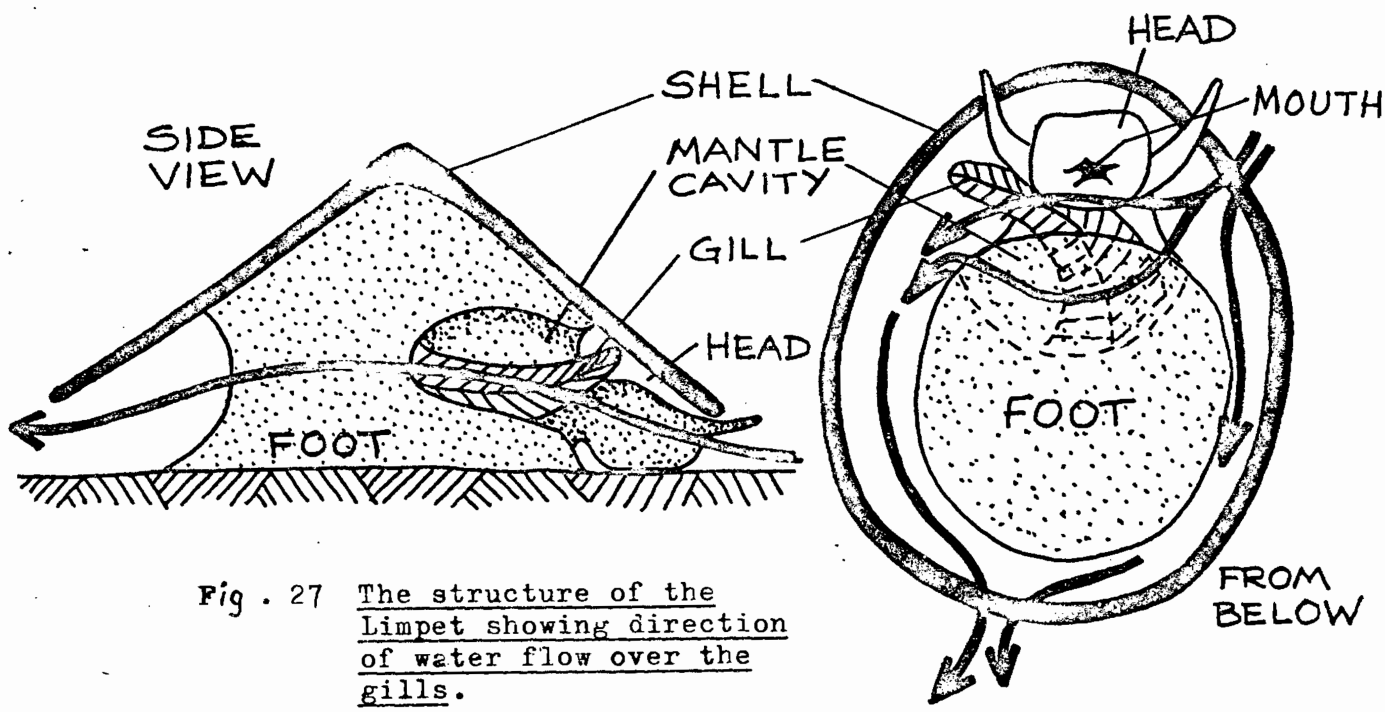


Fig . 27 The structure of the Limpet showing direction of water flow over the gills.

When exposed they pull their shells down close to the rock entrapping water under the edge of the shell, which they allow to evapourate slowly thus keeping cool even on hot rocks until they are covered by the rising tide again.

Limpets/...

Limpets on soft rocks wear a ring-shaped groove into the rock with their shells. Each day during low tide they return to this "home" to find the best possible water-tight fit on the rock.

Limpets on hard rocks wear away the edges of their shells to match the irregular rock surface.

Inside the shell there is a mantle cavity which contains a single gill and a head.

Limpets are grazing mollusc s. They move short distances over the rock licking away the algae that grow on the rocks (making them so slippery to walk on). Their tongue is covered with rows of tiny teeth; this belt-like tongue is called a radula. Limpets are herbivores in the food chains.

For further information see:

Yonge C.M., The Sea Shore (1963), pp. 135-142

INFORMATION SHEET 4/...

INFORMATION SHEET 4

SHORE BIRDS

THE BLACK-BACKED GULL

This is one of the two most common birds on our shores and can be found on all South African beaches, up river courses, following ships at sea and many kilometres inland scavenging with other gulls at municipal rubbish dumps. Although they are the top carnivores in the food chain they scavenge the beaches for the bulk of their food which is brought in on the incoming tide.

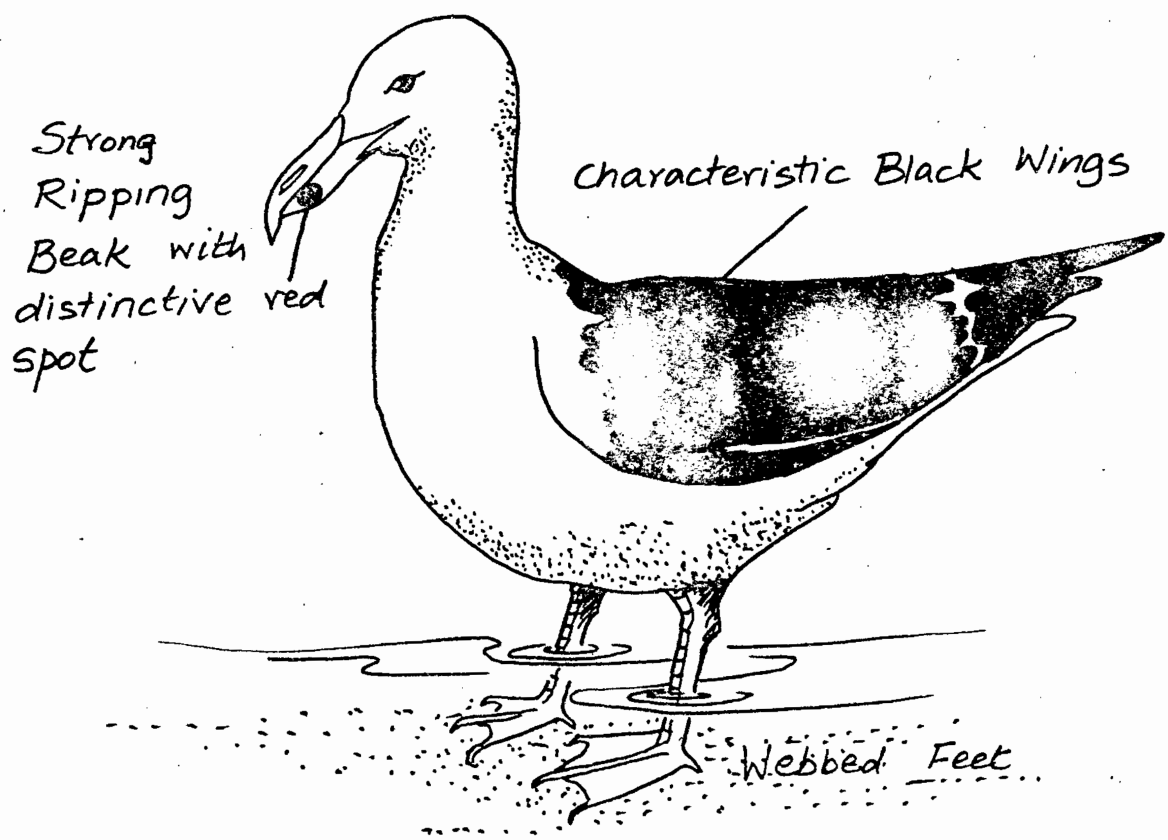


Fig. 28 The External Structure of the Black-Backed Gull

Dead/...

Dead fish, offal and dead marine creatures form the bulk of their diet. When this gull spots a bed of white mussels in the sand it skims down and tramples the wet sand with it's large webbed feet. This causes the mussels to rise to the surface. The gull seizes a mussel and flies up to about 15m above a rock or road surface. The shell is dropped and the gull is able to eat the soft body inside the shattered shell.

These large birds breed in colonies. The most important colony in the peninsula is at Swartklip. While they protect and feed their own chicks they are quite prepared to eat the chicks of other gulls, even their own neighbour's offspring.

They play an important role in keeping the beaches clean. If one gull spots food and dives after it many other gulls appear, apparently from nowhere rather like vulture, to attend the feast. The gulls are most active when the tide is out.

For further information see:

Mc Lachlan G.R., and Liversidge R., Roberts' Birds of South Africa. (1969)

INFORMATION SHEET 5

THE PASTURES OF THE SEA

PLANKTON

An acre of sea has over 10 tons mass of drifting single celled plants in it s surface water (about the same mass as a good crop of potatoes on the same area. The estimated annual world production of plankton (too small to see) is 150 000 million tons. The floating plankton is part of the base of every pyramid and food chain, e.g. 10 tons of plankton per acre constantly drifting past the filtering mussels produce 20 tons of mussels per acre per year.

There are two types of plankton, (a word that means, incidentally, "to drift helplessly".)

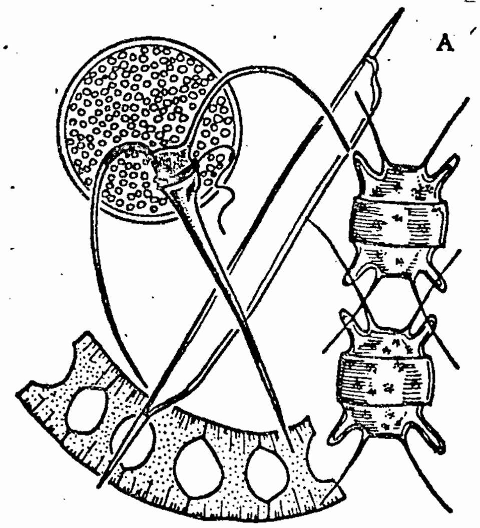
A. THE PHYTOPLANKTON

These are the floating microscopic plants, that produce starches in the sunlit surface waters by photosynthesis and, in the process, release 70% of the world's oxygen supplies.

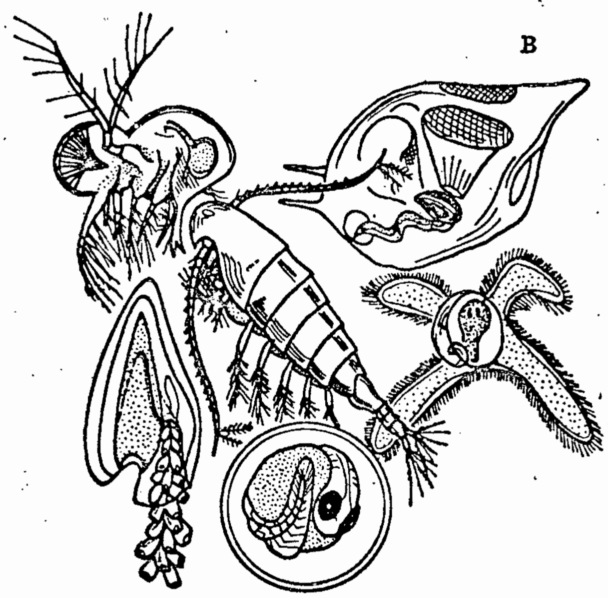
They consist of diatoms, dinoflagellates that cause the red tides seen off our coasts at times, bacteria that flash with bio - luminescence in the surf at night and masses of unicellular algae. Estimates of the quantity of diatoms in a cup of sea - water run to about 50 000 individuals. During the night these minute plants are spread evenly, vertically through the surface waters, but during the day they move down into deeper water attracting the feeding fish to greater depths.

Fig. 29./...

PHYTOPLANKTON



Some plankton shapes: (A) five kinds of plants and (B) six kinds of animals × up to 100, but not all drawn on the same scale.



ZOOPLANKTON

Fig. 29 Some Examples of Marine Plankton (Barrett 32)

B. ZOOPLANKTON/...

From:

32. Barrett J., Life on the Sea Shore (1974)

B. ZOOPLANKTON

Nearly all shore animals and plants spend part of their life cycle floating or swimming in the plankton. Protozoa, eggs, larvae, shrimps and other tiny crustaceans form the animal component of the plankton and feed on the phytoplankton, forming food themselves for larger animals. It has been estimated that there are some 400 million million pilchard eggs drifting in the English Channel alone. If all these eggs alone developed to maturity the seas would be packed solid with pilchards alone. Obviously there is very heavy predation as these tiny creatures and plants provide the basic food for all other animals in the oceans.

In the inter-tidal zone they are filtered from the water by mussels, sponges, bait and barnacles; gathered by the tentacles of tube and fan worms; stung by the poisonous tentacles of sea anemones and eaten directly by fish.

Without the plankton there would soon be no life in the sea and a bit later, no life on land either.

For further information see:

Newell R.C. and Newell G.E., Marine Plankton (1973)

INFORMATION SHEET 6

POOL FISH

THE KLIPFISH

When the tide comes in over the rocky shore , sea fishes from the sub-littoral move in searching for food. Some fish however are adapted to living in the pools and gullies of the shore itself although when they grow larger they tend to move to the sub-littoral fringe.

The Klipfish are probably the most common shore fish in the colder peninsula waters. Fourteen different species have been identified in False Bay.

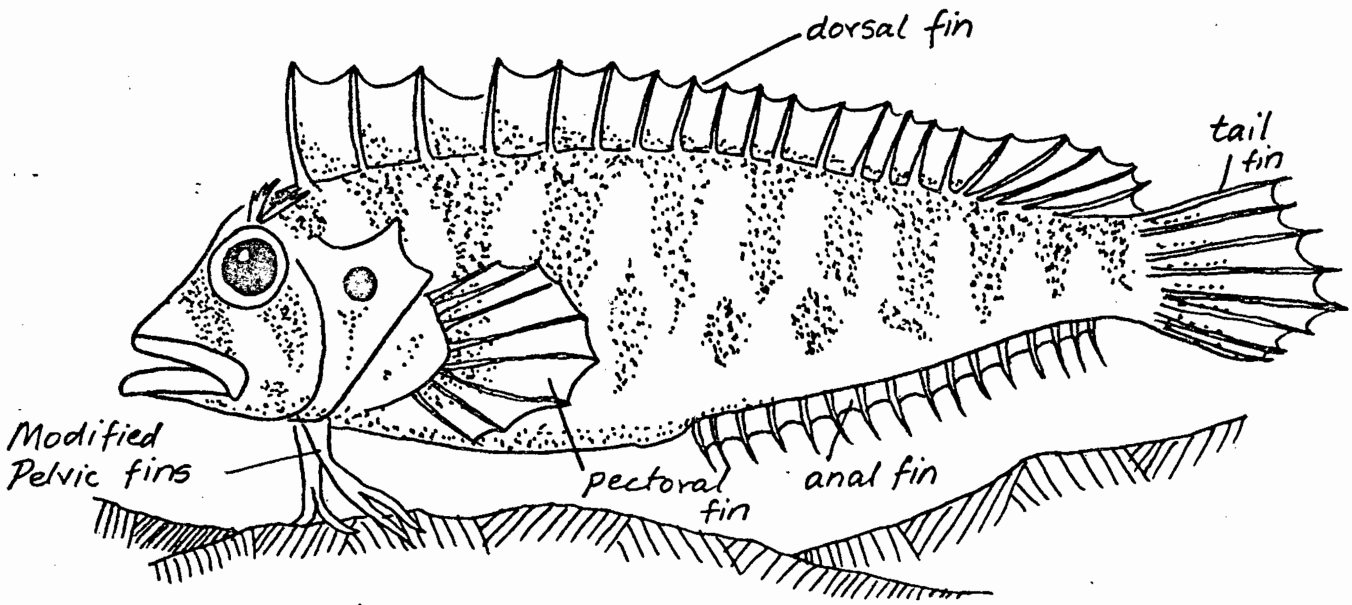


Fig.30 The External Structure of the Klipfish

At first glance the klipfish appears to have only one pair of fins (the pectoral fins) but it s pelvic fins have been modified to leg-like supports which can walk it slowly over the rocks in the pool without attracting attention or causing water movements.

It/...

It has a long dorsal fin along it s back and a large anal fin as well. All shore fish have modified their pelvic fins for this habitat, many of them as suckers to cling to the rocks.

Klipfish are carnivorous fish and dart out quickly to catch any food they can find, but retire equally quickly underneath a rock ledge or into the shelter of a seaweed or crack.

Their bodies are usually a mottled brown of no particular pattern helping them to blend easily into their surroundings when still. They have strong teeth for rasping off animals from the rocks and scaleless, slimy skins to avoid being easily captured by crabs and octopi in the pools.

As they grow larger (and specimens of up to 1 kg can be caught) they move down into the sub-littoral fringe. They may grow up to 50 cm in length.

Their eyes are large and protrude rather like a chameleon's. They can even move independently to follow danger or food from two different sources.

Their main problem is to prevent themselves being trapped in tidal pools too far up the shore or being washed up where they will soon provide food for hungry gulls.

INFORMATION SHEET 7/...

INFORMATION SHEET 7

THE SEA ANEMONE

This is one of the animals on the rocky shore that looks more like a flower than an animal. (The fan worm, sea cucumber and feather star are others).

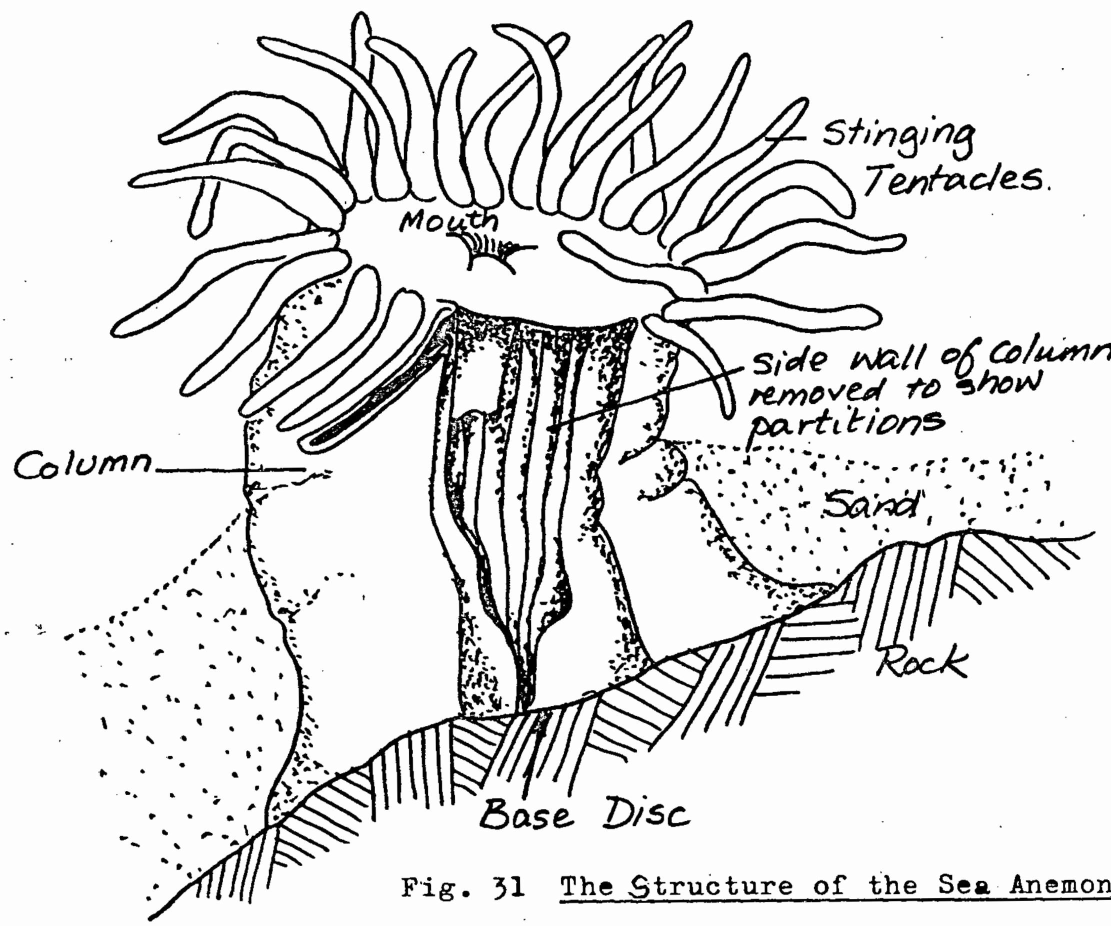


Fig. 31 The Structure of the Sea Anemone

Basically it is an unprotected, empty sac fixed firmly to the rock by a sucker-like base, the top end having a central mouth surrounded by a ring of hollow stinging tentacles. The sac is divided up by partitions running inwards from the wall of the column to enlarge it s inner feeding surface.

It/...

It has no gills but is far too large to survive by diffusion over it s outer surface. Instead it pumps a constant stream of water into it s mouth which ensures that oxygen gets to it s inner portions and at the same time carries plankton into it s large single stomach cavity. This water also serves to inflate the animal so that it s bulk is 90% water at least. For this reason it can also quickly deflate itself when threatened by enemies or when wave-action becomes too violent. Anemones do not live in exposed places on the shore, preferring rock crevices and cracks and hiding beneath or in the shelter of large rocks. Adult anemones can move slowly to new locations by sliding their basal discs along the rock bed.

Should a fish or shrimp venture within reach of the tentacles , microscopic poison darts quickly paralyse the animal. The tentacles bend down cramming the prey through the mouth into the stomach. The indigestible parts are expelled through the mouth several days later. Thus the anemone is a carnivore as it feeds on other animals. Only the tiny sea spider seems capable of attacking the tough and poisonous anemone. It climbs it s column and sucks it's body juices with it s piercing mouth parts. The anemone's eggs form part of the zooplankton, where most of them are eaten, preventing the shoreline being overcrowded with anemone.

As the tide recedes the anemone empties out it s water, drawing in it s tentacles and collapsing to a tiny, rubbery stump that is resistant to drying and mechanical injury.

INFORMATION SHEET 8/...

INFORMATION SHEET 8

THE BRISTLE WORM

This worm is a distant cousin of the earthworm. Both worms have bodies that consist of many segments. Each segment has bristles on it for gripping the ground as the worm passes. Bristle worms are noted for their abundance of bristles. Each segment has 2 paddle-shaped structures which are fringed with tufts of bristles.

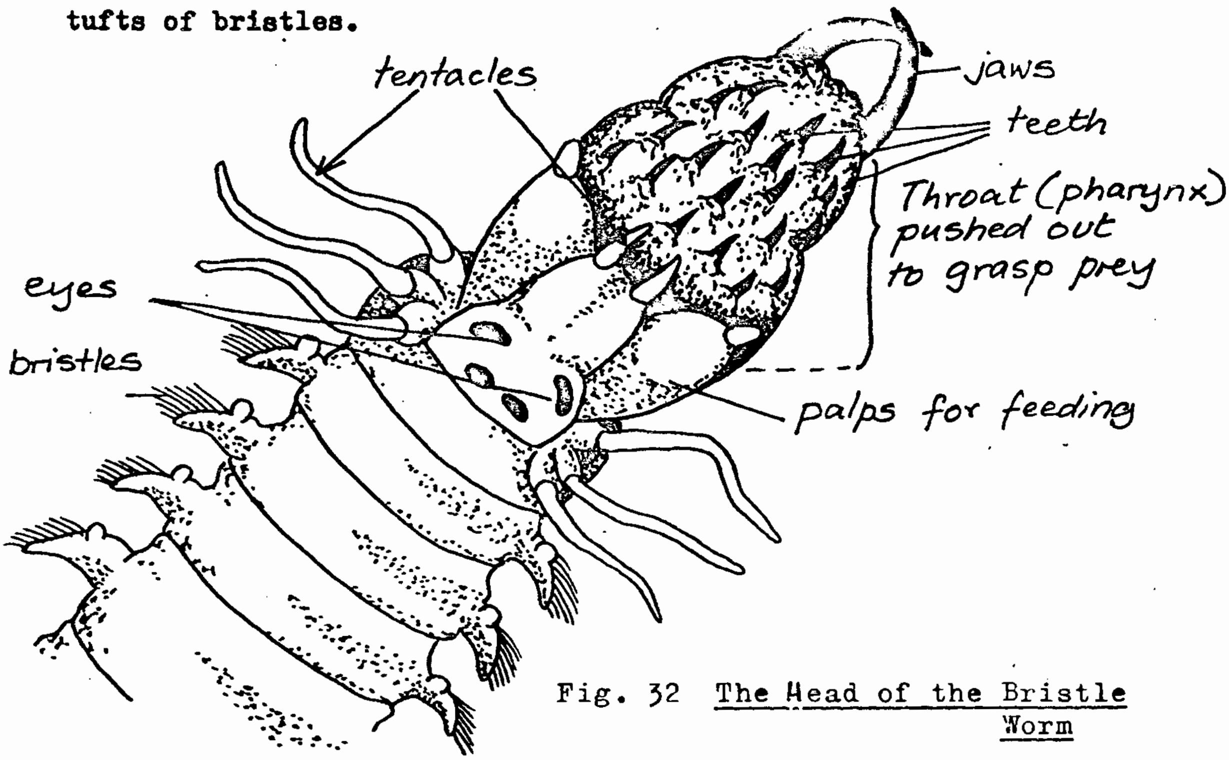


Fig. 32 The Head of the Bristle Worm

The head of the worm is covered with eyes and tentacles and ends in a large mouth. The worm eats plant and animal material that drifts down into the cracks and beneath boulders. It will also however catch living prey, such as other worms, small crustacea and sea slugs. It captures it s prey by pushing it s throat out through it s mouth and thus exposing it s powerful jaws and teeth so that they can seize the prey and draw it back into the body whole. These worms are thus herbivorous and carnivorous. Animals like this are called omnivores because they eat anything.

Being/...

Being a hunter and a scavenger the worm has to be able to move freely around the pools of the shore. It shuns the light, feeding mainly at night. During the day it can be found hiding in the seaweeds (particularly Sargassum weed and in the holdfasts of Kelp,) under rocks and buried in the sand.

