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G. K. Moodley
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A CRITICAL STUDY OF METHODS OF MEASURING THE ATTAINMENT OF PUPILS IN PRACTICAL WORK IN THE BIOLOGICAL SCIENCES WITH SPECIAL REFERENCE TO THE SITUATION PERTAINING TO INDIAN SCHOOLS

by

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CHAPTER ONE

THE CHANGING PATTERN OF BIOLOGICAL SCIENCES CURRICULUM AND THE GREATER EMPHASIS ON PRACTICAL WORK

1.1 NATURE OF BIOLOGICAL SCIENCE

A Committee representing the Association for Science Education, the Association of Assistant Mistresses and the Assistant Masters Association states, "In the past science has been taught in such a way that any mention of training in scientific habits of thought would be quite meaningless".[(1)] Similar views are expressed by J.F. Kerr[(2)] and the present writer[(3)] after an investigation of practical work in the biological sciences at schools. The implication of the views expressed above, indicate that biological science is not taught as a "science". Therefore a reappraisal of the nature of biological science is essential in order to determine its essential qualities. These inherent qualities of the subject could then give direction to the formulation of objectives of the course, provision of suitable learning experiences and designing appropriate assessment procedures.

Conant[(4)] defines sciences as, "an interconnected series of concepts and conceptual schemes that have developed as a result of experimentation and observation and are fruitful of further experimentation and observation". This view is shared by Telfer and Kennedy[(5)], Sears and Kessen,[(6)] Shamos,[(7)] Schwab[(8)] and Tricker.[(9)] In this context biological science is conceived as a product and process both of which are used to solve further problems. Acceptance of this view would make biological science a dynamic on-going process. The "process of science" refers to the inquiry process which involves such abilities as discerning problems, hypothesis construction, designing experiments, observing and recording, and handling results. The development of these abilities and the formation of biological concepts has been the basis on which the Biological Sciences Curriculum Study Projects[(10)] and the Nuffield Biological Science Projects[(11)] have been developed. Biological science through its methods of inquiry gives rise to an evolving body of knowledge (i.e. the product of science) in the form of facts and information which give increased understanding of biological concepts, principles and generalizations. Therefore biological science is not a mere collection of facts and information but a coherent system of knowledge (i.e. concepts, principles and generalizations) which has resulted from the frontiers of research through the methods of inquiry. This knowledge is tentative.

Biological knowledge encompasses man and his environment, and enables changes to be made in their relationship.[12] In this regard biological science should be viewed as an activity of man, not only in interpreting nature, but also in making "it possible for people to appreciate the worthiness of the scientific enterprise and use its achievement for attacking contemporary problems, as well as designing the future we seek".[13] In this context biological science is viewed as a social force or influence and an essential part of culture. An aim of the Nuffield A-Level Biological Science[14] is "to introduce students to a body of biological knowledge relevant to modern requirements, through investigating living things and studying the work of scientists. In doing so students will consider the processes of research and the implications of science for society". This tendency is apparent also in the Biological Sciences Curriculum Study Project.[15] Doubts are still expressed as to the achievement of this aim.[16]

Against the background of this discussion, the "nature of biological science" in this study will be taken to mean:

(i) it is a science that involves methods of inquiry;

(ii) methods of inquiry may involve experimentation or observation or both depending on the exercise;

(iii) methods of inquiry give rise to an evolving body of knowledge which is tentative;

(iv) this body of knowledge is structured and restructured, in the light of previous experience, in order to give meaning to concepts and principles;

(v) biological science is a social force or influence and an essential part of culture.

These inherent qualities of biological science have implications not only for the teaching and learning of the subject but also for assessing attainment in the subject.

1.2 THE PLACE OF PRACTICAL WORK IN THE BIOLOGICAL SCIENCE CURRICULUM

The term "practical work" means experiments and observational exercises conducted by the teacher as demonstrations as well as experiments and observational exercises carried out by the pupils. Practical work will require the exercise of manipulative skills, cognitive abilities and attitudes. "Biological science curriculum" refers to all experience for learning biological science which is planned and organised by the school in order to bring about desired changes in pupils in terms of pre-determined abilities and attitudes.