These worms can swim by laterally bending the body from side to side, rather like a snake, or creep over the bottom of the pool using their paddles and bristles like oars to row themselves across the surface. When digging into the mud they bury their heads in the mud and draw themselves into the hole made by pushing their throat (pharynx) into the mud repeatedly. Their bristles help to anchor them in the mud.

They are popular with fishermen as bait and with biologists as being one of the more beautiful inhabitants of the rocky shore. They come in a wide variety of forms. Some are free-swimming as described above; others build tube-like homes for themselves out of limy salts or sand particles, gathering their food from the plankton by means of their feather-like gills (the tube worms and fan worms).

For further information see:

Chapman G. and Barker W.B. Zoology (1964) pp. 124-132.

INFORMATION SHEET 9/...

INFORMATION SHEET 9

THE SHORE CRAB

This tiny crab is the only permanent crab living on the rocky shore all year round. It is without doubt the toughest creature on the shore. It can live out of water for up to a week and even vary the salt content of it s blood to match the freshwater conditions in river estuaries. It is a scavenger that eats everything, both plant and animal remains. Such an animal is called an omnivore.

It is well adapted to living on the more sheltered upper reaches of the shore. It forces it s way into cracks and under ledges using it s large folded pincers as a shield to protect itself. It is common among the stones on the shore but seldom found in the exposed portions. It s cousin the red rock crab has strong legs that can hold to the rock even in breaking waves, where the tiny shore crab would easily be swept away.

All crabs have 5 pairs of walking legs attached to the large head-thorax region (cephalo-thorax) which is covered by a shield called the carapace. The first pair of walking legs form pincers to defend the crab and assist it in getting food. Male shore crabs have larger pincers than females. The tail (abdomen) is flexible and segmented and is usually tucked up under the body defensively. Females shelter their eggs between their abdomens and bodies - at which stage we say they are "in berry" and may not be caught.

The shore crab is not a good swimmer but will not hesitate to scramble away sideways through the water to avoid capture. If cornered it raises it s pincers agressively, and a large specimen can nip a finger quite hard.

It is important to crabs to be able to shed their claws and legs at a moment's notice. As the tide tumbles the stones on the shore, crabs may find their limbs trapped.

In/...

In such cases or to avoid being eaten whole they quickly break off their legs (rather like a lizard's tail) and escape to grow another replacement limb. This process is known as autotomy (self-shedding).

When feeding these crabs grasp the food in the pincers and tease it into small shreds that are transferred to the hard jaws for further shredding before swallowing.

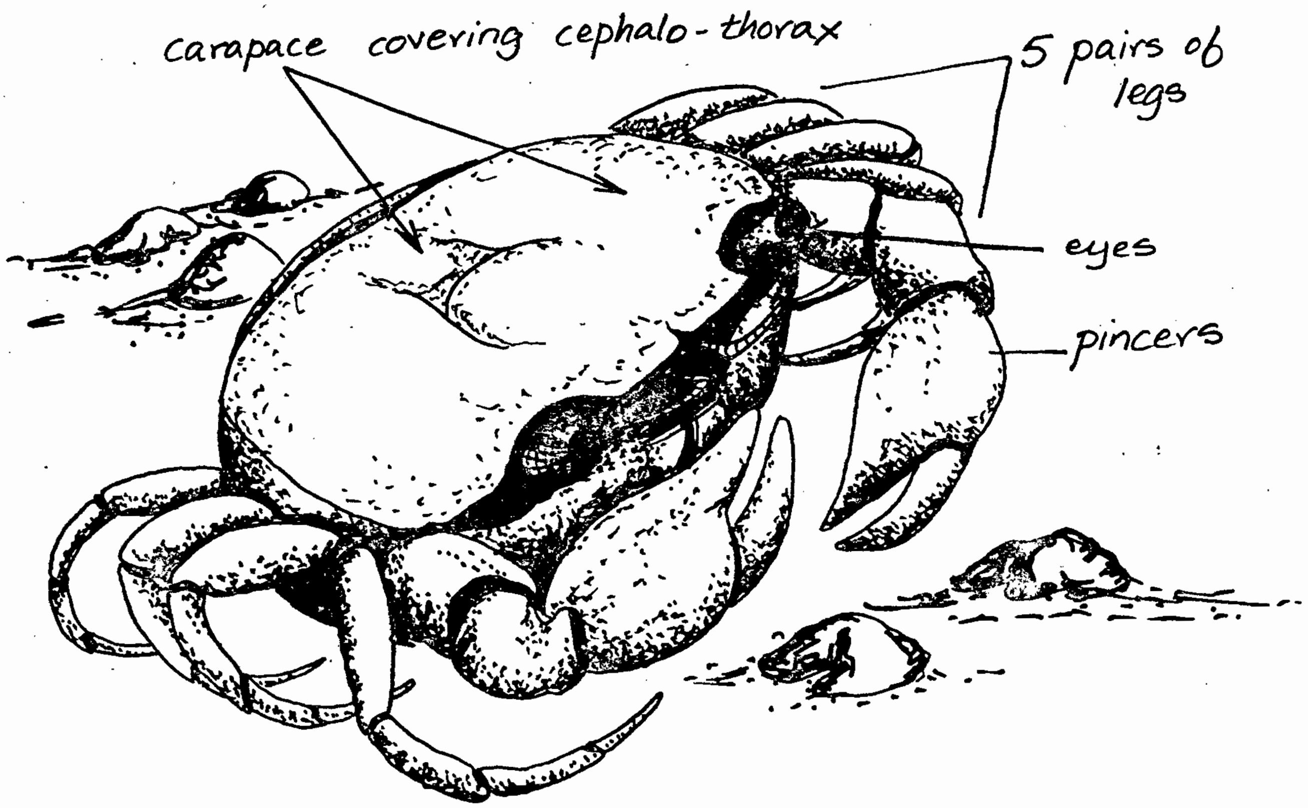


Fig. 33 The External Structure of the Shore Crab

INFORMATION SHEET 10

THE ACORN BARNACLE

The barnacle is the commonest of all shore animals and yet until 100 years ago we were not sure if it was a crustacean (crab family) or a mollusc (limpet family).

Today we know that it is a tiny free swimming crab larva that glues it s back to the rock and thus fixed and protected by a surrounding wall of six limy plates and covered by a hinged door consisting of 4 further limy plates, it is free to use it s legs as a fine casting net to literally kick plankton into it s mouth.

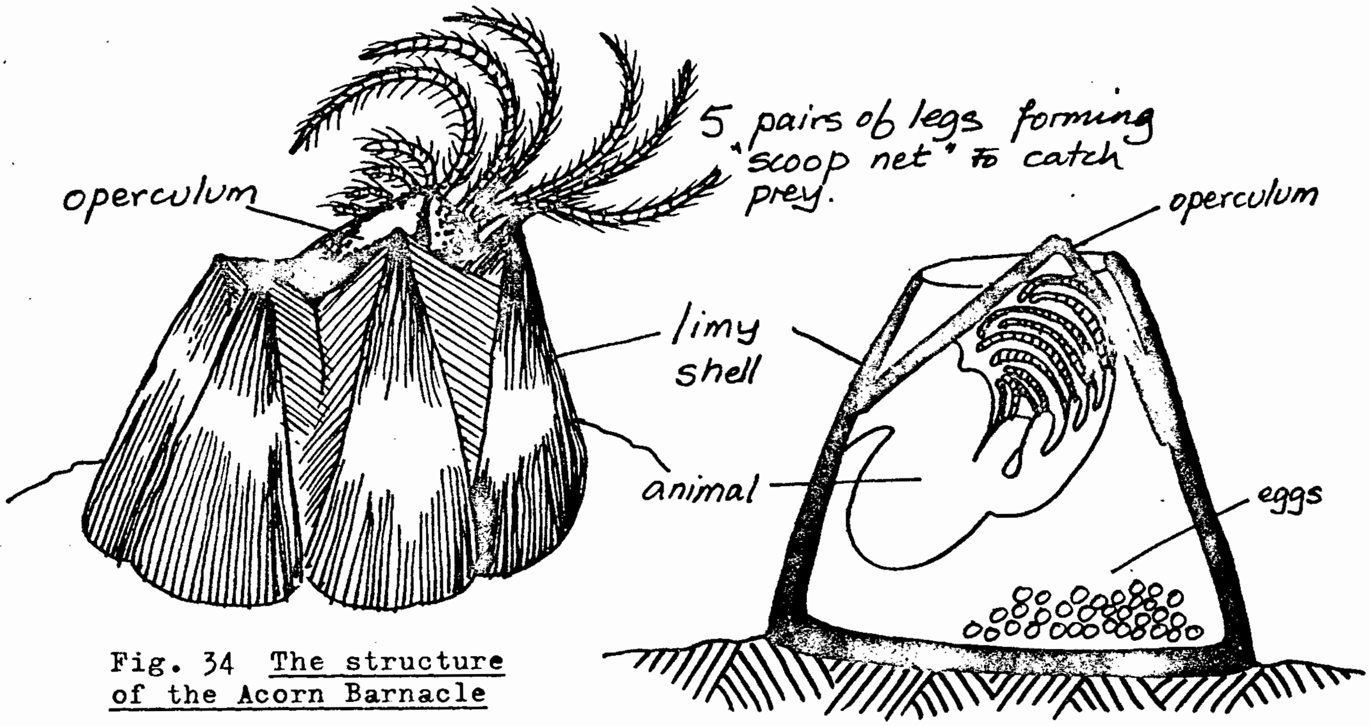


Fig. 34 The structure of the Acorn Barnacle

When the tides cover the barnacles the operculum opens and the legs (cirri) protrude and beat the water with a scooping motion, drawing the food in. This is a dangerous time for the barnacle as there is always the risk that a klipfish or similar animal will bite it s legs off or a whelk will poison it and eat out it s soft body contents.

However/...

However their survival is ensured by their vast numbers. It has been estimated that there are 35 000 to 60 000 tiny "catch nets" beating the water every square metre of a barnacle zone.

The broad base of the shell is firmly cemented to the rock and can resist the pounding of the waves and the tumbling of large stones easily. As the tide recedes the operculum closes over the legs and traps water inside the shell, which is allowed to evaporate slowly to keep the barnacle cool and moist until high tide.

The barnacles increase in size, not by moulting as do other crustaceans, but by enlarging their home by dissolving the inner surface of the plates and adding to the outer surface of the plates in some, as yet unknown, way.

They are usually found on the most exposed rock surfaces where large seaweed such as kelp cannot remain attached. Even the slightest brush by a seaweed is sufficient to sweep a newly settled barnacle larva off the rock, thus barnacles and kelp are never found together. This does not mean that the barnacle necessarily prefers the more exposed portions, but rather that it s chances of survival are better in these conditions.

For further information see:

Yonge C.M.: The Sea Shore (1963) pp. 130-135.
pp. 130 - 135.

UNIT 4/...

F. **UNIT FOUR:**

FIELD-TRIP TWO : TO INVESTIGATE THE EFFECTS OF HUMAN USE OF THE SHORE-LINE.

METHOD; Field trip. Pupils working in small groups.

ESTIMATED TIME REQUIRED : Half a day (approx. 1 hour at site.)

INFORMATION SHEET 11

PREPARATION FOR FIELD-TRIP TWO

This information sheet should be supplied to all groups.

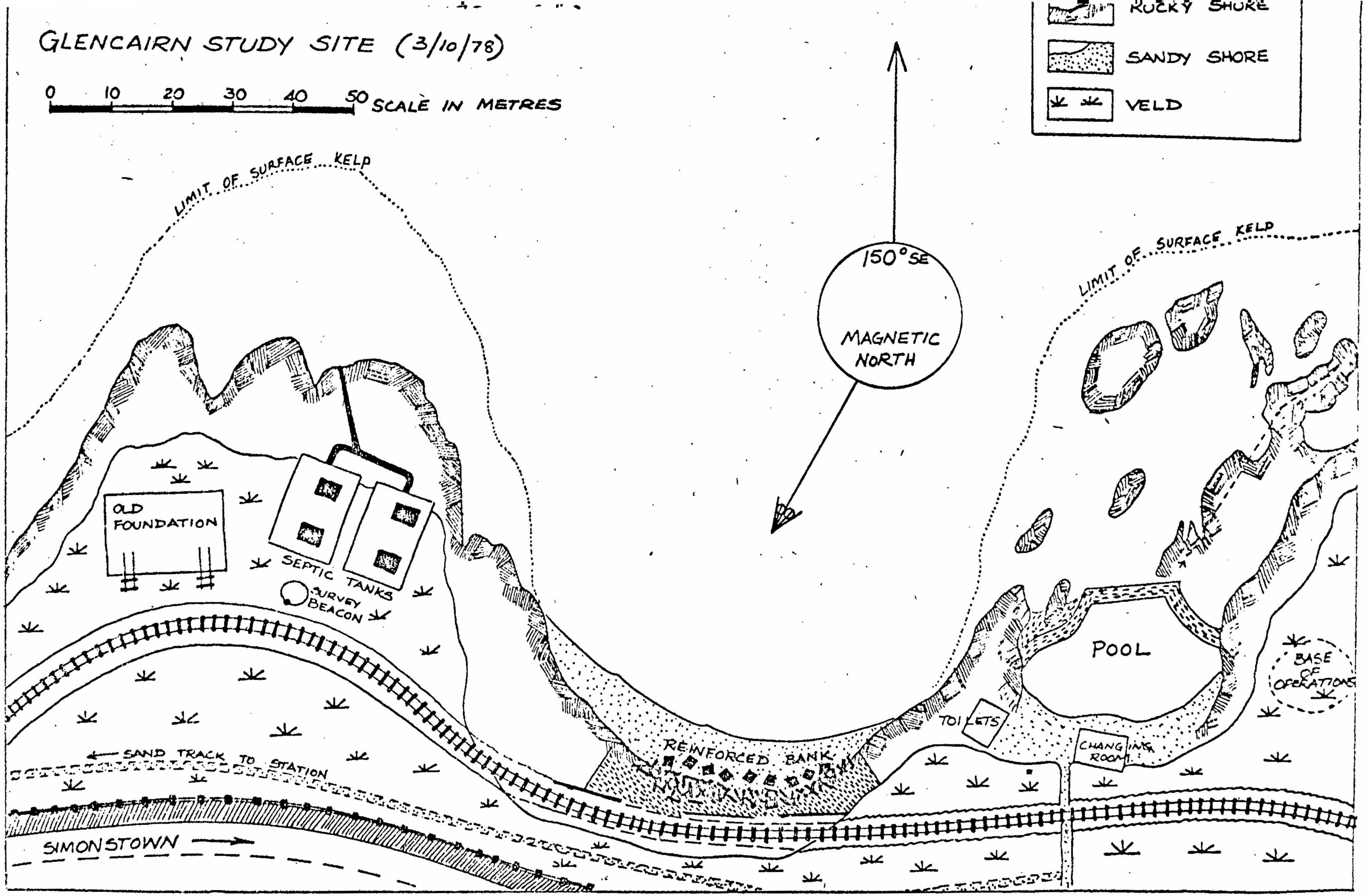
The purpose of this field-trip is to revisit the same site to collect data relating to human use of the shore. Man is not only the top carnivore in the marine food chain but an animal that exercises a considerable modifying influence on his environment that is too often damaging to breeding cycles and may poison lower components of the food webs that support him.

You will again work in the same groups as before, collecting data for later processing in the laboratory, and preparing a report for the class.

1. THE STUDY SITE

We will be returning to the same site as before for a completely different purpose. The area of study will be however much expanded to include the entire coastline shown in this map and to include all the land on the seaward side of the main road. Also the coast stretching towards Simonstown for about a further 300 metres (not shown on map) will be included.

2. THE TIME/...


GLENCAIRN STUDY SITE (3/10/78)
0 10 20 30 40 50 SCALE IN METRES
ROCKY SHORE
SANDY SHORE
VELD
LIMIT OF SURFACE KELP
LIMIT OF SURFACE KELP
150° SE
MAGNETIC NORTH
OLD FOUNDATION
SEPTIC TANKS
SURVEY BEACON
POOL
BASE OF OPERATIONS
TOILETS
CHANGING ROOM
REINFORCED BANK
← SAND TRACK TO STATION
SIMONSTOWN →

2. <u>THE TIME OF THE FIELD-TRIP</u>

It will be an advantage to visit the area as close to low tide as is convenient but this is not essential, provided that some animals can be collected from the shore. (This will not be possible at high tide.) The date of this second field-trip will probably be 3 to 3½ weeks after the first field trip. (approx. 21st of February.)

Final date: ....

3. <u>EQUIPMENT</u>

Provision for bus and train fare and suitable clothing. Special equipment will be specifically mentioned in the individual task sheets.

4. <u>GENERAL INSTRUCTIONS</u>

As before work outwards from the base of operations on your assigned tasks as soon as you arrive at the site.

<u>Warning</u>: 1. Take care not to walk on the railway line or too close to it.

2. Beware of standing on snakes in the grass veld.

3. Those groups collecting live shore animals, be careful not to miss the low tide.

You will have about 1 hour to complete all your tasks today.

Table 9/...

GROUP	TASK
1 + 2	Litter Survey
3 + 4	Impact of the railway line
5	The Sewage disposal plant
6	The Sewage Pollution
7	Environmental Marring
8	Casual uses and photography
9	The Industrial Pollution Threat

Table 9. Summary of Group Tasks.

ITEM	SOURCE	GROUP
Plastic Jerry cans	borrow	6,9
Methylene Blue	requisition	5
Black and White 35mm film (20 exposures)	Chemist purchase	8

Table 10. Equipment to be supplied by teacher for field trip.

TASK SHEET 1 /...

TASK SHEET 1 : GROUP ONE AND TWO

SECOND FIELD TRIP TO GLENCAIRN.

Littering is one of our social problems today. Your special task is to survey the litter along the coast for 300 metres in each direction from the base of operations.

1. Group 1 will work back towards Glencairn. Group 2 will work on towards Simonstown.

2. Each group will divide into two teams. One team will cover the shore, the other team will cover the land between the shore and the road. (Beware of the railway line).

3. Each team will carry a black plastic garbage bag labelled shore or super-shore. Have a supply of sandwich bags to put smaller loose items into e.g. broken bottle.

4. Pick up every man-made artifact you can find.

5. Make a rough sketch map of your area and mark in where you found concentrations of litter. e.g. a pile of cigarette butts, or a pile of beer cans.

6. Collect an throw away any foam balls you find from our previous field trip. They will not be regarded as regular litter for the purpose of this survey.

7. Make notes on the type of litter you collect in different places and try to guess the sort of person who left the litter behind.

e.g. Beercans on rocks - fisherman?
Papers on line - train commuters?
Wine bottle in grass - vagrant?

Note where there are concentrations of litter and account for them.

8. Note the position of municipal litter bins and comment on their adequacy.

---

9. When you return to the laboratory you will be expected to prepare a combined sketch map of the area giving details of where most litter is found or where special types of litter are found.

10. Prepare a wall chart that lists the predominant types of litter on:

a. The rocky shore
b. The beaches
c. The land above the shore below the railway line
d. The land below the road above the railway line.

11. Prepare a report for the class on the nature of the litter in the study area; who the litterers are likely to be; the likely effects of the different kinds of litter on the shore and super-shore life, including human beings.
Comment on the measures taken by our legislators to control littering of the shore.

12. Display your shore and super-shore litter.

For further information see:

1. The Sea-Shore Act (1935) paragraph 10.
2. The Sea Fisheries Act (1973) paragraph 16.
3. The Water Act. (1956) paragraph 23.

Photocopies of these acts are available in class.

EQUIPMENT LIST; (Complete this yourselves.)

FIELD-TRIP

1. 4 Black Garbage Bags
2. Sandwich bags
3. Note paper.

LABORATORY INVESTIGATION

1. 4 large sheets of white paper stuck together.
2. Poster card.
3. Display table.

TASK SHEET 2 : GROUP THREE AND FOUR

SECOND FIELD TRIP TO GLENCAIRN.

The South African Railways is an important link between Simonstown and the rest of the Peninsula. Your special task is to assess the impact of the S.A.R. on the study for 300 metres on either side of the base of operations.

1. Group 3 will work back towards Glencairn. Group 4 will work on towards Simonstown.

2. Take special care to walk well clear of the line at all times and remember that rains move along the line in both directions. Take a whistle with you to warn all members of the group as soon as you see a train approaching.

3. Prepare a sketch map of the use the railways make of this coastal strip.
Note the following aspects particularly:
   a. Where the environment has been modified to suit the railway line (e.g. embankments, reinforcement.)
   b. Where the railway line has been modified to suit the environment. (e.g. culverts.)

4. Make notes of any possible effects the railway could have on animal life in the area.
   (e.g. nesting birds etc.
   air pollution from brake dust.
   accidental fires.)

5. When you return to the laboratory you will be expected to prepare a combined sketch map of the area giving details of the items noted in point 3.

6. Prepare a brief report on the possible effects of the railway line on the coastal strip under consideration.

Include/...

Include the following in your report:

a. The number of trains per week.

b. The busy and lull periods during the 24 hour day.

c. The effect of the trains on bird life.

d. The number of steam locomotives on the line per week.

e. The number of commuters who use the trains and what alternative means of transport are available.

EQUIPMENT LIST: (Complete this yourselves.)

FIELD-TRIP

1. Whistles
2. Note pads
3.

LABORATORY INVESTIGATION.

1. Sheets of white paper
2. Train time-table
3.

TASK SHEET 3/...

TASK SHEET 3 : GROUP FIVE

SECOND FIELD TRIP TO GLENCAIRN

The disposal of sewage is an ever increasing urban problem. Your special task is to survey the shore and establish how the local community's solution affects the study area.

1. Prepare a rough sketch map of the area between the shore and the road marking in only the surface pipes, outlets and large septic tanks on the point. Work 300 metres in both directions from the base of operations. (Keep clear of the lines.)

2. Try to establish which pipes are water mains and which are sewers.

3. Note how the overflow of the septic tank has been damaged. What does this suggest to you about the siting of such engineering works? Get the photographer in Group 8 to take a photograph for your report.

4. If the sewer or effluent reaches the seawater, where will the prevailing current carry the wastes to? Are there any leisure facilities near by?

5. Drop a teaspoon of dye (methylene blue or brighter fabric dye) into the sea at these points to establish the direction of drift. (Take care of your clothes and hands.)

6. If you have any time left over visit a few of the houses on the other side of the main road and ask them if they are connected to the municipal sewers or have private septic tanks or french drains. (Make sure that you report to the teacher before leaving the study area.)

---

7. When you return to the laboratory you will be expected to prepare a sketch map of the area surveyed showing all the details listed in point 1.

8. Prepare a brief report on the possible effects of sewage disposal on public health and leisure facilities.

Include/...

Include the following in your report:

a. The effects on leisure facilities.

b. The effects on public health.

c. The legal situation.

d. Alternative treatments and solutions.

For further information see:

1. The Water Act (1956) paragraph 22 and 23.

2. The Public Health Act (1919)

These photocopies are available in class.

EQUIPMENT LIST: (Complete this yourselves.)

FIELD-TRIP

1. Dye
2. Note paper

LABORATORY INVESTIGATION

1. Books on sewage treatment.
2. Sheets of white paper.

TASK SHEET 4/...

TASK SHEET 4 : GROUP SIX

SECOND FIELD TRIP TO GLENCAIRN.

At at least one point on the coast a municipal septic tank is leaking effluent into the inter-tidal zone. It will be your task to investigate the affects of this effluent on the shore animals.

1. Take special care and handle equipment with a pair of rubber gloves to avoid any health risk.

2. Trace the course of the leak from the broken pipe through the shore to the sea.

3. How does this section of the rocky shore compare to the study area.
Do you notice any unusual species of plants or animals in the polluted water or species which are uncommonly abundant?

4. Compare the specimens in the polluted water with those on the shore nearby.
Are any species present on the shore missing in the polluted water?

5. Carefully collect a litre bottleful of the effluent wastes leaking from the pipe and screw the lid on firmly. Wash the outside of the bottle in clean seawater. Wrap it carefully in many layers of newspaper; place it in a tog-bag and take it back to school.

6. Collect a large plastic jerry can half full of fresh sea-water from the pool to take back to school.

7. Collect 30 large and 30 small periwinkles from the shore at a point where there is clearly no pollution. Transport them back to school inside the jerry-can of sea water.

8./...

8. When you return to the laboratory set up 3 tiny glass tanks each containing 10 large and 10 small periwinkles.
Label A - THE CONTROL and add 1 litre of fresh sea water to it.
Label B - MILD SEWAGE POLLUTION and add ¼ of your effluent solution to 1 litre of seawater.
Label C - STRONG SEWAGE POLLUTION and add the remainder of your effluent solution to 1 litre of seawater.

9. Leave the tanks standing overnight.

10. Tap each snail with a glass rod next day. Those that are adhering to the tank are considered to be healthy. Those that are loose and unattached or fall off without reattaching themselves are considered dead or dying. Calculate the % dead or dying in each tank, for small and large periwinkles after 24 hours.

11. You will be required to present a short report on the effects of sewage pollution on the rocky shore for your class.

Your report should include:

a. The observed abundance or absence of animal and plant species in polluted water.
b. The results of your tests with two species of periwinkles, and sea urchins.
c. The way in which poisons (sewage) enters and is spread through the marine food chains.
d. The legislation affecting water pollution of the seashore.

For further information see:

1. The Sea Fisheries Act (1973) paragraph 16.
2. The Water Act (1956) paragraph 23.
3. Simmons I.G., The Ecology of Natural Resources (1974) p. 240
4. Brown A., "The Fight to control the fouling of our seas." U.C.T. Vol. 5. No. 5 (1978)

These photocopies are available in class.

EQUIPMENT/...

EQUIPMENT LIST: (Complete this list yourselves.)

FIELD TRIP

1. Gloves
2. Litre bottle
3. Plastic Jerry-Can

LABORATORY

1. 3 small glass tanks
2.
3.

TASK SHEET 5 : GROUP 7

SECOND FIELD TRIP TO GLENCAIRN

Often unsightly buildings or poor maintenance can spoil the natural beauty of the environment. It is your special task to survey the study area for 300 metres along the coast in both directions to assess the extent of environmental marring in this area.