The nature of biological science and recent trends in biology in the United Kingdom and United States of America indicate the important role of practical work (inquiry process) in establishing and illustrating the theoretical basis of the course (i.e. concepts, principles and generalizations) as well as developing the necessary abilities and attitudes. Much practical work also involves, "the application of knowledge, the use of theoretical concepts and theoretical evaluation of the results obtained by the practical experience".(17) This integration of the practical and the theoretical bases of biological science results in a blurring of the distinctions between practical and theoretical work. This interrelationship between practical and theoretical work should be acknowledged and taken into account in assessment.(18)

Further support and evidence of the importance of practical work has come from educational psychologists. Biology is recognised as an evolving population of concepts(19) and providing students with first-hand experience through practical work aids in the formation of these concepts.(20) Clear and stable concepts are essential for generalizations and understanding of underlying principles in order to make learning meaningful. If pupils lack understanding of concepts, then many of the concepts remain abstract and meaningless.(21) From this standpoint, it follows that concept-formation should be the focus of attention in biology learning and teaching. The cognitive learning theories of Bruner,[22] Gagne,[23] and Piaget[24] have emphasised the need for experience with real objects in order to form meaningful primary concepts. Once these concepts are established they can be used in new combinations to form secondary concepts and conceptual schemes. These learning theories are implicit in the Nuffield Biological Science Projects ('O' and 'A'-Levels) and the Biological Sciences Curriculum Study. These projects assume the importance of the laboratory and the field as a means for students to gain greater understanding of and experience with biological science. Using Piaget's idea of concept-formation, the Schools Council, Nuffield Foundation and the Scottish Education Department, jointly developed the "Science 5 - 13" project.[25] The emphasis is on first-hand experience and the materials developed are related to the children's different stages of educational development rather than their chronological age. Schools Council Integrated Science Project (SCISP), which has been developed for brighter pupils of the ages of 13 to 16 years and is a highly structured course, is based on Gagne's theory of learning.[26]

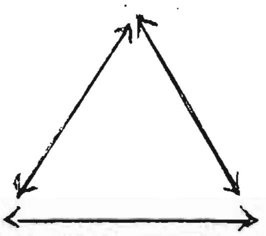
In the Republic of South Africa, the "Core Biology Syllabus" for the senior secondary level, which was prepared by a Joint Commission of C.E.H. and the Joint Matriculation Board and then adapted for use by the Education Departments and the Divisions of Education, recognises the unique value of practical work as a means of facilitating learning in biological sciences.[27] An analysis of the biological science syllabuses of examining boards from overseas countries also reflects a similar trend.[28][29][30]

A call for investigation and experimentation as an effective approach to the leraning and teaching of high school biology is also made periodically by local and overseas speakers at Science and Mathematics Conventions which are held biennially at various centres in the Republic of South Africa, and sponsored by the National Science Foundation.[31] A similar appeal is made overseas, at National[32] and International[33] gatherings of biology educators. A review of some of the journal articles,[34][35][36][37][38][39] reflects that practical work is an important part of the biological science course. The trends in biological science indicate that there is little disagreement with the view that practical work should be an integral part of a high school biology course.

1.3 REASONS FOR ASSESSING PRACTICAL WORK IN THE BIOLOGICAL SCIENCES

The abilities that ought to be developed through practical work are reflected in the Biological Sciences Curriculum Study and the Nuffield A-Level Biological Science (these abilities are indicated on page 1 of this study). In its "Biology Syllabus" the Division of Education, Department of Indian Affairs demarcates essential practical work to be undertaken by students at the senior secondary level.[40] It also identifies broad categories of abilities and attitudes to be developed through practical work.[41] Since these abilities and attitudes to be developed through practical work are considered as important attributes of students, one must measure in order to assess to what extent these have been attained in the context of a student's learning experience. Measurement to assess pupil attainment is an integral part of any educational process, as is shown by the following model:

OBJECTIVES (Range of abilities and attitudes to be developed through practical work)



MEANS (learning experience)

ENDS (measurement to assess pupils' attainment in practical work)