1. Prepare a sketch map of the surroundings and indicate on it any eyesores or poorly maintained structures, or abandoned wreckage.

2. Make notes on your survey of why you consider each point plotted to be an example of marring (spoiling).

3. Make recommendations as to suitable facilities at the pool, at the septic tanks.

4. Are there any structures that should have been demolished years ago?

5. To what extent do the overhead wire supports on the railway line mar the environment? Could we do without them?

6. Get the photographer from group 8 to take a few photographs to illustrate your report.

---

7. When you return to the laboratory you will be required to present a brief report on "ENVIRONMENTAL MARRING AT GLENCAIRN", and an illustrated sketch map of conditions now and your proposals.

Your report should include:

a. Conditions to be improved
(e.g. Rural walk with benches,
provision of litter bins,
Seeding with wild flowers,
Grassing over of septic tanks.)

b./...

b. Conditions to be corrected.

(e.g. Repair of sewage pipe , maintenance of toilets.)

c. Conditions to be prevented.

(e.g. Risk of oil pollution from harbour. Veld fires from steam locomotives.)

d. Conditions to be accepted.

(e.g. Importance of railway line. Shortage of capital for development.)

EQUIPMENT LIST: (Complete this list yourselves.)

FIELD-TRIP

1. Note paper
2.
3.

LABORATORY INVESTIGATION

1. Sheets of white paper.
2.
3.

NOTE.

See extract from the report of the Prime Minister's Advisory Council (Pollution Subsidiary Committee) Environmental Marring.

TASK SHEET 6/...

TASK SHEET 6 : GROUP 8

SECOND FIELD TRIP TO GLENCAIRN.

From time to time this area is used by many people for widely differing purposes. Some of the uses are obviously official e.g. Naval Shore Battery, Railway Line, Pool and Sewage Disposal facility.

However there are clues to unofficial uses that also must affect the beauty and usefulness of the area, if not it s animal and plant life as well. It is your special task to survey the area for such unofficial uses.

1. Cover the area 300m on either side of the base of operations.

2. A good place to start is with the tracks and paths; follow them to see where they go. Assess their useage by their width and trampled condition. What purpose do they serve? How would they affect the animal life and bird life in this area?

3. Are there any boats on the beaches? What purpose are they used for?

4. Check with Group 1 and 2 who are doing the litter survey. Have they got any suggestions to make about general uses of special areas?

5. Check out spots that would look attractive to rock anglers.

6. Are there any signs of rubbish dumping or rubble tipping?

7. Are there any boat ramps or tracks made by four-wheel-drive vehicles? Why should such vehicles move in this area?

8. The photographer in your group must be constantly available to take photographs for other groups.

9. On returning to the laboratory you are to compile a very brief report on your findings to the class. The film is to be handed in for developing today!

10/...

10. Your group has also been given the special task of preparing a report on " CULLING THE SEAL ISLAND SEALS ".
A series of newspaper cuttings are available in class and also the "Sea Birds and Seals Protection Act"(1973).

Approach the topic from 4 different directions (one per each member of the group.)

a. The seal cullers' point of view.
b. The local fisherman's point of view.
c. The animal lover's point of view.
d. The conservationist's point of view.

EQUIPMENT LIST: (Complete this list yourselves.)

FIELD-TRIP:

1. Camera and B and W film (20 exposures.)
2. Note paper.

LABORATORY INVESTIGATION:

1. Newspaper cuttings
2. Act (1973).

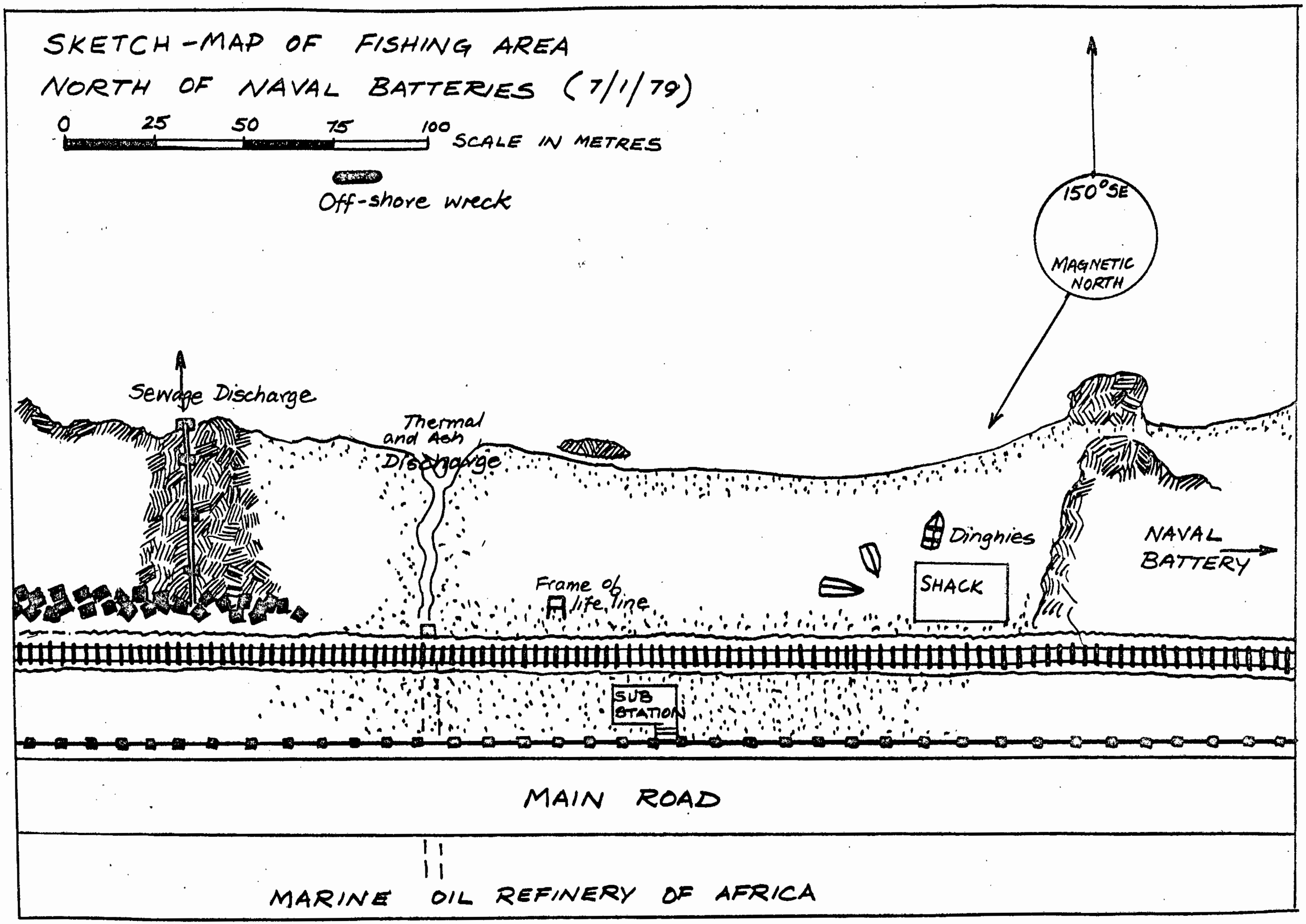
TASK SHEET 7: GROUP 9

SECOND FIELD-TRIP TO GLENCAIRN

It often happens that there is a conflict of interests relating to the use of the shore. It will be your task to assess the degree and significance of industrial pollution in the study area and its possible effects on the local trek fishermen.
When you reach Glencairn, move quickly down to the small beach north of the Naval Batteries just opposite the Marine Oil Refinery of Africa Pty. Ltd.
Consult the sketch map provided and identify the main features in the area.

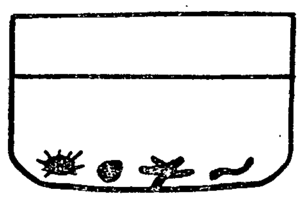
1. Take off your shoes and walk through the stream of water running through the beach area to the sea. How does it differ from normal streams? Establish the origin and function of this water.
2. Take a series of temperature readings from the water's edge to the mouth of the outlet pipe at two metre intervals. Use these figures to estimate the temperature of the water when it leaves the factory premises across the road.
3. Check the shore line for signs of black soot or ash. Dig a hole just above the water line and try to assess the effectiveness of the tides in carring this ash away.
4. Walk along the shore for an equal distance on each side of the outlet pipes discharge. Note the condition of the animals colonising the rocks. Is there a fairly barren area near the discharge point or not ? How do these rocks compare to the rocks further along the shore that also flank sandy (though unpolluted) beaches ?
Consider the effects of the ash that cannot be observed below the tide line, and its effects on the fauna and flora that attract feeding fish to this beach.
5. Collect a large thermos-flask full of hot water and a sample of heavily polluted sand (sand with a blackish tinge) and take them back to school.

6./....


SKETCH-MAP OF FISHING AREA
NORTH OF NAVAL BATTERIES (7/1/79)
0
25
50
75
100
SCALE IN METRES
Off-shore wreck
150°SE
MAGNETIC NORTH
Sewage Discharge
Thermal and Ash Discharge
Frame of life line
Dinghies
SHACK
NAVAL BATTERY
SUB STATION
MAIN ROAD
MARINE OIL REFINERY OF AFRICA

A119a

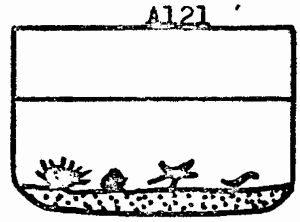
6. Also collect at the low tide in a richer, unpolluted area, nearer the pool, eight specimens of each of the following animals:-
   Bristle worms, large and small Periwinkles, Starfish, and Sea Urchins.
7. Take these animals back to school in a large sea-water container. Take care to store them in the shade as they die quickly if the water overheats.
8. You will also need a further quantity, say half a large plastic jerry-can , of fresh sea water for laboratory uses.
9. It only remains for you to interview any of the local trek-fishermen who practise seine fishing from this beach.
   Find out:
   (i) What equipment they use and try to estimate the extent of their financial commitment to making a living on this beach.
   (ii) Where they live and why they have to fish so far from home.
   (iii) What types of fish they catch.
   (iv) Whether more fish used to be caught from this beach before the Marine Oil Refinery started discharging ash and hot water into the sea.
   (v) Whether or not they have to pay for their use of the beach (e.g. licence fees etc.)
10. Which group of interests, the factory or the fishermen, is, in your opinion, likely to be able to exert more influence on the Municipality of Simonstown, and why?
11. What does the life-saving gear, now fallen into disuse, suggest about this beach as a leisure facility?
12. When you get back to school put all your specimens in a tank of seawater and aerate to keep alive until the next day.
13. Next day discard any dead animals and set up four small glass tanks asfollows, placing two specimens of each type in each tank, if possible. Cover the animals with two litres of seawater in each case. Label the first tank - CONTROL (Unpolluted).



CONTROL

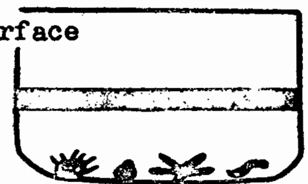
14./....

14. Add a two centimetre layer of polluted sand to the bottom of the second tank, making sure the animals are not smothered. Label the second tank - ASH POLLUTED.



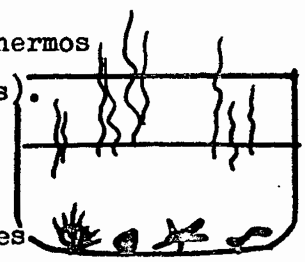
ASH POLLUTED

15. Add 100 ml of crude oil supplied to the surface of the third tank (33). Label the third tank - OIL POLLUTED.



OIL POLLUTED

16. Remove the fresh seawater from the fourth tank and pour the water collected in the thermos flask on the animals(approximately 2 litres). Label the fourth tank - HEAT POLLUTED. (It may be necessary to warm the water up to its original temperature when it reaches the shore.)



HEAT POLLUTED

17. Aerate all four tanks simultaneously for twenty-four hours.

18. Next day tap all specimens with a glass rod. Specimens that cannot adhere to the glass or move feebly are considered to be dead or dying. Compare your results for all four tanks, making careful notes. What can you conclude from these experiments ?

19. Prepare a report for the class on the impact of industrial pollution on the shore life at Glencairn.
    Your report should include:
    (a) The effects of heat, ash and oil discharges and pollution on rocky shore animals.
    (b) The possible effects of the Marine Oil Refinery on the livelihood of the trek fishermen.
    (c) The threat of large scale oil pollution on our shores and the preventative measures being taken to prevent it.

For/....

Oil pollution experiment adapted from:

33. De G. Griffith D. "Toxicity of crude oil and detergents to two tidal species of edible molluscs under artificial tidal coditions." In <u>Marine Pollution and Sea Life.</u> Ruivo M., (ed.)

For further information see:

1. Blumer M. Oil Contamination and the living resources of the Sea. (1972)
2. Blumer M. Oil Pollution of the Ocean (1969)
3. Brown A. The Fight to Control the Fouling of our Seas. (1978)
4. Holcomb R. Oil in the Ecosystem (1969)
5. Sharp P. Save our Seas (1978)
6. Report of the Prime Ministers Advisory Council (Pollution Subsidiary Committee) Marine Pollution.(1974.)

Photocopies of all these articles are available in class.

EQUIPMENT LIST: Complete this list yourselves.

FIELD-TRIP

1. Container for polluted sand.
2. Plastic jerry can to hold about 20 litres of seawater.
3. Large container for live animals,
4. Two litre thermos-flask.
5. Centigrade thermometer.
6.

LABORATORY INVESTIGATION

1. Four glass tanks.
2. Crude oil sample.
3. Air pumps.
4. Glass rods.
5.

G. UNIT 5/...

G. UNIT 5

THE FOLLOW-UP OF THE SECOND FIELD TRIP

METHOD: Groups investigate data and materials gathered on shore during field trip and present reports. Class debate courses of action and consequences. Teacher sums up all discussions.

ESTIMATED TIME:

17 periods.
(5 periods for investigation.)
(12 periods for reporting and summarising.)

INFORMATION SHEET 12

LABORATORY FOLLOW-UP TO FIELD-TRIP TWO

This information sheet should be supplied to all groups.

Yesterday we surveyed the impact of human usage of the coastline south of Glencairn station. Tasks were assigned and questions asked which you must now begin to complete in your groups.

The next few biology periods will be devoted to completing the tasks assigned and preparing class reports.

THINGS TO DO:

1. Read over your task sheet again and make a list of the things you have to do.

2. Divide these activities up among as many as possible, if possible, so that you do not waste any time. Each person in the group must be responsible for something.

3. If your report involves a lot of library research, you will have to bring the books to class or use your own time to complete your reading. Most of the recommended books are available in class on request.

4. Here is a full list of all the work to be prepared for next week's report-back sessions:

Table 10./...

GROUP	LAB. WORK	REPORT-BACK
1 + 2	Sketch-map of litter distribution. Wall chart of litter distribution. Display of litter.	Litter on the coast and it s effects.
3 + 4	Sketch-map of the S.A.R. impact on this area.	The impact of the S.A.R. on the coast strip south of Glencairn.
5	Sketch-map showing drainage and sewerage.	The effects of the sewerage system on public health and leisure facilities.
6	Experiment with the sensitivity of selected animals to sewage pollution.	The effects of sewage pollution on shore life at Glencairn.
7	Sketch-map locating examples of environ-mental marring. Illustrate with photographs.	Environmental marring on the coast at Glencairn.
8		Casual uses of the coastal belt. The culling of the Seal Island seals - Right or Wrong?
9	Experiment with the sensitivity of selected animals to industrial pollution	The threat posed by industrial pollution on the coastline

Table 11. Follow-up Assignments

5. All reports and investigations must be completed by

   ....

6. The reports must be written-up and handed in after each report-back with the names of the group members on each report.
7. Divide up your tasks now and start immediately.

A GUIDE TO THE TEACHER IN HANDLING THE SUMMARIES TO EACH REPORT.

Time allocation. It is anticipated that 4 periods will be sufficient for all groups to complete what will be essentially very brief but factual reports. The delivery of these reports to the class should in reality take much longer, say 12 periods.

Here the teacher's role in summarising is all important. Preferably the summaries should be integrated with the reports. This is the value-formative part of the programme. Issues demanding opinions and attitudes should be raised wherever possible.

The teacher should strive to stimulate debate and make sure that the class consider all angles in any given situation. The class should be constantly encouraged to propose solutions to existing problems identified in their reports. The consequences of such action should be carefully considered. Try to get class members to commit themselves to one side of the argument or the other, by show of hands, open debate, or secret ballot. They must be as mentally and emotionally involved in each issue, as if they were residents in the Glencairn area at a public meeting.

Do not avoid contentious issues or criticisms but stress the democratic process of solving problems in the light of economic realities.

In this respect this course is totally different from all other approaches to Biology teaching and the broad objective of responsible citizenship emerges clearly. It is also anticipated that the extremely high relevance of the situation for the pupils will ensure a continuing interest in the subject matter.

The content of the summaries should be varied and several different value-formative methods can be applied:

Table 11./...

GROUP	FOLLOW-UP SUMMARY
1 + 2	The class propose measures to control littering at Glencairn, and constructs a code of conduct for people using the area.
3 + 4	The class debate the desirability of maintaining a railway link with Simonstown.
5	The class propose (as if at public meeting) action to be taken as regards the disposal of sewage in the area. They also evaluate the consequences of such action.
6	The film: "<u>Our vanishing wilderness</u>" PS 951c 30 minutes, is screened. The effects of poisons in the ecosystem is discussed and the role of vested interests considered. (See Information Sheet 13)
7	The class vote improvements in the area. Considering the costs and means of raising necessary finance.
8	The film: "<u>Seal Island</u>" PS 521 25 minutes or "<u>The Fur Seal</u>" PS 353 10 minutes is screened. The various attitudes and interests in seal culling are debated and a vote taken on action in future years.
9	The teacher introduces the topic of conservation in the seas and the use of marine resources. (See Information Sheet 14)

Table 12. The Content of the Summaries.

Table 13/...

Table 13. <u>Equipment to be supplied by the teacher for laboratory investigations.</u>

ITEM	SOURCE	GROUP
Sheets of white paper (20)	Stationary stock	(1,2,)(3,4)5,7
Sheet of Poster card	Stationary purchase	(1,2)
6 Glass tanks	Stock or borrow.	6,9
Crude Oil	Caltex Refinery (or local garage.)	9
Rubber tube	Stock	9
Glass rod	Stock	9

N.B. Arrange with office to reimburse for the cost and developing film used on field trip, out of school funds.

A FINAL REMINDER

Please do not loose sight of the purpose of this programme. Remember it is not the teacher task to tell the children what to believe; that is <u>indoctrination</u>.

Rather it is your task to create situations that allow the children to form their own opinions; that is personal <u>value-formation</u>. It is not necessarily desirable that all your pupils should reach consensus on anything at all, as long as they all have a rational, responsible opinion of their own.

INFORMATION SHEET 13/...

INFORMATION SHEET 13

POISON IN THE ECOSYSTEM - Show the film recommended in Table 11, then read this adaptation from Silent Spring.

A Fable for Tororrow

(with apologies to Rachel Carson.)

There was once a seaside village on the coast of False Bay, where all life seemed to live in harmony with it s surroundings.

The town lay on a wagon track between a large city and a seaport town, between the mountains and the sea. In spring white clouds drifted across the water and above the mountain behind the town. In autumn gentle rains turned the mountain slopes green with vigorous new life. The steenbok stood on the rocks watching the gulls wheeling above the shore.

Along the coast, sugarbirds played in the proteas and baboons begged food from kindly travellers. Seabirds nested in the heath and reed grass grew **on the fringe of the shore. The area was famous for it s abundance and variety of wild flowers and birds. Many of the local people enjoyed catching the silvery fish that sported along the rocky coast in the forests of sea bamboo. Others enjoyed walking alone in the fresh sea air and enjoying communion with the wildflowers and birds along the coast or on the mountain slopes. So it had been for a long time after the first few farmers arrived to till the soil in the tiny valley behind the town.**

Then a strange blight crept over the area and everything began to change. A railway line was built from the city to the seaport town. The trains scared most of the birds away and intermittent fires killed the proteas and heath until nothing but weed grasses remained, choking all natural vegetation and providing no food for the lovely sugar birds and berry hunters. A hard tar road was built past the village, and the steenbok and tiny veld animals were often killed by speeding cars until none appeared at the village anymore.

The/...

The railway brought people to the town who liked to fish, but as it also brought others who left their rubbish in the grass and rock pools, slowly the pools were poisoned by the rotting rubbish. There was now less fish food and the fish began to disappear. More people came to live in the village and large septic tanks had to be built on the rocks emptying into the sea. Sometimes the excess flowed into the sea and was carried to the tidal pools where children swam, or was eaten by tiny animals that were eaten by the fish and gulls in turn. The farmers had to grow more food so they set traps for the baboons and dassies until there were no more in the area. When the hungry leopards and lynx attacked their sheep they shot them. When caterpillars attacked their crops they sprayed them. Streams carried the poisons down to the fish in the sea; the gulls' eggs would not form shells. There were fewer gulls next year. In the town the doctors had become more and more puzzled by new kinds of sickness appearing among their patients. There were several sudden and unexplained deaths, not only among adults but even among children.

There was a strange stillness. Only one or two listless gulls sat on the rocks. The fishermen complained that it was much harder to catch a fish nowadays. They felt that the nearby seals were to blame so thousands of seals were shot to allow the fish a chance to recover. It didn't help; there were still very few fish, but the number of sharks did increase. Several bathers were eaten by sharks. In spring the farmers were dismayed, the hens brooded but there were no chicks, the apple trees blossomed but there were no bees and so there was no fruit.

The brown grass on the coast was lifeless, no birds sung, the animals moved, no fishermen visited the shore, no holiday-makers swam at the beaches. Dead birds, fish and oil floated at the water's edge.

No witchcraft, no enemy action had silenced the rebirth of new life in this stricken world. The people had done it themselves.

Discuss/...

Discuss with the class the stage in this story that Glencairn has reached at present.

Read the story of Clear Lake from Silent Spring to the class to illustrate the accumulative effects of poisons in the ecosystem. (Silent Spring p. 56 to 58) (34)

Relate this story to the South African situation. Prepare yourself by reading the photocopy supplied:

Oliff W.D. Marine Pollution (1977) (35)

Point out that coastal city dwellers are at special risk.

From:

34. Carson R. Silent Spring (1966)

35. Oliff W.D., "Marine pollution". In Oceanography in South Africa (1977)

INFORMATION SHEET 14

RESPONSIBLE USE OF THE SEA

1. Irresponsible Use - Pollution

a. Extract from The Ra Expeditions - Thor Heyerdahl(36)

p.234

"Next day we were sailing through an ocean where the clear water on the surface was full of drifting black lumps of asphalt, seemingly never ending. Three days later we awoke to find the sea about us so filthy that we could not put our toothbrushes in it .... The Atlantic was no longer blue but grey-green and opaque, covered with clots of oil ranging from pinhead size to the dimensions of the average sandwich. Plastic bottles floated among the waste.

p.345

....Yet oil pollution was not modern man's only gift to the sea. As we kept a lookout scarcely a day passed with some form of plastic container, beer-can, bottle or more perishable materials such as packing-cases, cork or other rubbish drifting close by Ra II's sides."

Pollutants/...

---

36. Heyerdahl T., The Ra Expeditions (1970)

Pollutants that cause special problems in the sea are radio-isotapes, industrial effluents, oil, persistent pesticides, untreated sewage, fertilizer run-off and detergents. They all affect our coastal water markedly.

2. Irresponsible Use - Exploitation.

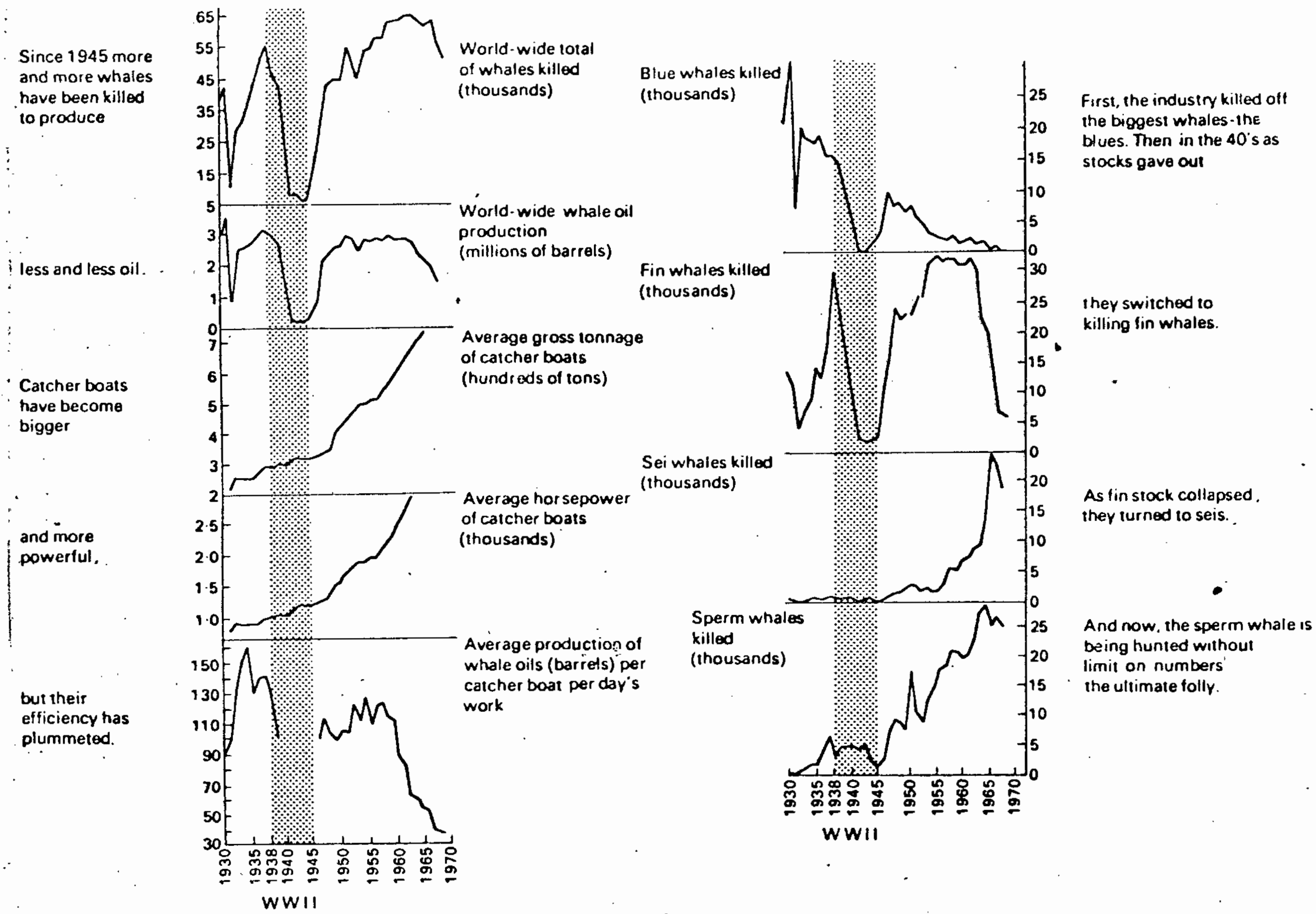


Fig. 35 The Whales are being systematically exterminated. (Simmons 37)

Make a transparency of this chart and discuss it with the class.

Could/...

37. Simmons I.G. The Ecology of Natural Resources. (1974)

Could this decline account for the abandoned Whaling stations at Donkergat (Saldanha Bay) and on the Bluff (Durban)?

Local examples of exploitation.

a. The collapse of the West Coast Pilchard Industry.

"Less known but as fatal was the collapse of our own West Cape pilchard resources which yielded 450 000 tons of pilchards a year at the beginning of the past decade and only one tenth of this amount at the end of the decade." (Lochner 38.)

Why did this resource collapse?

b. The culling of fur seals that have the best marketable pelts?

See the "Sea Birds and Seals Protection Act." (1973) (39) Photocopy available.

3. Responsible use - Seaweeds.

Note importance of the seaweeds in industry.

See the photocopy "SeaWeeds in the affairs of man." Simmons R.H. (40)

Fig. 36/...

38 Lochner J.P.A., "The exploitation of marine resources" In : Habitat RSA (1971)

39. The Statutes of the Republic of South Africa. The Sea Birds and Seals Protection Act. (1973)

Fig. 36 The Uses of Kelp

(Simmons 40)

40. Simmons R.H. "Seaweeds in the affairs of man". Veld and Flora. 1977.

Fay Anderson's watercolour is of Ecklonia maxima, the common kelp of the west coast, also known as the sea trumpet or sea bamboo.

Table 1: Alginic Acid and its Derivatives

Activity	*Use*
Chemical Industry	To make transparent plastic films; opaque soluble paper; dispersal and stabilizing agents for pesticides, insecticides and film-makers; to make special lubricants particularly for arc-welding rods; for rubber latex flotation; to make linoleums; wood and leather preserving; floor polishes and water-proofing treatments; artificial wood; emulsion stabilizers of liquid gas, liquid/solid and liquid/liquid preparations; etc.
Mining Industry	Flotation of ores; lubricating of drills.
Paint Industry	Emulsifier for water paints; emulsifier of vinyl-resin paints; to make lacquers and varnishes.
Building Industry	Water-proofing of cement, concrete and bricks; fire-proofing; as lubricant for moulds.
Paper Industry	High class finishes; grease-proofing; to make glues for cardboard manufacture.
Printing Industry	Dispersal agent in roller, screen and rotary screen processes; thickener of inking agents.
Textile Industry	Dye-printing; as a 'scaffolding' ('vanishing') thread in weaving ultra lightweight cloth or open-work effects; as a mordant in dyeing a variety of materials including wool; as an automatic separator between segments of a continuous series of machine-knitted garments; waterproofing and fire-proofing of textiles.
Pottery Industry	Stabilizing pigments and to make glazing suspensions.
Photographic Industry	To make heat-resisting emulsions.
Medicine	Carrier for antibiotics; soluble dressings and filaments; dressing for bone-grafts to hasten healing; blood-plasma substitute; antidote for strontium and lead poisoning; antilipaemics; anticoagulents.
Food Industry	Dietetic foods; artificial creams; icecream stabilizer; texture thickeners; stabilizing solid/liquid mixtures; fish and meat canning matrices; mayonnaises; chocolate suspensions in milk, etc; in jellies and custard powders; beer foam stabilizer; sausage skin substitute; etc.
Agriculture	Soil conditioner; water-loss prevention from roots during transplanting operations; dispersing agent for insecticide and fungicide sprays; improving tenacity of materials sprayed on to foliage.
Cosmetic Industry	Dispersal agent; perfume fixing; emulsifier and texture thickener; wetting agent in shampoos and lotions.
Pharmaceutics	Tablet binding material especially for rapid disintegration in water; ointment base; capsule case material; barrier creams; toothpaste texturizer.
Dentistry	Mouth moulds with plasticity; denture fixatives.

Conservation Measures.

See "The Sea Fisheries Act " (1973)

Sub section 12,13 and 16
for details of control measures in fish, shell and seaweed exploitation.

SPECIES	Minimum size	Closed season	Maximum per person
Black mussels	-	-	25
Red Bait	-	-	1,8kg
Bristle Worms	-	-	20
Octopus	-	-	2
Sea Urchin	-	-	20
Shore Crab	-	when in berry	15
Limpets	-	-	15
Periwinkle	-	-	50
Crayfish	88,9 mm cephalothorax	July to October	5
Perlemoen	114,3 mm	-	5

Table 14. Conservation Measures relating to the Rocky Shore.
(Department of Industries - Sea Fisheries' Branch.)

F. BOOKS, PHOTOCOPIES AND CUTTINGS FOR USE IN CLASS.

A. BOOKS AVAILABLE FOR USE IN CLASS

(These books may not be removed from the laboratory.)

1. Carson R., (1961):
   Silent Spring.

2. Chapman G, and Barker W.B., (1964):
   Zoology.

3. Day J.H., (1969):
   A Guide to Marine Life on South African Shores.

4. Mclachlan G.R., and Liversidge R., (1961):
   Roberts' Birds of South Africa.

5. Winterbottom J.M, and Uys C.J., (1969):
   Some Birds of the Cape.

6. Yonge C.M., (1949)
   The Sea Shore

B. PHOTOCOPIES AVAILABLE FOR USE IN CLASS

(These photocopies may not be removed from the laboratory.)

1. Blumer M., (1972):
   Oil Contamination and the Living Resources of the Sea.

2. Blumer M., (1969):
   Oil Pollution of the Ocean.

3. Brown A.C., (1978):
   The Fight to Control the Fouling of Our Seas.

4. Farb P., (1965):
   A Wave-Swept Home.

5. Holcomb R., (1969):
   Oil in the Ecosystem.

6. Newell R.C. (and G.E.,) :
   Marine Plankton. A practical guide. (1973)

7. Oliff W.D., (1977):
Marine Pollution

8. Sharp P., "Save our Seas" *Reader's Digest.* Vol. 113. 1978.

9. Simons R.H., "Seaweeds in the Affairs of Man." *Veld and Flora* 1977.

10. Simmons I.G., (1974)
The Ecology of Natural Resources.

11. Statutes of the Union of South Africa.
The Public Health Act (1919)

12. Statutes of the Union of South Africa.
The Sea-Shore Act (1935)

13. Statutes of the Union of South Africa.
The Water Act (1956)

14. Statutes of the Republic of South Africa.
The Sea Birds and Seals Protection Act (1973)

15. Statutes of the Republic of South Africa.
The Sea Fisheries Act (1973)

16. Report of the Prime Minister's Advisory Council (Pollution Subsidiary Committee):
Environmental Marring. 1974

17. Report of the Prime Minister's Advisory Council (Pollution Subsidiary Committee):
Marine Pollution 1974.

C. NEWSPAPER CUTTINGS AVAILABLE FOR USE IN CLASS.

(These will be pinned up for display. Photocopies are also available.)

1. Death Warrant on 75,500 S.A. Seals.
2. Seal's Death-Knell.
3. Seal Killing for Cash-Expert.

4. 'Cruel and senseless slaughter' of seals.
5. Sealskins could earn R50 000.
6. Brigitte Bardot phones in bid to rescue seals.
7. Brigitte's got it wrong, say seal men.
8. Don't kill the seals, 60 pupils plead.
9. Killing animals for commercial gain.
10. Poison pen letters for seal culler.
11. The seal slaughter begins.
12. Seaweed Farming.
13. The sneaks who pilfer pilchards in False Bay.
14. Island cats kill 50 000 sea birds a year.
15. West coast mussels to be checked.
16. Duisende dooie mossels op Kaapse strande.

I. ADVANCE FILM-ORDER LIST.

Films in Unit 1 (1st week)

1. What is Ecology (PS 762)
2. Animals of the Rocky Shore (PS 130)
3. The Community (PS 773)

Films in Unit 5 (8th week)

1. Our Vanishing Wilderness (PS 951c)
2. Seal Island (PS 521)

   or

   The Fur Seal (PS 353)

APPENDIX B:

SCALES AND TABLES OF RESULTS

THE ITEM POOL

The six aims of the Biology Syllabus were expanded into 84 intermediate affective objectives from which 166 attitude statements were constructed (hereafter called items). Each intermediate affective objective could be classified according to Blooms' Affective Domain Taxonomy.

ATTITUDE SCALE A. BIOLOGICAL RELATIONSHIPS

Aim on which this scale is based: To guide pupils to an understanding and an appreciation of the interdependence of living things (especially man) and their relationship to the physical environment. (THE ECOLOGICAL AIM)

F = A positive response is deemed favourable.
U = A negative response is deemed favourable.

INTERMEDIATE AFFECTIVE OBJECTIVES	ITEM POOL	RESPONSE
1.0 RECEIVING		
1.3 The pupil is sensitive to the interrelationships between all living things in their environment.	1. The more cats, dogs and children; the fewer the birds in the neighbourhood.	F
	2. Birds have no special preference for sitting in or visiting particular trees in our garden.	U
1.3 The pupil is aware of man's influence on living things and their environment.	3. More animals disappear from an area as a result of gardening than through hunting.	F
2.0 RESPONDING		
2.2 The pupil acquires an interest in all living things and how they relate to him.	4. It is a shame to kill snakes, they are so useful.	F
	5. Many plants and animals are of no use at all.	U
2.3. The pupil enjoys learning about the interrelationships between all living things and their environment.	6. Its fun to explore rock-pools at the beach.	F
	7. I couldn't care less about what an octopus eats.	U
2.3. The pupil develops a keen interest in discovering the habitats that living creatures occupy.	8. I would enjoy going on a field trip to hunt for different types of animal homes.	F

INTERMEDIATE AFFECTIVE OBJECTIVES	ITEM POOL	RESPONSE
	9. If I found a trail of ants in the garden, I would follow it to see where it ends or begins.	F
3.0 VALUING 3.1 The pupil believes that it is important to preserve the total environment of all animals and plants where possible.	10. Large parts of our country should be set aside unspoiled for wild animals and plants.	F
	11. It would be a good idea to convert the land wasted in game reserves into state farms to provide cheap food supplies for the needy in the townships.	U
3.2. The pupil assumes an active role in helping to preserve a threatened habitat.	12. Schools should accept the challenge of clearing the veld in specially allocated areas of all alien weeds (like Hakea etc.)	F
	13. I don't feel responsible to pick up the litter that others leave lying around picnic spots.	U
3.3 The pupil is convinced of the worth of trying to preserve a threatened ecological habitat.	14. People caught littering beaches should be banned from using them, for a year.	F
	15. People entering forestry areas should be made to leave their cigarettes, pipes, matches and lighters with the local forester.	F

4.0 ORGANISATION 4.1 The pupil forms judgments about society's responsibilities regarding nature conservation.	16. When the need for culling (thinning out an animals population) arises, the animals with the most economically profitable skins should be killed.	U
	17. There is no need for dogs in Cape Town to be licensed.	U
4.2 The pupil accepts the fact that often human needs must take priority over the maintenance of natural habitats.	18. The cable-way has improved Table Mountain as a public amenity by making it more accessible to all.	F
	19. Oil tankers should be banned from passing around Cape Point because of the risk of oil pollution on our beaches and damage to marine life forms.	U

ATTITUDE SCALE B. THE IMPORTANCE OF SCIENCE

Aim on which this scale is based: To teach pupils to appreciate how the development and application of scientific knowledge affects the progress of civilisation. (THE ROLE OF BIOLOGY AIM)

INTERMEDIATE AFFECTIVE OBJECTIVES	ITEM POOL	RESPONSE
1.0 RECEIVING 1.2 The pupil shows an awareness of the contributions that scientists make to society.	1. Scientists need the understanding and support of ordinary people.	F
	2. Only people who are going to do scientific work should have to study biology.	U
	3. A knowledge of science is essential to everyone.	F

	4. The discoveries of biologists do nothing for me personally.	U
1.2 The pupil is aware of the inter-dependance of all branches of knowledge.	5. Physics, Chemistry, and Biology are all part of the same broad subject.	F
	6. There are very clear boundaries separating Physics, Chemistry and Biology.	U
	7. All biologists should have a good grip of Physics, Chemistry and Mathematics in addition to Botany and Zoology.	F
	8. A biologist who studies Chemistry is wasting his time.	U
1.3 The pupil shows an appreciation of the contributions of scientists in society.	9. Medical research workers deserve more recognition for the role they play in preserving our health.	F
	10. Scientists are doing more harm than good in society today.	U
2.0 RESPONDING		
2.2 The pupil takes an interest in scientific discoveries and how they relate to society.	11. I would like to attend a lecture by Prof. Chris Barnard on "The possibility of building an artificial human heart".	F
	12. Too much time is devoted to science and scientists on television.	U

2.3 The pupil enjoys learning about new scientific discoveries that could possibly advance the progress of civilisation.	13. Occasionally I become so involved in a technical T.V. programme that I forget the time. 14. I wouldn't want to go on a class visit to the Sea Fisheries Institute during school holidays.	F U
3.0 VALUING		
3.1 The pupil acquires a respect for scientists working for man's improvement.	15. Doctors and nurses deserve everyone's respect and co-operation.	F
3.1 The pupil acquires a respect for research work and it s methods.	16. Many important discoveries are based on lucky guess-work. 17. Scientists do more for society because they are clever. 18. Scientists are successful problem-solvers because of the experimental methods they use.	U U F
3.2 The pupil assumes an active role in a voluntary class research project that has obvious relevance for him/her.	19. I'd like to assist in helping to measure wind speeds on the rubgy fields on Friday afternoon, to ensure that our new trees are planted in the best position to break the wind. 20. If I had the choice of helping to sample the air pollution from the power station after lunch break or go home instead; I'd rather go home.	F U

3.3 The pupil is convinced of the worth of scientific endeavour as a means of solving social problems.	21. It is important to look at all of life as "scientifically" as possible.	F
	22. Scientists are working to create a better world.	F
	23. Modern scientific discoveries have not helped the man-in-the-street very much.	U
	24. Without the contributions of scientists the world would soon become a lawless jungle.	F
4.0 ORGANISATION		
4.1 The pupil has a balanced view of the possible contributions and limitations of science to solve society's problems.	25. If all politicians had a scientific training in logic and reason, there would be world peace by now.	U
	26. Scientists will not solve our problems by creating more jobs for the poor or by growing more food for the hungry.	F
	27. Birth-control techniques cannot solve the problems of population explosion by themselves.	F

Items 1,2,4, 5 and 6 were borrowed or adapted from:
Brown S., Attitude Goals in Secondary School Science. (1976)

ATTITUDE SCALE C LEARNING BY LOOKING

Aim on which this scale is based:

To excite pupils interest in biological phenomena, to promote their powers of observation and to stimulate imaginative thinking. (THE LOOKING AND THINKING AIM)

INTERMEDIATE AFFECTIVE OBJECTIVES	ITEM POOL	RESPONSE
1.0 RECEIVING 1.3 The pupil pays attention to the biological phenomena.	1. I find plants and animals interesting.	F
	2. People make too much fuss about wild-life.	U
	3. I enjoy listening to and discussing other people's ideas.	F
2.0 RESPONDING 2.2 The pupil takes an interest in animals and plants.	4. I like horses, cats, birds and dogs.	F
	5. Gardening is boring.	U
2.2 The pupil shows a critical interest in hypotheses that propose creative solutions to biological problems.	6. I find the recent news of the first successful test-tube baby fascinating in it s implications.	F
2.3 The pupil takes pleasure in debating solutions to biological problems and in imaginative solutions.	7. I find it interesting to discuss the different ideas on the possible origins of life on earth.	F
	8. I never bother to fetch a magnifying glass to look at insects or plants more closely when I am at home.	U

	9. Too much time is wasted in practical classes when the teacher could tell us the answer in a few minutes.	U
2.3 The pupil keeps his own pets or plant collection or similar biological interest.	10. One of my hobbies is collecting shells/ insects/dried flowers/pressed flowers/ seeds/plants/birds eggs etc.	F
3.0 VALUING		
3.1 The pupil acquires a respect for creative imaginative thinking.	11. I don't think that all science fiction is improbable. Some authors have very interesting ideas.	F
3.1 The pupil acquires a respect for accurate observation.	12. It is most important to get the right answer that the teacher expects in any practical experiment - other answers are of no use at all.	U
3.2 The pupil is prepared to invest his/her own time in making detailed observations of biological phenomena.	13. I wouldn't mind staying behind for a while after school to study the animals that live in a drop of pondwater or in the plaque on teeth.	F
	14. I don't like biology projects where I am expected to study things by myself. This sort of work is only important to those who want to become scientists.	U
3.3 The pupil is devoted to the ideal of accurate observation.	15. I often seem to notice more than my friends when we are looking at something.	F
	16. I can't bear being rushed when I look at a specimen.	F

3.3 The pupil feels a sense of creative frustration over unsolved problems that drive him to further investigation.	17. I feel frustrated when the bell rings before I have enough time to complete the experiment I am working on.	F
	18. I never bother to try to repeat any of the demonstrations I have seen at school when I get home.	U

ATTITUDE SCALE D SCIENTISTS AT WORK
Aim on which this scale is based:
To enable pupils to grasp the scientific method of approach and to cultivate habits of logical and systematic thinking. (THE SCIENTIFIC METHOD AIM)

INTERMEDIATE AFFECTIVE OBJECTIVES	ITEM POOL	RESPONSE
1.0 RECEIVING		
1.3 The pupil shows a willingness to consider rational answers (cause and effect) in the face of traditional superstition.	1. There is no good or bad luck associated with Friday the 13th, black cats or walking under ladders.	F
	2. There is a lot of truth in horoscope predictions because people are like the stars they are born under.	U
1.3 The pupil shows a willingness to subject his opinions to critical judgment and hypothesis testing.	3. I often hesitate to give my opinion in class because when I am wrong I feel such a fool.	U
	4. It's important to talk about your ideas to see if others agree with you or not.	F
2.0 RESPONDING		
2.2 The pupil shows an interest in the results of experimental work.	5. Laboratory experiments are boring and waste a lot of time.	U

	6. No one can be sure his ideas are correct until they are tested experimentally.	F
2.2 The pupil shows an interest in the hypotheses and criticisms of others.	7. People that question everything annoy me.	U
	8. Sooner or later everyone comes up with at least one good idea.	F
2.2 The pupil shows an interest in logical arguments as an approach to problem-solving.	9. There is always a good reason for an experiment failing to produce the expected result.	F
	10. Doctors rely a great deal on intuition and luck when diagnosing a problem case.	U
2.2 The pupil shows an interest in the ways that scientists work.	11. Normal people cannot hope to understand scientists, because geniuses are a bit queer anyway.	U
	12. I would enjoy a vacation job as lab. assistant to a research chemist.	F
2.3 The pupil shows an interest in formulating and testing his own hypotheses.	13. I sometimes experiment with things in a tiny way to see if I'm right about what I think.	F
	14. I never seem to have any ideas that I would like to test experimentally.	U
2.3 The pupil debates for pleasure the solutions to problems demanding logical and systematic thinking.	15. I enjoy telling my friends about the detective stories I see on TV or read about.	F

	16. I can't stand discussions about chess manoeuvres/cross word puzzles or mathematical solutions to problems.	U
2.3 The pupil <u>shows obvious pleasure</u> in the logical and systematic organisation of his work.	17. I like my note books to be neat and tidy.	F
	18. Maths. teachers should not complain about messy working provided the right answer is obtained.	U
<u>3.0 VALUING</u>		
3.1 The pupil <u>does his own</u> experimental work at school on an unsolicited voluntary basis for interest's sake alone.	19. I would like to have permission to use the laboratory my byself after school to try some of my own experimental work.	F
	20. Science is not one of my favourite subjects.	U
3.1 The pupil <u>rejects</u> dogmatism in favour of retaining an open-mind.	21. If the teacher and I do the same experiment and get different answers; the teacher's result is the "right" one.	U
	22. If a good scientist says that a theory is true, all other scientists will believe him.	U
	23. Scientists should criticise each other's work.	F
3.1 The pupil <u>tolerates and accepts</u> objective criticism of his own hypotheses and work. He is aware of his limitations and is prepared to suspend judgment in humility and caution.	24. I don't mind being corrected when the other person knows more about it than I do.	F

	25. I can't bear being corrected by juniors or younger members of my family, even if they are right.	U
	26. I would never give a girl/boy the satisfaction of knowing they were right.	U
3.1 The pupil respects accurate scientific reporting and recording.	27. I believe we all should try to understand scientific articles, even if they are dull, because they are attempts to understand our world accurately.	F
	28. Scientists are too fussy about terminology and always seem ready to argue about tiny details.	U
3.2 The pupil is prepared to spend some of his holiday time investigating biological phenomena for interest's sake alone.	29. I wouldn't mind spending a few days interviewing the people in our neighbourhood to establish whether people with blue eyes are taller than people with brown eyes.	F
	30. I don't mind science at school, but my holidays are too precious to waste on science investigations.	U
3.2 The pupil rejects biassed scientific reporting with contempt.	31. Science experiments that give answers that do not confirm the research worker's theory are of no use and must be repeated again, or changed to prove the theory.	U
3.2 The pupil is prepared to accept responsibility for scientific investigations of obvious relevance.	32. It would be interesting for our class to investigate the reports of insects in the bread sold at a local shop.	F
3.3 The pupil is convinced of the value of the scientific approach.	33. People who do not think scientifically about their problems, usually come to the wrong conclusions.	F

3.3 The pupil shows scepticism in the face of facile solutions.	34. Simple solutions to problems are usually no solution at all.	F
4.0 ORGANISATION		
4.1 The pupil tries to apply the scientific method of problem-solving in other areas; (other than science.)	35. If my bicycle were stolen at a school rugby match, I would probably accuse a fellow pupil of being the thief.	U
	36. Scientific methods should be used by business men.	F
4.2 The pupil has a realistic acceptance and understanding of the assumptions and limitations of the scientific method.	37. Every experimentally proven law of science is infallibly correct.	U
	38. Science is only as correct as the guesses that scientists make about the facts they cannot measure, and upon which all their arguments depend.	F
	39. There is nothing that scientists cannot measure in the physical world.	U
	40. Scientists only believe the evidence of their eyes, ears and other senses. They never have strong beliefs about theories they have not proved to be true.	U
4.2 The pupil appreciates the dynamic nature of science and that there is always the possibility of new discoveries invalidating old hypotheses.	41. A scientist who claims to have been given a ride in a flying saucer - is mad!	U
	42. Man will never visit another galaxy in a life time, because we cannot travel faster than the speed of light.	U

	43. Scientists will never reject Einstein's Theory of Relativity.	U
5.0 CHARACTERISATION 5.1 The pupil shows a willingness to reconsider and if necessary change his/her mind when confronted with new evidence that negates his/her previously held theories.	44. No evidence would persuade me that our ancient ancestors came from Venus originally. 45. I would be prepared to reconsider my ideas about women in science, if it were conclusively proved that women are more logical and less emotional than men.	U F

ATTITUDE SCALE E READING SCIENTIFIC BOOKS

Aim on which this scale is based: To cultivate a desire to read widely and deeply on biological matters. (THE READING AIM)

INTERMEDIATE AFFECTIVE OBJECTIVES	ITEM POOL	RESPONSE
1.0 RECEIVING		
1.3 The pupil is alert to biological news.	1. I read most of the articles in the newspaper that are related to the biology we study at school.	F
	2. I can't remember the name of one scientific article that I have seen in a book or newspaper at home during the last three months.	U
2.0 RESPONDING		
2.2 The pupil is interested in popular articles dealing with biology in radio, T.V., newspapers, paperbacks and well-illustrated magazines.	3. I enjoy watching T.V. programmes that show animals living wild and hunting their food.	F
	4. I didn't take an interest in the articles in the press dealing with seal culling in False Bay.	U
	5. Scientific articles are all equally dull as far as I am concerned.	U
	6. I enjoy reading wildlife books that have lots of pictures of animals in them.	F
	7. I would prefer to read an article on "Surfing" than an article on "Sharks".	U
2.3 The pupil develops a keen interest in reading up a particular aspect of biology.	8. I don't have any special interest in biology, all biological articles are of equal interest to me.	U

2.3 The pupil is <u>prepared to use</u> scientific periodicals to follow up his interest.	9. I never bother to finish reading articles dealing with biological topics that are hard to understand.	U
	10. I would struggle on through a difficult article if it dealt with a topic that I was especially interested in.	F
3.0 VALUING		
3.1 The pupil <u>believes</u> that scientific writing is more truthful than other sources.	11. If a journalist and an expert botanist write articles on the growing of proteas, I would prefer to read the botanists account.	F
	12. Scientists are no more truthful in their writings than any other men.	U
3.1 The pupil <u>is aware of and compensates for</u> media bias.	13. You can't believe what you read in the newspapers, unless someone confirms it.	F
	14. The man-in-the street can rely on the honesty and integrity of newspaper reporters.	U
3.2 The pupil <u>chooses to read</u> biological works in preference to many others in his spare time and on holiday.	15. If I were given "A guide to South African Birdlife" for Christmas I would be disappointed.	U
	16. I sometimes borrow library books about animals or people who live with animals.	F
3.2 The pupil <u>prefers to read</u> authoritative accurate accounts rather than popular biassed accounts.	17. If I wanted to know more about Mars I would be more interested in reading the reports of the Mariner/Mars Probes by NASA than an account by a popular science-fiction writer.	F

ATTITUDE SCALE F CARING FOR NATURE
Aim on which this scale is based:
To foster in pupils a love for the South African fauna and flora and to stress the vital importance of nature conservation.
(THE CONSERVATION AIM)

INTERMEDIATE AFFECTIVE OBJECTIVES	ITEM POOL	RESPONSE
1.0 RECEIVING		
1.3 The pupil is sensitive to the beauty of our fauna and flora.	1. I often stop to look at wild flowers when walking in the veld.	F
	2. I don't know why people get so excited about visiting nature reserves.	U
1.3 The pupil is sensitive to alien plants.	3. I don't understand why so much fuss is made about alien weeds like Hakea.	U
	4. I don't care where plants come from; it doesn't make any difference.	U
1.3 The pupil is sensitive to pollution and environmental marring.	5. It doesn't really bother me when I see people dropping papers on the pavement or out of their car windows.	U
	6. I would be upset if the City Council tarred most of Rondebosch Common for a parking area.	F
2.0 RESPONDING		
2.2 The pupil wants to know more about conservation topics.	7. I would like to hear a lecture on alien plants in the Western Province.	F
	8. I think the people who worry about pollution are those who have nothing else to worry about.	U

2.2 The pupil is interested in the variety of South African plants and animals.	9.	I don't bother to look at bird displays in museums any more; they bore me.	U
	10.	I enjoy visiting Kirstenbosch, there is always something interesting to look at.	F
2.2 The pupil wants to know more about the methods of conservation.	11.	I would like to know how game rangers care for lions injured in fights.	F
	12.	It doesn't concern me where elephants find water in drought seasons.	U
2.2 The pupil shows a respect for all living things.	13.	I think all dangerous species e.g. snakes, sharks, scorpions etc. should be exterminated as soon as this is practical.	U
	14.	I would like to help with an S.P.C.A. collection at school.	F
2.3 The pupil enjoys walking in natural and unspoiled surroundings.	15.	I like walking through natural forests.	F
	16.	I can't see the point of going for a hike along the coast to Langebaan Lagoon.	U
2.3 The pupil takes a pleasure in South African wild animals and plants.	17.	I don't have a favourite wild flower; one flower is as good as another.	U
	18.	I wouldn't bother to stop and watch for a while a spider spinning a web.	U
3.0 VALUING			
3.1 The pupil shows concern and resentment over all forms of pollution.	19.	I get angry when I see children dropping papers on the school fields.	F

	20. It doesn't really matter if people swim in a reservoir, the water is always purified later anyway.	U
3.1 The pupil obeys the conservation laws and appreciates the need for them.	21. If we all just helped ourselves to a few wild flowers when we wanted them, there would soon be none left.	F
	22. It makes very little difference if you catch and keep one or two undersized crayfish.	U
3.1 The pupil takes a pride in South African wild flowers and plants.	23. Our proteas are amongst the most beautiful flowers in the world.	F
3.2 The pupil considers it his duty to do whatever practical concerning pollution wherever he finds it.	24. It is not my duty to clean up the litter other people leave behind.	U
	25. If I find a broken bottle on the beach I would take it to a rubbish bin.	F
3.2 The pupil is prepared to assume an active role in nature conservation.	26. I would be happy to help clean oil off seagulls if this were necessary.	F
	27. I wouldn't like to spend Saturday chopping down Hakea on Table Mountain.	U
3.2 The pupil visits game reserves on his own initiative.	28. I would like to walk the Boland Trail during the next long weekend.	F
3.2 The pupil watches T.V. programmes on nature conservation and wildlife whenever he can.	29. I think there are too many wildlife programmes on T.V.	U
3.2 The pupil would like to join a conservation society.	30. I would like to join one of these societies: The Cape Bird Club/The South African Botanical Society/The Wildlife Society.	F

3.2 The pupil <u>would like to grow</u> some wild flowers in his garden.	31. I wish we had more wild flowers growing in our garden at home. 32. I would be prepared to help plant proteas in our school gardens on Friday afternoon.	F F
3.2 The pupil <u>has developed a love</u> of the South African fauna and flora.	33. I <u>love</u> wild flowers and animals.	F
3.3 The pupil <u>is incensed</u> by acts of vandalism that damage the environment.	34. I hate people who carve their names on trees. 35. It takes a lot more than a few children breaking flowers off plants to make me see red.	F U
3.3 The pupil <u>is committed</u> to the conservation ethic and laws.	36. I would be prepared to serve as a voluntary conservation officer to help protect our wildlife.	F
<u>4.0 ORGANISATION</u> 4.1 The pupil <u>appreciates and understands</u> the distinction between conservation and preservation.	37. It is impossible to conserve our plants without shooting the excess game each year. 38. Animals and plants should never be interfered with in the reserves; rangers should leave them entirely alone to reach a natural balance.	F U
4.2 The pupil <u>appreciates</u> that human needs and the conservation ideal may sometimes be in conflict and is prepared to place human priorities ahead of other ideals.	39. It is wrong to shoot a leopard that survives by stealing sheep, once all his natural prey have disappeared. 40. It would be wrong to exclude the general public from nature reserves just because some thoughtless smokers start veld fires, thatdestroy animals and plants.	U F

SCORING THE ITEM POOL

Statements that in this author's opinion anticipated a favourable response were scored as follows:

Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
4	3	2	1	0

Statements that in this author's opinion anticipated an unfavourable response were scored in the reciprocal pattern.

SCALE	STATEMENTS ANTICIPATED	ITEM NUMBERS	SUB TOTALS
A	Favourable	1;3;4;8;9;10;12;14;15;18.	10
	Unfavourable	2;5;6;7;11;13;16;17;19	9
B	Favourable	1;3;5;7;9;11;13;15;18;19;21; 22;24;26;27.	15
	Unfavourable	2;4;6;8;10;12;14;16;17;20; 23;25.	12
C	Favourable	1;3;4;6;7;10;11;13;15;16;17.	11
	Unfavourable	2;5;8;9;12;14;18.	7
D	Favourable	1;4;6;8;9;12;13;15;17;19; 23;24;27;29;32;33;34;36;38;45.	20
	Unfavourable	2;3;5;7;10;11;14;16;18;20;21; 22;25;26;28;30;35;37;39;40;41; 42;43;44;31.	25
E	Favourable	1;3;6;10;11;13;16;17.	8
	Unfavourable	2;4;5;7;8;9;12;14;15.	9
F	Favourable	1;6;7;10;11;14;15;19;21;23;25; 26;28;30;31;32;33;34;36;37;40.	21
	Unfavourable	2;3;4;5;8;9;12;13;16;17;18;20; 22;24;27;29;35;38;39.	19

TOTALS FAVOURABLE STATEMENTS ANTICIPATED = 85
UNFAVOURABLE STATEMENTS ANTICIPATED = 81
166

PILOT TRIAL ONE

The purpose of this trial was to assess the content validity of the six scales by making use of five local biology teachers as judges thus forming hopefully a criterion group. This enabled the author to dispose of many items that the criterion group could not find a common response towards. In all some 27 items were discarded at this stage.

PILOT TRIAL ONE: UNPURIFIED SCALES

SCORES OF FIVE JUDGES EXPRESSED AS PERCENTAGES

JUDGES / SCALES	A	B	C	D	E	F
A'	69,7	69,4	75,0	60,2	77,9	66,9
B'	69,7	79,6	72,2	75,0	76,5	85,0
C'	72,4	72,2	77,8	68,3	72,1	84,4
D'	81,4	76,9	95,8	76,1	82,4	81,3
E'	71,1	68,5	68,1	65,6	76,5	76,9

MEAN PERCENTAGE SCORED ON EACH SCALE

72,9	73,3	77,8	69,1	77,1	78,9

THE RANGE OF SCORES ON EACH SCALE AS A PERCENTAGE

11,7	11,1	27,8	15,9	10,3	18,1

COMMENTARY

1. Scales C,E and F yielded the highest amount of concurrence with this author's anticipated favourable/unfavourable responses.
2. Scales C,D and F accomodated some widely differing opinions.
3. With the exception of scale D, all top-scorers in individual scales obtained almost 80% of the anticipated maximum score or better.
4. Scale D reveals itself as needing more purification than most of the other scales.

PILOT TRIAL ONE: UNPURIFIED SCALES

ANALYSIS OF POSITIVE RESPONSES/NEGATIVE RESPONSES TO ELIMINATE THE EFFECTS OF TEACHER CONSERVATISM.

If no distinction is made between strongly agree and agree, and strongly disagree and disagree, the effect of teacher conservatism in selecting extreme response options is eliminated.

		MEAN % POSITIVE RESPONSES FOR ALL FIVE JUDGES	% SCORE OF TOP-SCORING JUDGE
S	A	77,9	C' 89,5
C	B	80,7	A' 88,9
A	C	85,6	D' 100
L	D	71,4	C' 73,3
E	E	87,1	A'/E' 94,1
	F	88,0	C' 97,5

COMMENTARY

1. All scales yield a much higher mean percentage score than when they were scored according to Likert methods, thus indicating the significant role played by the conservatism of this group of judges.
2. Scale D is once again indicated by its low mean score to be unsound in its unpurified form.
3. All other scales indicate an almost 80% agreement with this author's assessment of the "correct" response to each statement thus indicating that biology teachers do form a rough criterion group on the assessment of attitudes based on the aims of the Cape Education Department's Biology Syllabus.

PILOT TRIAL ONE: UNPURIFIED SCALES

ANALYSIS OF CONTRARY RESPONSES

Where two or more judges indicated an agreement as to a response contary to what this author judged to be the "correct/favourable" response or indicated uncertainty, the item in question was deemed unfit to be retained in the scale.

SCALE	ITEM NUMBER	NUMBER OF JUDGES SELECTING A CONTRARY OR UNCERTAIN RESPONSE (2, 3, 4, 5)
A	3	2
	7	2
B	13	3
	17	3
	21	2
	24	2
C	10	2
	13	2
	15	3
D	3	3
	7	2
	8	2
	13	2
	16	2
	28	2
	29	2
	34	5
	38	2
	39	2
	41	3
	42	4
	43	3
	45	2
E	7	3
F	27	3
	37	3
	38	2
	39	4

TOTAL = 28 unsuitable items

COMMENTARY

1. Scale D contained the greatest number of unsuitable items.
2. Item D.34 was selected as a contrary or uncertain response by all judges. This item was retained and the scoring sequence reversed.
3. The remaining 27 items were discarded from the scales.

PILOT TRIAL ONE: UNPURIFIED SCALES

A SUMMARY OF THE ITEMS DISCARDED AFTER PILOT TRIAL ONE

SCALE	NUMBER OF UNPURIFIED ITEMS	ITEMS DISCARDED	NUMBER OF PURIFIED ITEMS
A	19	2	17
B	27	4	23
C	18	3	15
D	45	13	32
E	17	1	16
F	40	4	36
TOTALS	166	27	139

COMMENTARY

1. 139 items were deemed to have content validity based on the high degree of concurrence of the members of the criterion group.
2. Scale D had to undergo the most purification with the result that Scale F now has more items than scale D.
3. This may well have proved to be a factor in the very high reliability coefficient computed for Scale F after the second pilot trial.

PILOT TRIAL ONE: PURIFIED SCALES

SCORES OF FIVE JUDGES EXPRESSED AS PERCENTAGES

After the scales were purified the scores of the judges were computed afresh.

JUDGES / SCALES	A	B	C	D	E	F
A'	70,6	70,7	76,7	64,8	79,7	70,1
B'	73,5	85,9	78,3	85,2	75,0	89,6
C'	75,0	77,2	80,0	75,8	73,4	86,8
D'	79,4	82,6	95,0	82,8	82,8	85,4
E'	72,1	69,6	71,7	73,4	78,1	79,2

MEAN PERCENTAGE SCORES ON EACH SCALE

74,1	77,2	80,3	76,4	77,8	82,2

THE RANGE OF SCORES ON EACH SCALE AS A PERCENTAGE

8,8	16,3	23,3	20,3	9,4	19,4

THE IMPROVEMENT OF THE PURIFIED SCALES OVER UNPURIFIED SCALES EXPRESSED AS A PERCENTAGE

1,3	3,9	2,6	7,4	0,8	3,4

COMMENTARY

1. All scale means have improved as a result of purification as anticipated; particularly scale D.
2. The larger scales B, D and F showed larger improvements than the shorter scales.
3. All top-scoring judges obtained in excess of 82% with the exception of Scale A results.

PILOT TRIAL ONE: PURIFIED SCALES

ANALYSIS OF POSITIVE RESPONSES/NEGATIVE RESPONSES TO ELIMINATE THE EFFECTS OF TEACHER CONSERVATISM

Again no distinctions were recognised between extremely positive and moderately positive responses and vice versa.

		MEAN % POSITIVE RESPONSES FOR ALL FIVE JUDGES	% SCORE OF TOP-SCORING JUDGE
S	A	82,4	C' 94,1
C	B	89,6	B'/C' 95,7
A	C	92,0	A'/C'/D' 100
L	D	85,0	C' 93,8
E	E	90,0	A'/E' 100
	F	94,0	C' 100

IMPROVEMENT OF THE PURIFIED SCALE POSITIVE RESPONSE MEANS OVER THE UNPURIFIED SCALE POSITIVE RESPONSE MEANS EXPRESSED AS A PERCENTAGE

SCALES	A	B	C	D	E	F
MEAN IMPROVEMENT	4,5	8,9	6,4	13,6	3,0	2,0

COMMENTARY

1. All scale means yield a better than 82% concurrence; four scales yield a 90% concurrence.
2. All top-scoring judges obtained in excess of 93%.
3. Several judges are now in complete concurrence with the authors' estimation of what constitutes a "correct response".
4. On the basis of these results all six scales were deemed to have content validity in their purified form.

PILOT TRIAL TWO

The purpose of this trial was to administer the six scales partially purified in Pilot Trial One to a sample of students as similar as possible to the experimental and control groups who would write the Pre- and Post Tests. In the process items which were poor differentiators between the top 25% and the bottom 25% of scorers in each scale were eliminated. This established the construct validity of each scale if, as is commonly accepted in attitude scale construction, these two groups are considered to be internal criterion groups.

Satifactory reliability coefficients were computed for each scale.

THE PURIFIED TEST USED IN PILOT TRIAL TWO

NOTE: The sequence of items has been randomised.

SCIENCE, NATURE AND ME - How I feel about my world. Part 1.

We are trying to find ways and means of making biology lessons more useful and interesting. If you answer this test as honestly as you can and only give your true feelings to each item we will be much closer to succeeding.

This is an anonymous test. No one will ever know what your answers were, no one will even try to find out afterwards.

There are 139 items in this test. Please respond to each item by shading the answer block that is closest to your own feelings on the matter.

For example:

All science teachers are very clever.

Strongly agree	Agree	Uncertain	Disagree	Strongly Disagree

Important: You must answer every item.
You must only give one response per item.

A. RELATIONSHIPS IN NATURE

1. I don't feel that I ought to pick up the rubbish that other people leave at picnic sites.
2. The more cats, dogs and children; the fewer the birds in the neighbourhood.
3. People caught littering beaches should be banned from using them for a year.
4. Land wasted as game reserves should be converted to state farms to feed the hungry in our African townships.
5. People should not be allowed to take cigarettes, pipes matches or lighters into forestry areas.
6. All schools should consider the alien weeds growing in the countryside nearby as a challenge to clear them out. (eg. Port Jackson, Willow and Hakea.)

7. Birds have no special preference for sitting in or visiting particular trees in our garden.
8. I would enjoy going on a field trip to search for the places where different kinds of animals live.
9. Large parts of our country should be set aside unspoiled as wilderness areas for wild game and plants.
10. It's a shame to kill snakes, they are so useful.
11. There is no need for dogs in Cape Town to be licensed.
12. Oil tankers should be banned from passing Cape Point because oil pollution is a threat to marine life on our coasts.
13. The cable-way has improved Table Mountain by making it more accessible to all.
14. It's fun to explore rock-pools at the beach.
15. When seal culling become necessary, those animals with the best skins should be killed.
16. I enjoy following trails of ants in the garden to see where they are going to.
17. Many plants and animals are of no use at all.

B. THE IMPORTANCE OF SCIENCE.

1. There are very clear boundaries separating Physics, and Chemistry from Biology.
2. If all politicians had a scientific training in logic and reason, there might be peace in the world by now.
3. All biologists should have a sound grip of Physics, Chemistry and Mathematics in addition to Botany and Zoology.
4. Physics, Chemistry and Biology are all part of the same broad subject.
5. Too much time is devoted to science and scientists on television.
6. A knowledge of science is essential to everyone.
7. Birth-control techniques alone will never solve the problem of population explosion.

8. I wouldn't go on a class visit to the Sea Fisheries Institute if it were arranged during the school holidays.
9. Scientists are working to create a better world.
10. Many important discoveries are based on lucky guess-work.
11. I'd be interested in helping to measure wind speeds on the school fields after school on a windy day, to ensure that our new wind-break is planted in the best position.
12. The discoveries of biologists have done nothing for me.
13. Doctors and nurses deserve our respect and co-operation.
14. Modern scientific discoveries have not helped the man-in-the-street very much.
15. Medical research workers deserve more recognition for the role they play in preserving our health.
16. Scientists need the understanding and support of ordinary people.
17. I would like to hear a lecture by Prof. Chris Barnard at Seniors' Club on "The possibility of building an artificial human heart."
18. Scientists will never solve our problems by creating more jobs for the poor or growing more food for the hungry.
19. Only pupils who are hoping to do scientific work one day should have to study Biology.
20. A biologist who studies Chemistry is wasting his time.
21. Scientists are successful problem-solvers because of the experimental methods they use.
22. If I had the opportunity of helping to sample the air pollution from the power station after lunch break or go home instead; I'd rather go home.
23. Scientists are doing more harm than good in society today.

C. <u>LEARNING BY LOOKING</u>

1. I feel frustrated when the bell rings before I have had a sufficient chance to complete the experiment or problem I am working on.

2. I enjoy listening to and discussing other peoples ideas.
3. I find it interesting to discuss the different ideas on the possible origins of life on earth.
4. I can't bear being rushed when I am examining a specimen.
5. I find plants and animals very interesting.
6. Too much time is wasted in practical classes when the teacher could tell us the answers in a few minutes.
7. People make far too much fuss about wildlife.
8. I like horses, cats, birds and dogs.
9. I would never bother to specially fetch a magnifier to take a closer look at insects or plants in the garden at home.
10. I never try to repeat any of the demonstration experiments I have seen at school when I get home.
11. It is most important to get the right answer the teacher expects in any practical experiment - other answers are no use at all.
12. I don't like biology projects where I am expected to study things by myself. This sort of work is only important to those who wish to become scientists.
13. I don't think that all science fiction is improbable. Some authors have very interesting ideas.
14. I find the implications of the first successful test-tube baby fascinating.
15. Gardening is boring.

SCIENCE, NATURE AND ME - Part 2

D. SCIENTISTS AT WORK

1. I never seem to have any ideas that can be tested experimentally.
2. Simple solutions to problems are usually no solution at all.
3. Laboratory experiments are boring and waste a lot of time.
4. People who do not think scientifically about their problems usually come to the wrong conclusions.
5. Scientists only believe the evidence of their eyes, ears and other senses. For example, they would never have faith in an unproven theory.
6. Experimental results that do not confirm scientists' theories are useless.
7. There is a lot of truth in horoscope predictions; people are in reality like the stars they are born under.
8. It would be interesting for our class to investigate the reports of bread beetles found in the bread sold at a local shop.
9. I would appreciate being allowed to work in the school biology lab. by myself after school on a project of my own.
10. It's important to talk about your ideas to see if others agree with you or not.
11. I don't mind being corrected when the other person knows more about it than I do.
12. If my bicycle were stolen while I was at a school rugby match, I would probably instinctively conclude that one of our pupils had taken it.
13. Science is not one of my favourite subjects.
14. If the teacher and I do the same experiment and get different answers; the teacher's result is the right one.

15./...

15. I can't bear being corrected by juniors or younger members of my own family, even if they are right.
16. I enjoy telling my friends about detective stories I read or watch on T.V.
17. I like my note books to be neat and tidy.
18. Normal people cannot hope to understand scientists, because geniuses are a bit queer anyway.
19. Scientists should criticise each others' work.
20. I believe we should all try to understand scientific articles, even if they are dull at times, because they are accurate records of attempts to understand the world a bit better.
21. Mathematics teachers have no right to complain about messy working as long as the answer is correct.
22. There is always a good reason for an experiment failing to produce the expected result.
23. No one can be sure his ideas are correct until they are tested experimentally.
24. Every experimentally proven law of science is infallibly correct.
25. No evidence would ever persuade me that our ancient ancestors came to live on earth as astronauts from Venus originally.
26. Scientific methods should be used by all business men.
27. Doctors rely a great deal on intuition and luck when diagnosing a problem case.
28. There is no good or bad luck associated with Friday the 13th, seeing black cats or walking under ladders.
29. I don't mind science at school, but my holidays are too precious to waste on scientific investigations.
30. I would never give a girl (or boy) the satisfaction of knowing they were right and I was wrong.
31. I would enjoy a vacation job as lab. assistant to a research chemist.
32. If a great scientist claims that a theory is true, all other scientists will believe him.

E./...

E. <u>READING SCIENTIFIC BOOKS</u>

1. If I find articles written on the cultivation of proteas by a journalist and a botanist, I would prefer to read the botanist's account.
2. I don't have any <u>special</u> interest in biology; all biological articles are of equal interest to me.
3. I didn't take an interest in the articles in the press dealing with seal culling in False Bay.
4. The man-in-the-street can rely on the honesty and integrity of newspaper reporters.
5. I enjoy watching T.V. programmes that show wild animals and how they live.
6. I read all the articles in the newspaper that I find relating to the biology we study at school.
7. If I were given a wildlife book eg. <u>A Guide to South African Birdlife</u> for a Christmas present, I should be disappointed.
8. Scientific articles are all equally dull as far as I am concerned.
9. I can't remember the name of a single scientific article that I have read in a book, magazine or newspaper during the last three months.
10. Scientists are no more truthful in their writings than other men.
11. I would struggle on through a difficult article if it dealt with a topic that I was especially interested in.
12. I never bother to finish reading articles dealing with biological topics that are hard to understand.
13. I sometimes borrow library books about animals or people who live and work with animals.
14. You can't accept what you read in the newspapers unless someone confirms the story.
15. If I wanted to know more about Mars, I would prefer reading the reports of the Mariner/Mars Probes by NASA rather than a popular account by a well-known science fiction writer.

16/...

16. I enjoy reading wildlife books that have lots of pictures of animals in them.

F. MAN AND NATURE

1. I would be happy to help clean oil off seagulls if necessary.
2. It doesn't bother me how thirsty wild animals may be in times of drought.
3. If I found a broken bottle on the beach I would take it to a rubbish bin.
4. I don't bother to look at bird displays in museums any more; they bore me.
5. I don't understand why so much fuss is made about alien weeds like Hakea.
6. I would be prepared to assist as a voluntary conservation officer during the holidays to help protect our wildlife.
7. I think there are too many wildlife programmes on T.V.
8. I would be upset if the City Council tarred most of Rondebosch Common for a parking area.
9. I don't have a favourite wild flower; one flower is as good as another.
10. Our proteas are amongst the most beautiful flowers in the world.
11. It's not my duty to clean up the litter that others drop in the school grounds.
12. I get angry when I see children dropping papers on the school fields.
13. I think that all dangerous species (eg. snakes, sharks, scorpions etc.) should be exterminated as soon as this is practical.
14. I can't see the point of going for a hike along the coast to Langebaan Lagoon.
15. I think the people who worry about pollution are those who have no other problems to worry about.

16. It doesn't really bother me when I see people dropping papers on the pavements or throwing them out of car windows.
17. I don't care where plants come from; it doesn't make any difference to me.
18. I enjoy visiting Kirstenbosch; there is always something interesting to look at.
19. I wish we had more wild flowers growing in our garden at home.
20. I would be prepared to help with the planting of extra proteas in our school garden on a Friday afternoon.
21. I don't know why others get so excited about visiting nature reserves.
22. I hate people who carve their names on trees.
23. I would like to help with an S.P.C.A. collection at school.
24. I would like to know how game rangers care for lions injured in fights.
25. I like walking through natural forests.
26. If I saw a spider spinning a web, I wouldn't bother to stop and watch it for a while.
27. I often stop to look at wild flowers when walking in the veld.
28. I would like to join a nature orientated society one day eg. The Cape Bird Club; The Mountain Club of South Africa; The South African Botanical Society or the Wildlife Society.
29. I <u>love</u> wild flowers and animals.
30. If we all just helped ourselves to a few wild flowers when we wanted them, there would soon be none left.
31. I would like to walk the Boland Trail during the next long weekend.
32. It makes no difference if you catch and keep one or two undersized crayfish now and then.
33. It doesn't really matter if people swim in a reservoir, the water is always purified before we drink it anyway.

34/...

34. It takes a lot more than a few children picking and breaking flower heads to make me see red.
35. I would like to hear a lecture on alien plants growing in the Western Cape.
36. It would be wrong to exclude the general public from nature reserves just because some thoughtless person started a veld fire that destroyed plant and animal life.

PILOT TRIAL TWO:

TOTAL SCORES AND MEANS OF PILOT SAMPLE

SUBJECT	SCALES A	B	C	D	E	F
BIOLOGY ONLY GROUP 1	52	52	37	73	55	115
2	49	52	38	78	41	78
3	47	58	45	68	44	118
4	45	57	39	82	36	98
5	41	39	49	95	48	108
6	48	46	38	78	36	85
7	38	42	26	67	29	98
8	36	39	36	72	40	97
9	48	45	46	74	42	78
10	41	48	36	72	41	88
11	41	64	38	90	51	122
12	42	60	44	79	40	102
13	46	65	45	85	47	119
14	54	66	54	96	57	129
15	44	53	42	81	46	112
16	36	54	36	80	47	96
17	37	55	37	68	30	78
18	38	63	38	75	39	82
19	38	53	31	62	39	77
20	44	42	31	74	31	75
SUB MEAN MEAN I.Q. = 107,61	43,25	52,65	39,30	77,45	41,95	97,75
BIOLOGY AND PHYSICAL SCIENCE GROUP 21	52	61	49	83	38	102
22	41	60	36	74	41	105
23	47	51	46	82	35	102
24	39	59	38	79	32	89
25	44	57	45	85	37	86
26	48	74	37	76	32	100
27	38	43	36	74	36	71
28	53	57	50	65	50	95
29	36	53	46	77	46	94
30	51	63	38	71	26	80
31	42	61	47	70	38	116
32	56	69	47	94	57	124
33	47	58	42	91	44	95
34	49	58	37	75	41	115
35	48	48	23	66	23	84
36	44	66	47	70	42	88
37	37	63	44	85	42	94
38	49	62	39	80	31	89
39	43	74	52	101	50	127
40	53	69	50	89	44	113
SUB MEAN MEAN I.Q. = 118,66	45,85	60,30	42,45	79,35	39,25	98,45
TOTAL MEAN	44,55	56,48	40,88	78,40	40,60	98,10

PILOT TRIAL TWO: SCALE A

PURIFICATION OF SCALE A

The raw scores for this scale have been ranked and divided into a high score (top 25%) and a low score group (bottom 25%). The mean score achieved by each group for each item has been computed.

DIFFERENCE OF MEANS OF HIGH AND LOW SCORING GROUPS			
ITEMS	HIGH MEANS	LOW MEANS	DIFFERENCE
1	2,7	1,5	1,2
2	2,2	1,3	0,9
3	2,5	1,6	0,9
4	3,7	3,0	0,7
5	3.5	2,4	1,1
6	2,6	2,1	0,5
7	3,0	1,8	1,2
8	3,9	2,9	1,0
9	3,6	3,4	0,2
10	2,8	1,5	1,3
11	3,7	2,7	1,0
12	1,2	1,3	-0,1
13	2,8	2,8	0
14	3,6	2,0	1,6
15	2,8	2,8	0
16	3,0	1,4	1,6
17	3,6	2,7	0,9

RANK DIFFERENCE OF MEANS		FINAL ITEM SELECTION
RANK DIFF. OF MEANS	ITEMS	
1,6	14	PURIFIED SCALE ITEMS
1,6	16	
1,3	10	
1,2	7	
1,2	1	
1,1	5	
1,0	11	
1,0	8	
0,9	17	
0,9	3	
0,9	2	DISCARDED ITEMS
0,7	4	
0,5	6	
0,2	9	
0	13	
0	15	
-0,1	12	

COMMENTARY

1. We assume that the High and Low scoring groups are in fact criterion groups in terms of which we can evaluate the items. From this we infer that the purified scale has construct validity.
2. The split half reliability coefficient of this scale was found to be r = 0,64 (after correction).

PILOT TRIAL TWO: SCALE B

PURIFICATION OF SCALE B

See introductory paragraph accompanying Scale A .

DIFFERENCE OF MEANS OF HIGH AND LOW SCORING GROUPS			
ITEMS	HIGH MEANS	LOW MEANS	DIFFERENCE
1	3,1	2,1	1,0
2	2,0	1,4	0,6
3	3,1	1,4	1,7
4	2,9	2,1	0,8
5	3,4	2,2	1,2
6	3,2	1,4	1,8
7	2,7	1,9	0,9
8	2,4	0,5	1,9
9	2,8	1,5	1,3
10	3,3	2,0	1,3
11	2,2	0,9	1,3
12	3,2	2,8	0,4
13	3,6	3,1	0,5
14	3,4	2,0	1,4
15	3,3	3,2	0,1
16	3,2	2,5	0,7
17	3,6	2,6	1,0
18	1,4	1,6	-0,2
19	3,5	2,5	1,0
20	3,6	2,3	1,3
21	1,8	1,8	0
22	2,1	0,7	1,4
23	3,3	1,8	1,5

RANK DIFFERENCE OF MEANS		FINAL ITEM SELECTION
RANK DIFF. OF MEANS	ITEMS	
1,9	8	PURIFIED SCALE ITEMS
1,8	6	
1,7	3	
1,5	23	
1,4	22	
1,4	14	
1,3	11	
1,3	10	
1,3	20	
1,3	9	
1,2	5	
1,0	1	
1,0	19	
1,0	17	
0,9	7	DISCARDED ITEMS
0,8	4	
0,7	16	
0,6	2	
0,5	13	
0,4	12	
0,1	15	
0	21	
-0,2	18	

COMMENTARY

1. We assume that the High and Low scoring groups are in fact criterion groups in terms of which we can evaluate the items. From this we infer that the purified scale has construct validity.
2. The split half reliability coefficient of this scale was found to be r = 0,66 (after correction).

PILOT TRIAL TWO: SCALE C

PURIFICATION OF SCALE C

See introductory paragraph accompanying Scale A.

DIFFERENCE OF MEANS OF HIGH AND LOW SCORING GROUPS			
ITEMS	HIGH MEANS	LOW MEANS	DIFFERENCE
1	3,7	2,7	1,0
2	3,6	2,9	0,7
3	3,5	2,8	0,7
4	3,6	2,2	1,4
5	3,7	2,4	1,3
6	3,8	2,1	1,7
7	3,7	2,4	1,3
8	3,6	3,5	0,1
9	2,8	1,2	1,6
10	2,4	0,9	1,5
11	3,0	2,2	0,8
12	3,2	1,3	1,9
13	3,0	2,1	0,9
14	2,8	2,9	-0,1
15	2,7	1,2	1,5

RANK DIFFERENCE OF MEANS		FINAL ITEM SELECTION
RANK DIFF. OF MEANS	ITEMS	
1,9	12	PURIFIED SCALE ITEMS
1,7	6	
1,6	9	
1,5	10	
1,5	15	
1,4	4	
1,3	5	
1,3	7	
1,0	1	
0,9	13	
0,8	11	DISCARDED ITEMS
0,7	2	
0,7	3	
0,1	8	
-0,1	14	

COMMENTARY

1. We assume that the High and Low scoring groups are in fact criterion groups in terms of which we can evaluate the items. From this we infer that the purified scale has construct validity.
2. The split half reliability coefficient of this scale was found to be r = 0,72 (after correction).

PILOT TRIAL TWO: SCALE D

PURIFICATION OF SCALE D

See introductory paragraph accompanying Scale A.

DIFFERENCE OF MEANS OF HIGH AND LOW SCORING GROUPS				RANK DIFFERENCE OF MEANS		FINAL ITEM SELECTION
ITEMS	HIGH MEANS	LOW MEANS	DIFFERENCE	RANK DIFF. OF MEANS	ITEMS	
1	2,5	1,4	1,1	2,2	13	PURIFIED SCALE ITEMS
2	3,0	2,6	0,4	1,8	5	
3	3,6	2,0	1,6	1,7	29	
4	1,1	1,9	-0,8	1,6	3	
5	3,3	1,5	1,8	1,6	9	
6	3,1	2,5	0,6	1,3	20	
7	2,7	3,4	-0,7	1,3	31	
8	2,9	2,2	0,7	1,2	21	
9	3,4	1,8	1,6	1,1	1	
10	3,3	2,6	0,7	1,1	27	
11	3,3	2,8	0,5	1,0	18	
12	2,5	3,0	-0,5	1,0	25	
13	2,9	0,7	2,2	1,0	30	
14	3,3	2,7	0,6	0,9	26	
15	2,0	1,5	0,5	0,7	8	DISCARDED ITEMS
16	2,8	2,2	0,6	0,7	10	
17	3,2	3,0	0,2	0,6	6	
18	2,9	1,9	1,0	0,6	14	
19	2,6	2,6	0	0,6	16	
20	2,9	1,6	1,3	0,6	22	
21	2,8	1,6	1,2	0,5	11	
22	2,9	2,3	0,6	0,5	15	
23	2,8	3,1	-0,3	0,4	2	
24	2,4	2,0	0,4	0,4	24	
25	2,3	1,3	1,0	0,2	17	
26	2,2	1,3	0,9	0,2	32	
27	3,2	2,1	1,1	0,1	28	
28	3,4	3,3	0,1	0	19	
29	2,5	0,8	1,7	-0,3	23	
30	2,9	1,9	1,0	-0,5	12	
31	3,0	1,7	1,3	-0,7	7	
32	3,2	3,0	0,2	-0,8	4	

COMMENTARY

1. We assume that the High and Low scoring groups are in fact criterion groups in terms of which we can evaluate items. From this we infer that the purified scale has construct validity.
2. The split half reliability coefficient of this scale was found to be r = 0,80 (after correction).

PILOT TRIAL TWO: SCALE E

PURIFICATION OF SCALE E

See introductory paragraph accompanying Scale A.

DIFFERENCE OF MEANS OF HIGH AND LOW SCORING GROUPS			
ITEMS	HIGH MEANS	LOW MEANS	DIFFERENCE
1	2,2	2,0	0,2
2	3,4	1,9	1,5
3	3,4	2,4	1,0
4	3,9	2,0	1,9
5	4,0	2,6	1,6
6	2,5	0,7	1,8
7	3,4	1,1	1,3
8	2,8	1,9	0,9
9	2,6	1,0	1,6
10	2,5	2,2	0,3
11	3,6	3,1	0,5
12	3,0	1,1	1,9
13	3,1	1,2	1,9
14	2,9	2,4	0,5
15	3,0	2,4	0,6
16	3,4	2,6	0,8

RANK DIFFERENCE OF MEANS		FINAL ITEM SELECTION
RANK DIFF. OF MEANS	ITEMS	
1,9	12	PURIFIED SCALE ITEMS
1,9	13	
1,9	4	
1,8	6	
1,6	5	
1,6	9	
1,5	2	
1,3	7	
1,0	3	
0,9	8	
0,8	16	DISCARDED ITEMS
0,6	15	
0,5	14	
0,5	11	
0,3	10	
0,2	1	

COMMENTARY

1. We assume that the High and Low scoring groups are in fact criterion groups interms of which we can evaluate the items. From this we infer that the purified scale has construct validity.
2. The split half reliability coefficient for this scale was found to be r = 0,79 (after correction),

PILOT TRIAL TWO: SCALE F

PURIFICATION OF SCALE F

See introductory paragraph accompanying Scale A.

DIFFERENCE OF MEANS OF HIGH AND LOW SCORING GROUPS			
ITEMS	HIGH MEANS	LOW MEANS	DIFFERENCE
1	3,5	3,4	0,1
2	3,8	3,9	-0,1
3	3,4	2,6	0,8
4	3,5	2,2	1,3
5	3,4	2,1	1,3
6	3,2	2,4	0,8
7	3,6	2,7	0,9
8	4,0	3,0	1,0
9	2,7	1,6	1,1
10	3,2	2,2	1,0
11	2,4	1,6	0,8
12	3,6	1,9	1,7
13	3,9	2,9	1,0
14	3,7	2,4	1,3
15	4,0	2,4	1,6
16	3,8	3,0	0,8
17	3,1	1,8	1,3
18	3,6	1,9	1,7
19	3,1	2,0	1,1
20	2,4	0,7	1,7
21	3,5	1,9	1,6
22	3,1	1,8	1,3
23	3,0	2,3	0,7
24	3,7	2,5	1,2
25	3,9	2,4	1,5
26	3,4	2,0	1,4
27	3,3	1,8	1,5
28	3,0	1,3	1,7
29	3,6	1,8	1,8
30	3,6	1,9	1,7
31	3,2	1,3	1,9
32	3,7	2,8	0,9
33	2,9	2,2	0,7
34	2,5	2,3	0,2
35	2,4	1,4	1,0
36	2,9	2,6	0,3

RANK DIFFERENCE OF MEANS		FINAL ITEM SELECTION
RANK DIFF. OF MEANS	ITEMS	
1,9	31	PURIFIED SCALE ITEMS
1,8	29	
1,7	28	
1,7	20	
1,7	18	
1,7	12	
1,7	30	
1,6	15	
1,6	21	
1,5	27	
1,5	25	
1,4	26	
1,3	17	
1,3	22	
1,3	14	
1,3	5	
1,3	4	
1,2	24	
1,1	19	
1,1	9	
1,0	35	DISCARDED ITEMS
1,0	13	
1,0	10	
1,0	8	
0,9	7	
0,9	32	
0,8	6	
0,8	3	
0,8	16	
0,8	11	
0,7	23	
0,7	33	
0,3	36	
0,2	34	
0,1	1	
-0,1	2	

COMMENTARY

1. We assume that the High and Low scoring groups are in fact criterion groups in terms of which we can evaluate the items. From this we infer that the purified scale has construct validity. 2. The split half reliability coefficient of this scale was found to be r = 0,92 (after correction).

PILOT TRIAL TWO: A SUMMARY OF THE PURIFIED ITEMS BY SCALES

SCALES

ITEMS INCLUDED IN PURIFIED SCALES

A	B	C	D	E	F
1	1	1	1	2	4
3	3	4	3	3	5
5	5	5	5	4	9
7	6	6	9	5	12
8	8	7	13	6	14
10	9	9	18	7	15
11	10	10	20	8	17
14	11	12	21	9	18
16	14	13	25	12	19
17	17	15	26	13	20
	19		27		21
	20		29		22
	22		30		24
	23		31		25
					26
					27
					28
					29
					30
					31

RELIABILITY COEFFICIENT (r)

0,64	0,66	0,72	0,80	0,79	0,92

THE PRETEST

Having constructed a reasonably valid and reliable set of attitude scales, the purpose of the pretest was to assess the initial attitudes of the experimental and control groups as a whole with regard to the six affective attitude clusters as embodied in the six aims of the Biology Syllabus and as measured by the six purified scales. This would enable the author to establish what attitude differences existed before the implementation of the environmental programme with the experimental group. There were two control groups; one group wrote the pretest,the other group did not, in order to enable the author to establish later on to what extent the pretest itself was a learning experience.

INDIVIDUAL RECORDS

Students were also asked to keep individual time and reading records, a copy of which is included in this section.

THE PRETEST

Note: The sequence of items has been randomised.

SCIENCE, NATURE AND ME - How I feel about my world.

Explanation: We are trying to find ways and means of making biology lessons more useful and interesting. If you answer as honestly as you can and only state your true feelings no matter what they may be, we will be a whole lot closer to success in our aims.

This sheet is intentionally anonymous. No one will ever know who you were, and no one will try to find out afterwards. This is to encourage you to give your true feelings about each item, rather than what you think the best answer is in any case.

There are 78 items. Please respond to each item by shading the block that is closest to your own feelings in the matter, there are no right answers, only different opinions.

For example:

All science teachers are very clever.

Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
	▒▒▒			

Important: 1. You must only shade one block per item.

2. You must respond once to every item.

A. RELATIONSHIPS IN NATURE.

1. I don't feel that I ought to pick up the rubbish that other people leave at picnic sites.
2. People caught littering beaches should be banned from using them for a year.
3. People should not be allowed to take cigarettes, pipes, matches or lighters into forestry areas.
4. Birds have no special preference for sitting in or visiting particular trees in our garden.
5. I would enjoy going on a field trip to search for the places where different kinds of animals live.

6. It's a shame to kill snakes, they are so useful.
7. There is no need for dogs in Cape Town to be licensed.
8. It's fun to explore rock-pools at the beach.
9. I enjoy following trails of ants in the garden to see where they are going to.
10. Many plants and animals are of no use at all.

B. THE IMPORTANCE OF SCIENCE

1. There are very clear boundaries separating Physics and Chemistry from Biology.
2. All biologists should have a sound grip of Physics, Chemistry and Mathematics in addition to Botany and Zoology.
3. Too much time is devoted to science and scientists on television.
4. A knowledge of science is essential to everyone.
5. I wouldn't go on a class visit to the Sea Fisheries Institute if it were arranged during the school holidays.
6. Scientists are working to create a better world.
7. Many important discoveries are based on lucky guess-work.
8. I'd be interested in helping to measure wind speeds on the school fields after school on a windy day to ensure that our new wind-break is planted in the best position.
9. Modern scientific discoveries have not helped the man-in-the-street very much.
10. I would like to hear a lecture by Prof. Chris Barnard at Seniors Club on "The possibility of building an artificial human heart".
11. Only pupils who are hoping to do scientific work one day should have to study Biology.
12. A biologist who studies Chemistry is wasting his time.
13. If I had the opportunity of helping to sample the air pollution from the power station after lunch break or go home instead; I'd rather go home.
14. Scientists are doing more harm than good in society today.

C./...

C. LEARNING BY LOOKING

1. I feel frustrated when the bell rings before I have had a sufficient chance to complete the experiment or problem I am working on.
2. I can't bear being rushed when examining a specimen.
3. I find plants and animals very interesting.
4. Too much time is wasted in practical classes when the teacher could tell us the answers in a few minutes.
5. People make far too much fuss about wildlife.
6. I would never bother to specially fetch a magnifier to take a closer look at insects or plants in the garden at home.
7. I never try to repeat any of the demonstration experiments I have seen at school when I get home.
8. I don't like Biology projects where I am expected to study things by myself. This sort of work is only important for those who wish to become scientists.
9. I don't think that all science fiction is improbable. Some authors have very interesting ideas.
10. Gardening is boring.

D. SCIENTISTS AT WORK

1. I never seem to have any ideas that can be tested experimentally.
2. Laboratory experiments are boring and waste a lot of time.
3. Scientists only believe the evidence of their eyes, ears and other senses. For example - they would never have faith in an unproven theory.
4. I would appreciate being allowed to work in the school biology lab. myself, after school on a project of my own.
5. Science is not one of my favourite subjects.
6. Normal people cannot hope to understand scientists, because geniuses are a bit queer anyway.

7/...

7. I believe we should all try to understand scientific articles even if they are dull at times, because they are accurate records of attempts to understand the world a bit better.
8. Mathematics teachers have no right to complain about messy working as long as the answer is correct.
9. No evidence would ever persuade me that our ancient ancestors came to live on earth as astronauts from Venus originally.
10. Scientific methods should be used by all business men.
11. Doctors rely a good deal on intuition and luck when diagnosing a problem case.
12. I don't mind science at school, but my holidays are too precious to waste on scientific investigations.
13. I would never give a girl (or boy) the satisfaction of knowing they were right and I was wrong.
14. I would enjoy a vacation job as lab. assistant to a research chemist.

E. READING SCIENTIFIC BOOKS

1. I don't have any special interest in Biology; all biological are of equal interest to me.
2. I didn't take an interest in the articles in the press dealing with seal culling in False Bay.
3. The man-in-the-street can rely on the honesty and integrity of newspaper reporters.
4. I enjoy watching T.V. programmes of wild animals and how they live.
5. I read all the articles in the newspaper that I find relating to the Biology that we study at school.
6. If I were given a wildlife book e.g. A Guide to South African Birdlife for a Christmas present, I would be disappointed.
7. Scientific articles are all equally dull as far as I am concerned.
8. I can't remember the name of a single scientific article that I have read in a book, magazine or newspaper during the last three months.

9. I never bother to finish reading articles dealing with biological topics that are hard to understand.
10. I sometimes borrow library books that concern animals or the people who live and work with them.

F. <u>MAN AND NATURE</u>

1. I don't bother to look at bird displays in museums any more. They bore me.
2. I don't understand why so much fuss is made about alien weeds like Hakea.
3. I don't have a favourite wild flower; one flower is as good as another.
4. I get angry when I see children dropping papers on the school fields.
5. I can't see the point of going for a hike along the coast to Langebaan Lagoon.
6. I think the people who worry about pollution are those that have no other problems to worry about.
7. I don't care where plants come from; it doesn't make any difference to me.
8. I enjoy visiting Kirstenbosch; there is always something different to look at.
9. I wish we had more wild flowers growing in our garden at home.
10. I would be prepared to help with the planting of extra proteas in our school garden on a Friday afternoon.
11. I don't know why others get so excited about visiting game reserves.
12. I hate people who carve their names on trees.
13. I would like to know how game rangers care for lions injured in fights.
14. I like walking through natural forests.
15. If I saw a spider spinning a web, I <u>wouldn't</u> bother to stop and watch it for a while.
16. I often stop to look at wild flowers when walking in the veld.

17./...

17. I would like to join a nature-orientated society one day, eg. The Cape Bird Club <u>or</u> The Mountain Club of South Africa <u>or</u> The South African Botanical Society <u>or</u> The Wildlife Society.
18. I <u>love</u> wild flowers and animals.
19. If we all just helped ourselves to a few wild flowers when we wanted them, there would soon be none left.
20. I would like to walk the Boland Trail during the next long weekend.

INDIVIDUAL RECORD OF READING AND PERSONAL INVESTIGATION

THIS RECORD IS COMPLETELY ANONYMOUS.

Record your class grouping in this space. CLASS 8 _______

This chart is designed to supply details of any changes in your reading pattern and record the time you spent in any extra work in Biology this term.

Please keep this chart in your desk at school and keep it up to date by completing it once a week.

There is no "correct" number of books to read or "ideal" number of hours to spend on Biology work, so please be completely honest as regards your record.

A. YOUR READING RECORD

Please list all the books you have looked at, even if you only read one page, or articles, magazines, newspaper reports or supplied photocopies.
Only those read during this first term are required.
To enable us to classify the pattern of your reading please tick the appropriate columns.

TITLE OF ARTICLE NAME OF BOOK (Please print)	Part of class assignment (i.e. compulsory)	Voluntary (Pure interest alone.)	Scientific Topic Yes	No

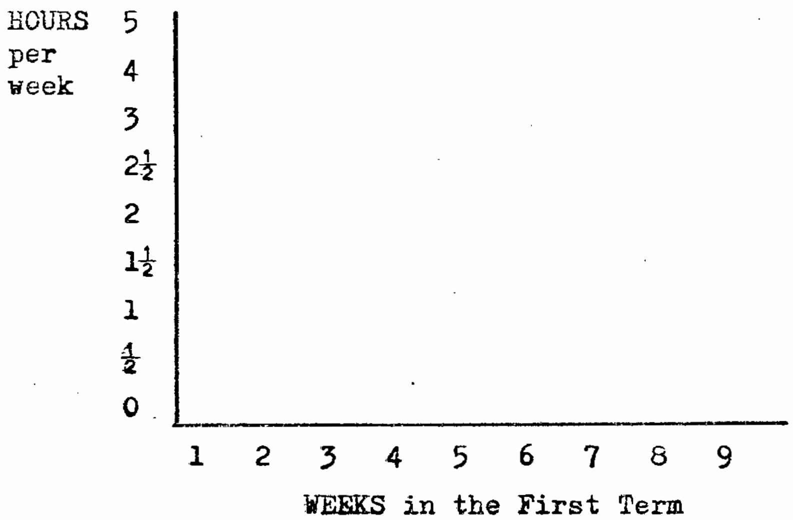
Has this past term (First term 1979) produced any changes in your normal reading habits? If the answer is yes; please explain the difference in a sentence or two, on the back of this sheet.

B. <u>YOUR TIME RECORD</u>

Please keep a weekly record of the number of hours you personally spent working or reading for your Biology assignments, OUTSIDE OF REGULAR CLASSROOM TIME and list the total for each week in the table below.

WEEK	h	WEEK	h
1		6	
2		7	
3		8	
4		9	
5			

Now graph your hours against weeks below.



C. <u>YOUR OPINION RECORD</u> (For the experimental group only)

1. Did you enjoy this experimental programme? ____________
(YES/NO)

2. Why did you enjoy / not enjoy this programme?

____

____

____

3. In what way is this programme better / or worse than normal Biology lessons you have received up until this year?

____

____

____

4. Would you like to change over to this method of studying Biology for the rest of your school course?

____
(YES/NO)

5. If your answer was YES to number 1 or 4, please explain how you feel this course has benefitted you where you may not have benefitted otherwise.

____

____

List any further remarks on the other side of this page.

PRETEST

COMPARISON OF MEANS OBTAINED BY EXPERIMENTAL AND CONTROL GROUPS

SCALES

	A	B	C	D	E	F
Mean of Experimental group	25,29	33,19	27,68	35,96	25,11	49,89
Expression as %	63,23	59,27	69,20	64,21	62,78	62,36
Mean of Control group	25,06	29,15	25,64	26,91	22,82	51,55
Expression as %	62,65	52,05	64,10	48,05	57,05	64,44
Difference in means	0,23	4,04	2,04	9,05	2,29	1,66
Expression as %	0,58	7,22	5,10	16,16	5,73	2,08
t value for 30 degrees of freedom	<1,00	1,84	<1,00	8,26 **	<1,00	<1,00
Mean of Combined Groups	25,16	31,00	26,57	31,07	23,87	50,79
Expression as %	62,90	55,36	66,43	55,48	59,67	63,48

** Significant difference in means at 1% level of confidence

Mean difference of at least 4,40 needed to establish a significant difference at the 5% level of confidence.

PRETEST: SCALE A

COMPARISON OF ITEM MEANS OBTAINED BY EXPERIMENTAL AND CONTROL GROUPS

ITEM	MEANS		DIFFERENCE IN MEANS	COMBINED MEANS
	EXPERIMENTAL GROUP	CONTROL GROUP		
1	1,54	1,88	0,34	1,72
2	2,04	2,03	0,01	2,03
3	2,61	2,60	0,01	2,61
4	2,64	2,90	0,26	2,78
5	3,11	3,00	0,11	2,97
6	2,21	2,06	0,15	2,13
7	2,96	3,00	0,04	2,98
8	2,96	2,82	0,14	2,89
9	2,04	1,70	0,34	1,85
10	3,11	2,94	0,17	3,02

COMMENTARY

No significant difference between the means of the two groups.

Mean difference of at least 0,59 needed to establish a significant difference at the 5% level of confidence.

PRETEST: SCALE B

COMPARISON OF ITEM MEANS OBTAINED BY EXPERIMENTAL AND CONTROL GROUPS

ITEM	MEANS		DIFFERENCE IN MEANS	COMBINED MEANS
	EXPERIMENTAL GROUP	CONTROL GROUP		
1	2,46	2,36	0,10	2,41
2	2,79	1,94	0,85**	2,32
3	2,86	1,82	1,04**	2,30
4	2,71	2,09	0,62*	2,34
5	2,04	1,97	0,07	2,00
6	2,21	1,97	0,24	2,08
7	2,50	2,27	0,23	2,38
8	1,39	1,36	0,03	1,38
9	2,82	2,15	0,67*	2,46
10	2,79	2,61	0,18	2,69
11	2,96	2,39	0,57	2,66
12	3,25	2,73	0,52	2,97
13	1,46	1,61	0,15	1,54
14	2,46	1,85	0,61*	2,13

COMMENTARY

* The mean differences of items 4,9 and 14 are significant at the 5% level of confidence.

** The mean differences of items 2 and 3 are significant at the 1% level of confidence.

Mean difference of at least 0,59 needed to establish a significant difference at the 5% level of confidence.
Mean difference of at least 0,83 needed to establish a significant difference at the 1% level of confidence.

PRETEST: SCALE C

COMPARISON OF ITEM MEANS OBTAINED BY EXPERIMENTAL AND CONTROL GROUPS

ITEM	MEANS		DIFFERENCE IN MEANS	COMBINED MEANS
	EXPERIMENTAL GROUP	CONTROL GROUP		
1	3,42	2,73	0,69*	3,05
2	3,25	2,82	0,43	3,02
3	2,96	2,94	0,02	2,95
4	3,57	2,82	0,75*	3,16
5	2,96	3,12	0,16	3,05
6	2,36	1,97	0,39	2,15
7	1,86	1,73	0,13	1,79
8	2,68	2,45	0,23	2,56
9	3,18	2,79	0,39	2,97
10	1,68	2,24	0,56	1,98

COMMENTARY

* The mean differences of items 1 and 4 are significant at the 5% level of confidence.

Mean difference of at least 0,59 needed to establish a significant difference at the 5% level of confidence.

PRETEST: SCALE D

COMPARISON OF ITEM MEANS OBTAINED BY EXPERIMENTAL AND CONTROL GROUPS

ITEM	MEANS		DIFFERENCE IN MEANS	COMBINED MEANS
	EXPERIMENTAL GROUP	CONTROL GROUP		
1	1,82	1,45	0,37	1,62
2	3,43	2,67	0,75*	3,02
3	2,11	1,36	0,75*	1,70
4	2,79	2,09	0,70*	2,41
5	2,93	1,09	1,84**	1,93
6	2,43	1,91	0,52	2,15
7	2,64	2,09	0,53	2,34
8	2,50	2,15	0,35	2,31
9	1,64	1,36	0,28	1,49
10	2,25	1,52	0,73*	1,85
11	2,96	3,00	0,04	2,98
12	2,18	1,12	1,06**	1,61
13	2,68	2,76	0,04	2,72
14	3,11	2,30	0,81*	2,67

COMMENTARY

* The mean differences of items 2,3,4, 10 and 14 are significant at the 5% level of confidence.

** The mean differences of items 5 and 12 are significant at the 1% level of confidence.

Mean difference of at least 0,59 needed to establish a significant difference at the 5% level of confidence.
Mean difference of at least 0,83 needed to establish a significant difference at the 1% level of confidence.

PRETEST: SCALE E

COMPARISON OF ITEM MEANS OBTAINED BY EXPERIMENTAL AND CONTROL GROUPS

ITEM	MEANS		DIFFERENCE IN MEANS	COMBINED MEANS
	EXPERIMENTAL GROUP	CONTROL GROUP		
1	2,46	2,24	0,22	2,34
2	2,89	3,27	0,38	3,10
3	3,25	3,03	0,22	3,13
4	3,36	3,03	0,33	3,18
5	1,75	1,42	0,33	1,57
6	2,36	2,24	0,12	2,30
7	2,89	2,21	0,68*	2,52
8	2,21	1,58	0,63*	1,87
9	1,82	2,00	0,18	1,92
10	2,25	1,94	0,31	2,08

COMMENTARY

* The mean difference of items 7 and 8 are significant at the 5% level of confidence

Mean differences of at least 0,59 needed to establish a significant difference at the 5% level of confidence.

PRETEST: SCALE F

COMPARISON OF ITEM MEANS OBTAINED BY EXPERIMENTAL AND CONTROL GROUPS

ITEM	MEANS		DIFFERENCE IN MEANS	COMBINED MEANS
	EXPERIMENTAL GROUP	CONTROL GROUP		
1	2,39	2,58	0,19	2,49
2	2,86	2,73	0,13	2,79
3	1,96	2,48	0,48	2,24
4	2,21	2,21	0,00	2,21
5	2,93	3,18	0,25	3,07
6	2,86	3,30	0,44	3,10
7	2,68	2,56	0,12	2,61
8	1,82	2,30	0,48	2,08
9	2,32	2,36	0,04	2,34
10	1,18	1,21	0,03	1,20
11	3,11	2,79	0,32	2,93
12	2,36	2,09	0,27	2,21
13	3,25	3,21	0,04	3,22
14	3,07	3,03	0,04	3,05
15	2,96	2,64	0,32	2,79
16	2,11	2,58	0,47	2,36
17	2,29	2,03	0,26	2,15
18	2,36	2,61	0,25	2,49
19	2,82	3,24	0,42	3,05
20	2,39	2,27	0,12	2,33

COMMENTARY

No significant difference between the means of the two groups.

Mean difference of at least 0,59 needed to establish a significant difference at the 5% level of confidence.

PRETEST

SUMMARY OF SIGNIFICANT DIFFERENCES BETWEEN EXPERIMENTAL AND CONTROL GROUPS ON INDIVIDUAL ITEMS

SIGNIFICANT DIFFERENCES AT THE 5% LEVEL OF CONFIDENCE

A	B	C	D	E	F
-	4 9 14	1 4	2 3 4 10 14	7 8	-

SIGNIFICANT DIFFERENCES AT THE 1% LEVEL OF CONFIDENCE

A	B	C	D	E	F
-	2 3	-	5 12	-	-

THE POST TEST

After the conclusion of the experimental programme, the pretest was repeated as a post test. The author's purpose was to establish the extent of significant difference between the two groups that could be attributed to the programme. Two control groups were used at this stage in order that a comparison could be made between the control group that wrote the pretest and the group that did not write the pretest.

INDIVIDUAL RECORDS

The pupils' personal time and reading records were evaluated at this stage.

THE POST TEST

Note: The items are in the same sequence as the pretest items.

SCIENCE, NATURE AND ME - How I feel about my world.

Explanation: During this term you have been given many opportunities to reconsider some of your ideas and opinions about your world and the people who share it with you. This may mean that some of the answers to the questions you answered at the start of this term have changed, as you gained a better understanding of what was involved concerning the relationships in nature, and the importance of the scientist and his methods for identifying and solving problems. You have learned to observe scientifically, and use experimental methods to get to the facts. You have probably read more "scientific" reading matter in the last two months than in the whole of your life preceeding this programme. You have had an opportunity to measure the impact man makes on nature at firsthand.
These experiences may have changed your outlook somewhat, so this is another opportunity for you to record how you feel about these things right now, in the light of what you now know.

HEREAFTER THE POST TEST IS IDENTICAL TO THE PRETEST TABLED ON PAGES B49 TO B53.

Namely:

SCALE A - RELATIONSHIPS IN NATURE page B49
SCALE B - THE IMPORTANCE OF SCIENCE page B50
SCALE C - LEARNING BY LOOKING page B51
SCALE D - SCIENTISTS AT WORK page B51
SCALE E - READING SCIENTIFIC BOOKS page B52
SCALE F - MAN AND NATURE page B53

POST TEST

COMPARISON OF MEANS OBTAINED BY EXPERIMENTAL AND CONTROL GROUP A

	SCALES					
	A	B	C	D	E	F
Mean of Experimental Group	27,0	37,8	29,1	38,2	26,6	55,5
Expression as %	67,5	67,7	72,8	68,2	66,6	69,4
Mean of Control Group A	24,8	31,0	24,4	26,1	21,8	50,4
Expression as %	62,0	55,4	61,1	46,6	54,5	63,0
Difference in means	2,2	6,8	4,7	12,1	4,8	5,1
Expression as %	5,5	12,3	11,7	21,6	12,1	6,4
t value for 30 degrees of freedom	1,60	2,42*	$>$2,04*	$>$2,75**	2,31*	$>$2,04*

* Significant difference in means at 5% level of confidence
** Significant difference in means at 1% level of confidence

Mean difference of about 4,40 needed to establish a significant difference at the 5% level of confidence.

The pre- and post- test means of the Experimental and Control Group A have been compared on page B75.

POST TEST: SCALE A

COMPARISON OF ITEM MEANS OBTAINED BY EXPERIMENTAL GROUP AND CONTROL A USING RAW SCORES ONLY BEFORE ADJUSTMENT FOR PRETEST DIFFERENCES

ITEM	MEANS		DIFFERENCE IN MEANS
	EXPERIMENTAL GROUP	CONTROL GROUP	
1	2,07	1,59	0,48
2	2,35	1,90	0,45
3	3,03	2,62	0,41
4	2,60	2,84	0,24
5	3,32	3,09	0,23
6	2,57	2,34	0,17
7	2,96	3,03	0,07
8	2,96	2,53	0,43
9	1,89	1,96	0,07
10	3,21	2,96	0,25

COMMENTARY

No significant difference between the means of the two groups is found.

Mean difference of about 0,59 needed to establish a significant difference at the 5% level of confidence.

PRETEST/POST TEST: SCALE A

ADJUSTMENT OF POST TEST ITEM MEAN DIFFERENCES OBTAINED BY EXPERIMENTAL GROUP AND CONTROL A TO COMPENSATE FOR PRETEST DIFFERENCES

ITEM No's	ITEM POOL No's	DIFFERENCE BETWEEN ITEM MEANS OBTAINED ON POST TEST AND PRETEST		DIFFERENCE OF DIFFERENCES
		EXPERIMENTAL GROUP (DE)	CONTROL A (DA)	(DE – DA)
4	2	−0,04	−0,06	0,02
6	4	0,36	0,28	0,08
10	5	0,10	0,02	0,08
8	6	0,00	−0,29	0,29
5	8	0,21	0,09	0,12
9	9	−0,15	0,26	−0,41+
1	13	0,53	−0,29	0,82*
2	14	0,31	−0,13	0,44+
3	15	0,42	0,02	0,40+
7	17	0,00	0,03	0,03

** $p \leqslant 0{,}01$
* $0{,}05 \leqslant p < 0{,}01$ } FIRM CONCLUSIONS

++ $0{,}10 \leqslant p < 0{,}05$
+ $0{,}20 \leqslant p < 0{,}10$ } DEVELOPING TRENDS

POST TEST: SCALE B

COMPARISON OF ITEM MEANS OBTAINED BY EXPERIMENTAL GROUP

AND CONTROL A USING RAW SCORES ONLY BEFORE ADJUSTMENT FOR PRETEST DIFFERENCES.

ITEM	MEANS		DIFFERENCE IN MEANS
	EXPERIMENTAL GROUP	CONTROL GROUP	
1	2,50	2,28	0,22
2	2,53	1,90	0,63 *
3	2,89	2,40	0,49
4	2,50	2,50	0,00
5	2,17	1,81	0,36
6	2,60	2,00	0,60 *
7	2,89	2,50	0,39
8	1,82	1,43	0,39
9	3,46	2,40	1,06 **
10	3,10	2,75	0,35
11	3,07	2,53	0,54
12	3,32	2,93	0,39
13	2,28	1,56	0,72 *
14	2,42	2,18	0,24

COMMENTARY

* The mean difference of items 2, 6 and 13 are significant at the 5% level of confidence.

** The mean difference of item 9 is significant at the 1% level of confidence.

> Mean difference of about 0,59 needed to establish a significant difference at the 5% level of confidence.
> Mean difference of about 0,83 needed to establish a significant difference at the 1% level of confidence.

PRETEST/POST TEST: SCALE B

ADJUSTMENT OF POST TEST ITEM MEAN DIFFERENCES OBTAINED BY EXPERIMENTAL GROUP AND CONTROL A TO COMPENSATE FOR PRETEST DIFFERENCES

ITEM No's	ITEM POOL No's	DIFFERENCE BETWEEN ITEM MEANS OBTAINED ON POST TEST AND PRETEST		DIFFERENCE OF DIFFERENCES
		EXPERIMENTAL GROUP (DE)	CONTROL A (DA)	(DE – DA)
11	2	0,11	0,14	– 0,03
4	3	–0,21	0,41	– 0,62*
1	6	0,04	–0,08	0,12
2	7	–0,26	–0,04	– 0,22
12	8	0,07	0,20	– 0,13
14	10	–0,04	0,33	– 0,37+
10	11	0,31	0,14	0,17
3	12	0,03	0,58	– 0,55++
5	14	0,13	–0,16	0,29
7	16	0,39	0,23	0,16
8	19	0,43	0,07	0,36+
13	20	0,82	–0,05	0,87**
6	22	0,39	0,03	0,36+
9	23	0,64	0,25	0,39+

** $p \leqslant 0,01$ }
* $0,05 \leqslant p < 0,01$ } FIRM CONCLUSIONS

++ $0,10 \leqslant p < 0,05$ }
+ $0,20 \leqslant p < 0,10$ } DEVELOPING TRENDS

POST TEST: SCALE C

COMPARISON OF ITEM MEANS OBTAINED BY EXPERIMENTAL GROUP AND CONTROL A USING RAW SCORES ONLY BEFORE ADJUSTMENT FOR PRETEST DIFFERENCES.

ITEM	MEANS		DIFFERENCE IN MEANS
	EXPERIMENTAL GROUP	CONTROL GROUP	
1	3,07	2,50	0,57
2	3,21	2,75	0,46
3	3,14	2,62	0,52
4	3,32	2,90	0,42
5	3,64	3,09	0,55
6	2,35	2,25	0,10
7	2,28	1,71	0,57
8	2,75	2,12	0,63 *
9	3,35	2,43	0,92 **
10	1,96	2,06	0,10

COMMENTARY

* The mean difference of item 8 is significant at the 5% level of confidence.

** The mean difference of item 9 is significant at the 1% level of confidence.

Mean difference of about 0,59 needed to establish a significant difference at the 5% level of confidence.
Mean difference of about 0,83 needed to establish a significant difference at the 1% level of confidence.

PRETEST/POST TEST: SCALE C

ADJUSTMENT OF POST TEST ITEM MEAN DIFFERENCES OBTAINED BY EXPERIMENTAL GROUP AND CONTROL A TO COMPENSATE FOR PRETEST DIFFERENCES

ITEM No's	ITEM POOL No's	DIFFERENCE BETWEEN ITEM MEANS OBTAINED ON POST TEST AND PRETEST		DIFFERENCE OF DIFFERENCES (DE – DA)
		EXPERIMENTAL GROUP (DE)	CONTROL A (DA)	
3	1	0,18	-0,32	0,50++
5	2	0,68	-0,03	0,71*
10	5	0,28	-0,18	0,46+
6	8	-0,01	0,28	– 0,29
4	9	-0,25	0,08	– 0,33
9	11	0,17	-0,36	0,53++
8	14	0,07	-0,33	0,40+
2	16	-0,04	-0,07	0,03
1	17	-0,35	-0,23	0,12
7	18	0,42	-0,02	0,44+

** $p < 0,01$ }
* $0,05 \leqslant p < 0,01$ } FIRM CONCLUSIONS

++ $0,10 \leqslant p < 0,05$ }
+ $0,20 \leqslant p < 0,10$ } DEVELOPING TRENDS

POST TEST: SCALE D

COMPARISON OF ITEM MEANS OBTAINED BY EXPERIMENTAL GROUP AND CONTROL A USING RAW SCORES ONLY BEFORE ADJUSTMENT FOR PRETEST DIFFERENCES.

ITEM	MEANS		DIFFERENCE IN MEANS
	EXPERIMENTAL GROUP	CONTROL GROUP	
1	1,85	1,56	0,29
2	3,39	2,43	0,96 **
3	2,10	1,62	0,48
4	2,92	1,81	1,11 **
5	3,07	1,12	1,95 **
6	2,85	1,87	0,98 **
7	3,00	2,15	0,85 **
8	2,78	2,09	0,69 *
9	2,64	1,40	1,24 **
10	2,35	1,53	0,82 *
11	2,85	2,65	0,20
12	2,35	1,34	1,01 **
13	3,00	2,81	0,19
14	3,25	1,96	1,29 **

COMMENTARY

* The mean difference of items 8 and 10 are significant at the 5% level of confidence.

** The mean difference of items 2,4,5,6,7,9,12 and 14 are significant at the 1% level of confidence.

Mean difference of about 0,59 needed to establish a significant difference at the 5% level of confidence.
Mean difference of about 0,83 needed to establish a significant difference at the 1% level of confidence.

PRETEST/POST TEST: SCALE D

ADJUSTMENT OF POST TEST ITEM MEAN DIFFERENCES OBTAINED BY EXPERIMENTAL GROUP AND CONTROL A TO COMPENSATE FOR PRETEST DIFFERENCES

ITEM No's	ITEM POOL No's	DIFFERENCE BETWEEN ITEM MEANS OBTAINED ON POST TEST AND PRETEST		DIFFERENCE OF DIFFERENCES
		EXPERIMENTAL GROUP(DE)	CONTROL A (DA)	(DE - DA)
2	5	-0,04	-0,24	0,20
11	10	-0,09	-0,35	0,26
6	11	0,42	-0,04	0,46+
14	12	0,14	-0,34	0,48++
1	14	0,03	0,11	− 0,08
8	18	0,28	-0,06	0,34
4	19	0,13	-0,28	0,41+
5	20	0,14	0,03	0,11
13	26	0,32	0,05	0,27
7	27	0,36	0,06	0,30
12	30	0,17	0,22	− 0,05
10	36	0,10	0,01	0,09
3	40	-0,01	0,26	− 0,27
9	44	1,00	0,04	0,96**

** $p \leqslant 0{,}01$ } FIRM CONCLUSIONS
* $0{,}05 \leqslant p < 0{,}01$

++ $0{,}10 \leqslant p < 0{,}05$ } DEVELOPING TRENDS
+ $0{,}20 \leqslant p < 0{,}10$

POST TEST: SCALE E

COMPARISON OF ITEM MEANS OBTAINED BY EXPERIMENTAL GROUP AND CONTROL A USING RAW SCORES ONLY BEFORE ADJUSTMENT FOR PRETEST DIFFERENCES

ITEM	MEANS		DIFFERENCE IN MEANS
	EXPERIMENTAL GROUP	CONTROL GROUP	
1	2,32	2,06	0,26
2	2,78	3,00	0,22
3	3,32	2,90	0,42
4	3,50	2,93	0,57
5	1,92	1,53	0,39
6	2,50	1,96	0,54
7	3,21	2,06	1,15 **
8	3,00	2,06	0,94 **
9	2,17	1,68	0,49
10	2,67	2,06	0,61 *

COMMENTARY

* The mean difference of item 10 is significant at the 5% level of confidence.

** The mean difference of items 7 and 8 are significant at the 1% level of confidence.

Mean difference of about 0,59 needed to establish a significant difference at the 5% level of confidence. Mean difference of about 0,83 needed to establish a significant difference at the 1% level of confidence.

PRETEST/POST TEST: SCALE E

ADJUSTMENT OF POST TEST ITEM MEAN DIFFERENCES OBTAINED BY EXPERIMENTAL GROUP AND CONTROL A TO COMPENSATE FOR PRETEST DIFFERENCES

ITEM No's	ITEM POOL No's	DIFFERENCE BETWEEN ITEM MEANS OBTAINED ON POST TEST AND PRETEST		DIFFERENCE OF DIFFERENCES
		EXPERIMENTAL GROUP (DE)	CONTROL A (DA)	(DE - DA)
5	1	0,17	0,11	0,06
8	2	0,79	0,48	0,31
4	3	0,14	-0,10	0,24
2	4	-0,11	-0,27	0,16
7	5	0,32	-0,15	0,47++
1	8	-0,14	-0,18	0,04
9	9	0,35	-0,32	0,67*
3	14	0,07	-0,13	0,20
6	15	0,14	-0,28	0,42+
10	16	0,42	0,12	0,30

* $0,05 \leqslant p < 0,01$ } FIRM CONCLUSIONS

++ $0,10 \leqslant p < 0,05$

\+ $0,20 \leqslant p < 0,10$ } DEVELOPING TRENDS

POST TEST: SCALE F

COMPARISON OF ITEM MEANS OBTAINED BY EXPERIMENTAL GROUP AND CONTROL A USING RAW SCORES ONLY BEFORE ADJUSTMENT FOR PRETEST DIFFERENCES.

ITEM	MEANS		DIFFERENCE IN MEANS
	EXPERIMENTAL GROUP	CONTROL GROUP	
1	2,57	2,62	0,05
2	2,82	3,00	0,18
3	2,46	2,43	0,03
4	2,57	2,43	0,14
5	3,17	3,00	0,17
6	3,53	2,90	0,63 *
7	3,14	2,59	0,55
8	2,14	2,09	0,05
9	2,57	2,21	0,36
10	1,64	1,18	0,46
11	3,32	3,00	0,32
12	2,32	2,09	0,23
13	3,35	3,03	0,33
14	3,28	2,96	0,32
15	3,25	2,75	0,50
16	2,28	2,31	0,03
17	2,60	1,84	0,76 *
18	2,75	2,65	0,10
19	3,21	3,31	0,10
20	2,64	2,09	0,55

COMMENTARY

* The mean difference of items 6 and 17 are significant at the 5% level of confidence.

Mean difference of about 0,59 needed to establish a significant difference at the 5% level of confidence.

PRETEST/POST TEST: SCALE F

ADJUSTMENT OF POST TEST ITEM MEAN DIFFERENCES OBTAINED BY EXPERIMENTAL GROUP AND CONTROL A TO COMPENSATE FOR PRETEST DIFFERENCES

ITEM No's	ITEM POOL No's	DIFFERENCES BETWEEN ITEM MEANS OBTAINED ON POST TEST AND PRETEST		DIFFERENCE OF DIFFERENCES
		EXPERIMENTAL GROUP(DE)	CONTROL A (DA)	(DE – DA)
16	1	0,17	-0,27	0,44+
11	2	0,21	0,21	0,00
2	3	-0,04	0,27	– 0,31
7	4	0,46	0,03	0,43+
6	8	0,67	-0,40	1,07**
1	9	0,18	0,04	0,14
8	10	0,32	-0,21	0,53++
13	11	0,10	-0,18	0,28
14	15	0,21	-0,07	0,28
5	16	0,24	-0,18	0,42+
3	17	0,50	-0,05	0,55++
15	18	0,29	0,11	0,18
4	19	0,36	0,22	0,14
19	21	0,39	0,07	0,32
20	28	0,25	-0,18	0,43+
17	30	0,31	-0,19	0,50++
9	31	0,25	-0,15	0,40+
10	32	0,46	-0,03	0,49++
18	33	0,39	0,04	0,35
12	34	-0,04	0,00	– 0,04

** $p \leqslant 0{,}01$ * $0{,}05 \leqslant p < 0{,}01$ FIRM CONCLUSIONS

++ $0{,}10 \leqslant p < 0{,}05$ + $0{,}20 \leqslant p < 0{,}10$ DEVELOPING TRENDS

POST TEST

COMPARISON OF PRE- AND POST TEST RESULTS OF EXPERIMENTAL GROUP AND CONTROL A

EXPERIMENTAL GROUP

SCALES

	A	B	C	D	E	F
Pretest Means	25,3	33,2	27,7	36,0	25,1	49,9
Expression as %	63,2	59,3	69,2	64,2	62,8	62,4
Post test Means	27,0	37,8	29,1	38,2	26,6	55,5
Expression as %	67,5	67,7	72,8	68,2	66,6	69,4
Difference in means	1,7	4,6	1,4	2,2	1,5	5,6
Expression as %	4,3	8,4	3,6	4,0	3,8	7,0
t value for 30 degrees of freedom	1,22	1,82	<1,22	1,35	<1,22	1,85

CONTROL A

	A	B	C	D	E	F
Pretest Means	25,1	29,2	25,6	26,9	22,8	51,5
Expression as %	62,7	52,1	64,1	48,1	57,1	64,4
Post Test Means	24,8	31,0	24,4	26,1	21,8	50,4
Expression as %	62,0	55,4	61,1	46,6	54,5	63,0
Difference in means	-0,3	1,8	-1,2	-0,8	-1,0	-1,1
Expression as %	-0,7	3,3	-3,0	-1,5	-2,6	-1,4
t value for 30 degrees of freedom	<1,35	<1,35	<1,35	<1,35	<1,35	<1,35

POST TEST

COMPARISON OF MEANS OBTAINED BY CONTROL GROUPS A AND B

	SCALES					
	A	B	C	D	E	F
Mean of Control A	24,8	31,0	24,4	26,1	21,8	50,4
Expression as %	62,0	55,4	61,1	46,6	54,5	63,0
Mean of Control B	20,5	29,5	23,7	25,4	20,2	49,6
Expression as %	51,1	52,7	59,1	45,4	50,5	62,0
Difference in means	4,3	1,5	0,7	0,7	1,6	0,8
Expression as %	10,9	2,7	2,0	1,2	4,0	1,0
t value for 30 degrees of freedom	2,86**	$<$0,72	$<$0,72	$<$0,72	0,72	$<$0,72

COMMENTARY

Only Scale A shows a significant difference between the two control groups after the post test.

THE POST-POST TEST

A term of normal lecture/demonstration teaching followed the experimental programme. At the end of this second term the post test was repeated as a post-post test. The writer's purpose was to see if the changes in attitude noted on the post test were still significantly different from pretest levels or otherwise.
Only one control group was used, hereafter referred to as Control A.

Note: The items are in the same sequence as the post test items.

SCIENCE, NATURE AND ME – How I feel about my world.

Explanation: Some of you have had the opportunity during the first term to participate in a programme designed to make Biology a more relevant and interesting school subject.
At the same time it was designed to help you rethink some of your opinions about and attitudes towards your world and the people who share it with you.
Since the end of the first term you have been taught Biology by more traditional methods, unless you have been taught in the conventional style right from the beginning of the year as some classes have been taught. This might mean that once the excitement of the programme abated, you may have been inclined to have second thoughts about some of the statements in these scales or even feel just as strongly about them as ever.
This is the final opportunity for you to state your views, anonymously, about how you feel about these statements right now!

Your teacher will share the available results of the responses you made as a class before and after the experimental programme, once you have completed this task, which marks the end of the experiment.

Your interest and co-operation have helped to pave the way to a more stimulating approach to Biology teaching. Thank you !

There are still 78 items. Please respond to all items by shading the block closest to your own feelings in the matter. There are no right answers, only different opinions.

HEREAFTER THE POST-POST TEST IS IDENTICAL TO THE PRETEST TABLED ON PAGES B49 TO B53.

Namely:

SCALE A - RELATIONSHIPS IN NATURE page B49
SCALE B - THE IMPORTANCE OF SCIENCE page B50
SCALE C - LEARNING BY LOOKING page B51
SCALE D - SCIENTISTS AT WORK page B51
SCALE E - READING SCIENTIFIC BOOKS page B52
SCALE F - MAN AND NATURE page B53

THE POST-POST TEST

COMPARISON OF MEANS OBTAINED BY EXPERIMENTAL AND CONTROL GROUP A ON ALL THREE PHASES OF TESTING

(Means expressed as percentages and raw scores indicated in brackets.)

EXPERIMENTAL GROUP	A	B	C	D	E	F
PRETEST (1E)	63,2 (25,3)	59,3 (33,2)	69,2 (27,7)	64,2 (36,0)	62,8 (25,1)	62,4 (49,9)
POST TEST (2E)	67,5 (27,0)	67,7 (37,0)	72,8 (29,1)	68,2 (38,2)	66,6 (26,6)	69,4 (55,5)
POST-POST TEST (3E)	67,1 (26,8)	65,7 (36,8)	71,9 (28,7)	68,5 (38,4)	67,2 (26,9)	69,1 (55,3)

CONTROL GROUP A	A	B	C	D	E	F
PRETEST (1A)	62,7 (25,1)	52,1 (29,2)	64,1 (25,6)	48,1 (26,9)	57,1 (22,8)	64,4 (51,6)
POST TEST (2A)	62,0 (24,8)	55,4 (31,0)	61,1 (24,4)	46,6 (26,1)	54,5 (21,8)	63,0 (50,4)
POST-POST TEST (3A)	64,7 (25,7)	54,2 (30,4)	62,6 (25,0)	47,5 (26,6)	59,1 (23,6)	67,9 (54,4)

The differences between these tests are compared on page B79

COMPARISON OF DIFFERENCES OBTAINED BY EXPERIMENTAL GROUP AND CONTROL GROUP A ON ALL THREE PHASES OF TESTING

Note: The symbols being used were introduced on page B78
Means are expressed as percentages and raw scores are indicated in brackets.

EXPERIMENTAL GROUP	A	B	C	D	E	F	From page:
2E - 1E	4,3 (1,7)	8,4* (4,6)	3,6 (1,4)	4,0 (2,2)	3,8 (1,5)	7,0* (5,6)	B75
3E - 2E	-0,4 (-0,2)	-2,0 (-0,4)	-0,9 (-0,4)	0,3 (0,2)	0,6 (0,3)	-0,3 (-0,2)	
3E - 1E	3,8 (1,5)	6,4 (3,6)	2,5 (1,0)	4,3 (2,4)	4,5 (1,8)	6,8* (5,4)	

CONTROL GROUP A	A	B	C	D	E	F	From page:
2A - 1A	-0,7 (-0,3)	3,3 (1,8)	-3,0 (-1,2)	-1,5 (-0,8)	-2,6 (-1,0)	-1,4 (-1,1)	B75
3A - 2A	2,7 (1,1)	-1,2 (-0,6)	1,5 (0,6)	0,9 (0,5)	4,6 (1,8)	4,9 (4,0)	
3A - 1A	1,5 (0,6)	2,1 (1,2)	-1,5 (-0,6)	-0,5 (-0,3)	2,0 (0,8)	3,5 (2,8)	

* Significant difference at the 5% level of confidence.

Continued from the previous page:

COMPARISON OF DIFFERENCES BEFORE AND AFTER ADJUSTMENT FOR PRETEST DIFFENCES

Note: The symbols being used were introduced on page B78
Means are expressed as percentages and raw scores are indicated in brackets.

BEFORE ADJUSTMENT	A	B	C	D	E	F	From page:
1E - 1A	0,6 (0,2)	7,2 (4,0)	5,1 (2,0)	16,2** (9,1)	5,7 (2,3)	-2,1 (-1,7)	B58
2E - 2A	5,5 (2,2)	12,3* (6,8)	11,7* (4,7)	21,6** (12,1)	12,1* (4,8)	6,4* (5,1)	B68
3E - 3A	2,4 (1,1)	11,5* (6,4)	9,3 (3,7)	21,0** (11,8)	8,1 (3,3)	1,2 (0,9)	

AFTER ADJUSTMENT	A	B	C	D	E	F	From page:
(2E-2A)-(1E-1A)	4,9 (2,0)	5,1 (2,8)	6,6 (2,7)	5,4 (3,0)	6,4 (2,5)	8,5* (6,8)	p. 251
(3E-3A)-(1E-1A)	1,8 (0,9)	4,3 (2,4)	4,2 (1,7)	4,8 (2,7)	2,4 (1,0)	3,3 (2,6)	

* Significant difference at the 5% level of confidence
** Significant difference at the 1% level of confidence

POST-POST TEST: SCALE A

COMPARISON OF ITEM MEANS OBTAINED BY EXPERIMENTAL AND CONTROL GROUP A USING RAW SCORES ONLY BEFORE ADJUSTMENT FOR PRETEST DIFFERENCES.

ITEM	MEANS		DIFFERENCE IN MEANS
	EXPERIMENTAL GROUP	CONTROL GROUP	
1	1,77	1,52	0,25
2	2,35	2,45	-0,10
3	3,08	2,97	0,11
4	2,92	3,19	-0,27
5	3,31	2,90	0,41
6	2,50	2,52	-0,02
7	3,08	3,03	0,05
8	2,73	2,74	-0,01
9	2,15	1,39	0,76*
10	3,31	3,16	0,15

COMMENTARY

* The mean difference of item 9 is significant at the 5% level of confidence.

PRETEST/POST-POST TEST : SCALE A

ADJUSTMENT OF POST-POST TEST ITEM MEAN DIFFERENCES OBTAINED BY EXPERIMENTAL GROUP AND CONTROL GROUP A TO COMPENSATE FOR PRETEST DIFFERENCES.

ITEM No's	ITEM POOL No's	DIFFERENCE BETWEEN ITEM MEANS OBTAINED ON POST-POST TEST AND PRETEST		DIFFERENCE OF DIFFERENCES (DE - DA)
		EXPERIMENTAL GROUP (DE)	CONTROL GROUP (DA)	
4	2	0,28	0,29	-0,01
6	4	0,29	0,46	-0,17
10	5	0,20	0,22	-0,02
8	6	-0,23	-0,08	-0,15
5	8	0,20	-0,10	0,30
9	9	0,11	-0,31	0,42+
1	13	0,23	-0,36	0,59*
2	14	0,31	0,42	-0,11
3	15	0,47	0,37	0,10
7	17	0,12	0,03	0,09

** $p \leqslant 0,01$ } Significant differences

* $0,05 \geqslant p > 0,01$ }

++ $0,10 \geqslant p > 0,05$ } Moderately significant differences

+ $0,20 \geqslant p > 0,10$ }

POST TEST/POST-POST TEST: SCALE A

COMPARISON OF SIGNIFICANT AND MODERATELY SIGNIFICANT MEAN DIFFERENCES OBTAINED WHEN ADJUSTED POST TEST AND POST-POST TEST DIFFERENCES OBTAINED BY EXPERIMENTAL AND CONTROL GROUPS ARE COMPARED FOR EACH ITEM.

ITEM No.	ADJUSTED POST TEST DIFFERENCES From page B69a	ADJUSTED POST-POST TEST DIFFERENCES From page B80a
1	0,82*	0,59*
2	0,44+	-0,11
3	0,40+	0,10
4	0,02	-0,01
5	0,12	0,30
6	0,08	-0,17
7	0,03	0,09
8	0,29	-0,15
9	-0,41+	0,42+
10	0,08	-0,02

**	$p < 0,01$	Significant differences
*	$0,05 > p > 0,01$	
++	$0,10 > p > 0,05$	Moderately significant differences
+	$0,20 > p > 0,10$	

POST -POST TEST : SCALE B

COMPARISON OF ITEM MEANS OBTAINED BY EXPERIMENTAL AND CONTROL GROUP A USING RAW SCORES ONLY BEFORE ADJUSTMENT FOR PRETEST DIFFERENCES.

ITEM	MEANS		DIFFERENCE IN MEANS
	EXPERIMENTAL GROUP	CONTROL GROUP	
1	2,69	2,23	0,46
2	2,58	2,06	0,52
3	3,04	1,87	1,17**
4	2,38	2,13	0,25
5	2,12	2,26	-0,14
6	2,42	2,13	0,29
7	3,04	2,48	0,56
8	1,77	1,42	0,35
9	3,04	2,42	0,62*
10	2,92	2,65	0,27
11	3,08	2,29	0,79*
12	3,15	2,48	0,67*
13	1,85	1,84	0,01
14	2,85	2,19	0,66*

COMMENTARY

* The mean difference of items 9,11,12 and 14 are significant at at the 5% level of confidence.

** The mean difference of item 3 is significant at the 1% level of confidence.

PRETEST/POST-POST TEST : SCALE B

ADJUSTMENT OF POST-POST TEST ITEM MEAN DIFFERENCES OBTAINED BY EXPERIMENTAL GROUP AND CONTROL GROUP A TO COMPENSATE FOR PRETEST DIFFERENCES.

ITEM No's	ITEM POOL No's	DIFFERENCE BETWEEN ITEM MEANS OBTAINED ON POST-POST TEST AND PRETEST		DIFFERENCE OF DIFFERENCES (DE - DA)
		EXPERIMENTAL GROUP (DE)	CONTROL GROUP(DA)	
11	2	0,12	-0,10	0,22
4	3	-0,33	0,04	-0,37+
1	6	0,23	-0,13	0,36+
2	7	-0,21	0,12	-0,33
12	8	-0,10	-0,35	0,25
14	10	0,39	0,34	0,05
10	11	0,13	0,04	0,09
3	12	0,18	0,05	0,13
5	14	0,08	0,29	-0,21
7	16	0,54	0,21	0,33
8	19	0,38	0,06	0,32
13	20	0,39	0,23	0,16
6	22	0,21	0,16	0,05
9	23	0,22	0,27	-0,05

+ $0,20 \gg p > 0,10$

POST TEST / POST -POST TEST : SCALE B

COMPARISON OF SIGNIFICANT AND MODERATELY SIGNIFICANT MEAN DIFFERENCES OBTAINED WHEN ADJUSTED POST TEST AND POST - POST TEST DIFFERENCES OBTAINED BY EXPERIMENTAL AND CONTROL GROUPS ARE COMPARED FOR EACH ITEM.

ITEM No.	ADJUSTED POST TEST DIFFERENCES From page B70a	ADJUSTED POST - POST TEST DIFFERENCES From page B81a
1	0,12	0,36+
2	-0,22	-0,33
3	-0,55++	0,13
4	-0,62*	-0,37+
5	0,29	-0,21
6	0,36+	0,05
7	0,16	0,33
8	0,36+	0,32
9	0,39+	-0,05
10	0,17	0,09
11	-0,03	0,22
12	-0,13	0,25
13	0,87**	0,16
14	-0,37+	0,05

$$\left.\begin{array}{ll} ** & p \ll 0,01 \\ * & 0,05 \gg p > 0,01 \end{array}\right\} \text{Significant differences}$$

$$\left.\begin{array}{ll} ++ & 0,10 \gg p > 0,05 \\ + & 0,20 \gg p > 0,10 \end{array}\right\} \text{Moderately significant differences}$$

POST-POST TEST: SCALE C

COMPARISON OF ITEM MEANS OBTAINED BY EXPERIMENTAL AND CONTROL GROUP A USING RAW SCORES ONLY BEFORE ADJUSTMENT FOR PRETEST DIFFERENCES.

ITEM	MEANS		DIFFERENCE IN MEANS
	EXPERIMENTAL GROUP	CONTROL GROUP	
1	3,12	2,84	0,28
2	3,04	2,84	0,20
3	3,19	2,87	0,32
4	3,19	3,03	0,16
5	3,46	3,29	0,17
6	2,50	1,94	0,56
7	2,12	1,39	0,73*
8	3,08	2,19	0,89**
9	3,00	2,35	0,65*
10	1,96	2,45	-0,49

COMMENTARY

* The mean difference of items 7 and 9 are significant at the 5% level of confidence.

** The mean difference of item 8 is significant at the 1% level of confidence.

PRETEST/POST - POST TEST : SCALE C

ADJUSTMENT OF POST - POST TEST ITEM MEAN DIFFERENCES OBTAINED BY EXPERIMENTAL GROUP AND CONTROL GROUP A TO COMPENSATE FOR PRETEST DIFFERENCES.

ITEM No's	ITEM POOL No's	DIFFERENCE BETWEEN ITEM MEANS OBTAINED ON POST-POST TEST AND PRETEST		DIFFERENCE OF DIFFERENCES (DE - DA)
		EXPERIMENTAL GROUP (DE)	CONTROL GROUP (DA)	
3	1	0,23	-0,07	0,30
5	2	0,50	0,17	0,33
10	5	0,28	0,21	0,07
6	8	0,14	-0,03	0,17
4	9	-0,38	0,21	-0,59*
9	11	-0,18	-0,44	0,26
8	14	0,40	-0,26	0,66*
2	16	-0,21	0,02	-0,23
1	17	-0,30	0,11	-0,41+
7	18	0,26	-0,34	0,60*

* $0,05 \geqslant p > 0,01$ } Significant differences

++ $0,10 \geqslant p > 0,05$ }
\+ $0,20 \geqslant p > 0,10$ } Moderately significant differences

POST TEST/POST - POST TEST : SCALE C

COMPARISON OF SIGNIFICANT AND MODERATELY SIGNIFICANT MEAN DIFFERENCES OBTAINED WHEN ADJUSTED POST TEST AND POST - POST TEST DIFFERENCES OBTAINED BY EXPERIMENTAL AND CONTROL GROUPS ARE COMPARED FOR EACH ITEM.

ITEM No.	ADJUSTED POST TEST DIFFERENCES From page B71a	ADJUSTED POST-POST TEST DIFFERENCES From page B82a
1	0,12	-0,41+
2	0,03	-0,23
3	0,50++	0,30
4	-0,33	-0,59*
5	0,71*	0,33
6	-0,29	0,17
7	0,44+	0,60*
8	0,40+	0,66*
9	0,53++	0,26
10	0,46+	0,07

* $0,05 \geq p > 0,01$ Significant difference

++ $0,10 \geq p > 0,05$ Moderately significant difference

+ $0,20 \geq p > 0,10$

POST - POST TEST : SCALE D

COMPARISON OF ITEM MEANS OBTAINED BY EXPERIMENTAL AND CONTROL GROUP A USING RAW SCORES ONLY BEFORE ADJUSTMENT FOR PRETEST DIFFERENCES.

ITEM	MEANS		DIFFERENCE IN MEANS
	EXPERIMENTAL GROUP	CONTROL GROUP	
1	2,00	1,48	0,52
2	3,31	2,71	0,60*
3	2,08	1,32	0,76*
4	2,77	2,06	0,71*
5	2,81	1,00	1,81**
6	3,19	1,68	1,51**
7	2,88	2,23	0,65*
8	3,04	2,29	0,75*
9	2,46	1,55	0,90**
10	2,42	1,58	0,84**
11	3,00	2,58	0,42
12	2,35	1,03	1,29**
13	3,15	2,90	0,25
14	3,00	2,13	0,87**

COMMENTARY

* The mean difference of items 2,3,4,7 and 8 are significant at the 5% level of confidence.

** The mean difference of items 5,6,9,10,12 and 14 are significant at the 1% level of confidence.

PRETEST/POST - POST TEST : SCALE D

ADJUSTMENT OF POST-POST TEST ITEM MEAN DIFFERENCES OBTAINED BY EXPERIMENTAL GROUP AND CONTROL GROUP A TO COMPENSATE FOR PRETEST DIFFERENCES.

ITEM No's	ITEM POOL No's	DIFFERENCES BETWEEN ITEM MEANS OBTAINED ON POST-POST TEST AND PRETEST		DIFFERENCE OF DIFFERENCES (DE - DA)
		EXPERIMENTAL GROUP (DE)	CONTROL GROUP (DA)	
2	5	-0,12	0,04	-0,16
11	10	0,04	-0,42	0,46+
6	11	0,86	-0,23	1,09**
14	12	-0,11	-0,17	0,06
1	14	0,18	0,03	0,15
8	18	0,54	0,14	0,40+
4	19	-0,02	-0,03	0,01
5	20	-0,12	-0,09	-0,03
13	26	0,47	0,14	0,33
7	27	0,24	0,14	0,10
12	30	0,17	-0,09	0,26
10	36	0,17	0,06	0,11
3	40	-0,03	-0,04	0,01
9	44	0,82	0,19	0,63*

** $p \leqslant 0{,}01$
* $0{,}05 \geqslant p > 0{,}01$
} Significant differences

++ $0{,}10 \geqslant p > 0{,}05$
\+ $0{,}20 \geqslant p > 0{,}10$
} Moderately significant differences

POST TEST/POST-POST TEST : SCALE D

COMPARISON OF SIGNIFICANT AND MODERATELY SIGNIFICANT MEAN DIFFERENCES OBTAINED WHEN ADJUSTED POST TEST AND POST-POST TEST DIFFERENCES OBTAINED BY EXPERIMENTAL AND CONTROL GROUPS ARE COMPARED FOR EACH ITEM.

ITEM No.	ADJUSTED POST TEST DIFFERENCES From page B72a	ADJUSTED POST-POST TEST DIFFERENCES From page B 83a
1	-0,08	0,15
2	0,20	-0,16
3	-0,27	0,01
4	0,41+	0,01
5	0,11	-0,03
6	0,46+	1,09**
7	0,30	0,10
8	0,34	0,40+
9	0,96**	0,63*
10	0,09	0,11
11	0,26	0,46+
12	-0,05	0,26
13	0,27	0,33
14	0,48++	0,06

** $p \leqslant 0,01$
* $0,05 \geqslant p > 0,01$
} Significant differences

++ $0,10 \geqslant p > 0,05$
+ $0,20 \geqslant p > 0,10$
} Moderately significant differences

POST-POST TEST : SCALE E

COMPARISON OF ITEM MEANS OBTAINED BY EXPERIMENTAL AND CONTROL GROUP A USING RAW SCORES ONLY BEFORE ADJUSTMENT FOR PRETEST DIFFERENCES.

ITEM	MEANS		DIFFERENCE IN MEANS
	EXPERIMENTAL GROUP	CONTROL GROUP	
1	2,81	2,55	0,26
2	2,73	3,03	-0,30
3	3,35	3,29	0,06
4	3,50	3,32	0,18
5	1,77	1,61	0,16
6	2,54	1,97	0,57
7	3,08	2,03	1,05**
8	2,54	2,16	0,38
9	2,19	1,84	0,35
10	2,58	1,77	0,81*

* The mean difference of item 10 is significant at the 5% level of confidence.

** The mean difference of item 7 is significant at the 1% level of confidence.

PRETEST/POST-POST TEST : SCALE E

ADJUSTMENT OF POST-POST TEST ITEM MEAN DIFFERENCES OBTAINED BY EXPERIMENTAL GROUP AND CONTROL GROUP A TO COMPENSATE FOR PRETEST DIFFERENCES.

ITEM No's	ITEM POOL No's	DIFFERENCE BETWEEN ITEM MEANS OBTAINED ON POST-POST TEST AND PRETEST		DIFFERENCE OF DIFFERENCES (DE - DA)
		EXPERIMENTAL GROUP (DE)	CONTROL GROUP (DA)	
5	1	0,02	0,19	-0,17
8	2	0,18	-0,08	0,26
4	3	0,14	0,29	-0,15
2	4	-0,16	-0,24	0,08
7	5	0,19	-0,18	0,37+
1	8	0,37	0,31	0,06
9	9	0,37	-0,16	0,53++
3	14	0,10	0,26	-0,16
6	15	0,18	-0,27	0,45+
10	16	0,33	-0,17	0,50++

$$\left.\begin{array}{ll} ++ & 0{,}10 \geqslant p > 0{,}05 \\ + & 0{,}20 \geqslant p > 0{,}10 \end{array}\right\}$$ Moderately significant differences.

POST TEST/POST-POST TEST : SCALE E

COMPARISON OF SIGNIFICANT AND MODERATELY SIGNIFICANT MEAN DIFFERENCES OBTAINED WHEN ADJUSTED POST TEST AND POST-POST TEST DIFFERENCES OBTAINED BY EXPERIMENTAL AND CONTROL GROUPS ARE COMPARED FOR EACH ITEM.

ITEM No.	ADJUSTED POST TEST DIFFERENCES From page B73a	ADJUSTED POST-POST TEST DIFFERENCES From page B84a
1	0,04	0,06
2	0,16	0,08
3	0,20	-0,16
4	0,24	-0,15
5	0,06	-0,17
6	0,42+	0,45+
7	0,47++	0,37+
8	0,31	0,26
9	0,67*	0,53++
10	0,30	0,50++

* $0,05 \geqslant p > 0,01$ } Significant differences

++ $0,10 \geqslant p > 0,05$ }
\+ $0,20 \geqslant p > 0,10$ } Moderately significant differences

POST-POST TEST: SCALE F

COMPARISON OF ITEM MEANS OBTAINED BY EXPERIMENTAL AND CONTROL GROUP A USING RAW SCORES ONLY BEFORE ADJUSTMENT FOR PRETEST DIFFERENCES.

ITEM	MEANS		DIFFERENCE IN MEANS
	EXPERIMENTAL GROUP	CONTROL GROUP	
1	2,69	2,77	-0,08
2	2,92	2,94	-0,02
3	2,46	2,45	0,01
4	2,46	2,81	-0,35
5	2,92	3,13	-0,21
6	3,42	3,13	0,29
7	3,00	2,81	0,19
8	2,15	2,45	-0,30
9	2,69	2,48	0,21
10	1,58	1,52	0,06
11	3,31	3,13	0,18
12	2,38	2,03	0,35
13	3,15	3,13	0,02
14	3,42	3,19	0,23
15	2,88	2,97	-0,09
16	2,65	2,68	-0,03
17	2,50	2,32	0,18
18	2,92	2,77	0,15
19	3,31	3,23	0,08
20	2,58	2,32	0,26

COMMENTARY

There was no significant difference between the two groups on the post-post test.

PRETEST/POST-POST TEST : SCALE F

ADJUSTMENT OF POST-POST TEST ITEM MEAN DIFFERENCES OBTAINED BY EXPERIMENTAL GROUP AND CONTROL GROUP A TO COMPENSATE FOR PRETEST DIFFERENCES.

ITEM No's	ITEM POOL No's	DIFFERENCE BETWEEN ITEM MEANS OBTAINED ON POST-POST TEST AND PRETEST		DIFFERENCE OF DIFFERENCES (DE - DA)
		EXPERIMENTAL GROUP (DE)	CONTROL GROUP (DA)	
16	1	0,54	0,10	0,44+
11	2	0,20	0,34	-0,14
2	3	0,06	0,21	-0,15
7	4	0,32	0,25	0,07
6	8	0,56	-0,17	0,73 *
1	9	0,30	0,19	0,11
8	10	0,32	0,15	0,17
13	11	-0,10	-0,08	-0,02
14	15	0,35	0,16	0,19
5	16	-0,01	-0,05	0,04
3	17	0,50	-0,03	0,53++
15	18	-0,08	0,33	-0,41+
4	19	0,25	0,60	-0,35+
19	21	0,49	-0,01	0,50++
20	28	0,19	0,05	0,14
17	30	0,21	0,29	-0,08
9	31	0,37	0,12	0,25
10	32	0,40	0,31	0,09
18	33	0,56	0,16	0,40+
12	34	0,02	-0,06	0,08

See page B83b for explanation of symbols.

POST TEST/POST-POST TEST: SCALE F

COMPARISON OF SIGNIFICANT AND MODERATELY SIGNIFICANT MEAN DIFFERENCES OBTAINED WHEN ADJUSTED POST TEST AND POST-POST TEST DIFFERENCES OBTAINED BY EXPERIMENTAL AND CONTROL GROUPS ARE COMPARED FOR EACH ITEM.

ITEM No.	ADJUSTED POST TEST DIFFERENCES From page B74a	ADJUSTED POST-POST TEST DIFFERENCES From page B85a
1	0,14	0,11
2	-0,31	-0,15
3	0,55++	0,53++
4	0,14	-0,35+
5	0,42+	0,04
6	1,07**	0,73*
7	0,43+	0,07
8	0,53++	0,17
9	0,40+	0,25
10	0,49++	0,09
11	0,00	-0,14
12	-0,04	0,08
13	0,28	-0,02
14	0,28	0,19
15	0,28	-0,41+
16	0,44+	0,44+
17	0,50++	-0,08
18	0,35+	0,40+
19	0,32	0,50++
20	0,43+	0,14

See page B83b for explanation of symbols.