The objective-means-ends model indicates the close interrelationship between the abilities and attitudes that are to be developed (expected) outcomes), the appropriate instructional or teaching strategies adopted to develop these abilities and attitudes and measurement to ascertain whether the objectives have been attained. "In this connection it will be noted that educational measurement is conceived, not as a process quite apart from instruction, but rather as an integral part of it".[42] Therefore measurement to assess pupil attainment in practical work is an integral part of the educational process. There are also certain outcomes of practical work that are not shared with theoretical work, such as manual skills, observation of biological materials and direct inference made from biological material.[43] Therefore, it would be unrealistic to provide for a pupil any form of certification of attain= ment in biological science without including an assessment in practical work. In this regard Kelly and Lister state "The need for some measurement of pupils' performance in practical work is based on the desirability of reflecting the important role of practical work in the courses they take. This is seen as an act of fairness to the pupils and as an incentive to them".[44]

Against this background there seems to be little disagreement with the view that there is need for some measurement in order to assess pupil attainment in practical work in the biological sciences.[45]

1.4 REVIEW OF RESEARCH STUDIES WITH REGARD TO ASSESSMENT OF PRACTICAL WORK

While it is recognised that some form of measurement is necessary in order to assess pupil attainment in practical work the methods of measurement have received very little attention in terms of research studies. Review of educational research in science teaching in Britain by Peel[46] (1955) and Richmond[47] (1973) indicates that research in the field of assessment has been relatively neglected. Connaughton[48] (1969) of the National Foundation of Educational Research Unit in England and Wales states that "The reliabilities and validities of practical and oral tests are almost unknown quantities at the moment". In the United States of America, except for the work by Robinson[49] (1969), no systematic research seems to have been done on practical examinations in science up to 1979; at any rate as far as can be judged from the review of the American Biology Teacher, Harvard Educational Review, School Science and Mathematics, Science Education News, the Yearbook of the National Society for the Study of Education and the Dissertation Abstracts. Robinson,[50] in "Evaluating Laboratory Work in High School Biology" in United States of America, states: "Assessment of the contributions of the laboratory to science instruction has received little attention in the literature of science education". He goes on to state that if laboratory investigation is to serve a unique function then, "further research and development of appropriate evaluative instruments are desirable. Perhaps laboratory practical examinations can make a unique contribution to this problem".[51] In the United States of America research study has been focussed on methods of teaching science.[52][53][54][55][56][57] In South Africa there is no evidence of any systematic research in assessment of practical work. In order to evaluate the findings of the various research workers it is necessary to review these. This will be done in the sections that follow. Literature and research findings are also reviewed in the appropriate sections of the present study.

Kerr and his colleagues reviewed the position of assessment of practical work in biology in England and Wales in 1962. Their findings with regard to external practical examinations are:[58]

(i) teachers favoured the retention of practical examinations;

(ii) practical examinations measured limited aspects of practical ability;

(iii) this form of assessment had an undesirable backwash effect on practical work because it encouraged undue attention to training in techniques, measuring things and getting the "right answer";

(iv) the examining boards experienced considerable difficulties in organising practical examinations, mainly owing to the large number of candidates;

(v) the practical examination that was set was influenced by organisational rather than educational factors.

They suggest that, "more responsibility for the assessment of practical ability should be given to the teacher by allowing the schools to set, supervise and mark their own tests",[59] with guidance from external moderators. This suggestion is made to make the practical assessment more flexible. They further recommend a "combined assessment based on examination, interview, continuous assessment, record book and individual investigation project or, more likely, on a selection of these methods of evaluation".[60] A similar view (i.e. assessment should be in the hands of teachers) was expressed by Beloe and his Committee members appointed by the Secondary School Examinations Council (1958) in a report on "Secondary School Examinations other than the GCE".[61] These suggestions have now been implemented in the United Kingdom for the Mode 3 of the CSE examinations for all subjects.[62] The syllabus is drawn up by teachers and the examinations are set and marked by the schools themselves, subject to the moderation of standards by the examining boards.[63] Suggestions for selecting moderators and moderating teacher-awarded marks are included in the Schools Council Examination Bulletin No 5[64] and No 31[65] and information booklets supplied by examining boards.[66] Hoste and Bloomfield found no evidence that standards were different for candidates awarded grades by cumulative assessment (both practical and theory) and by examination (written and practical conducted at the end of the year by teachers) in CSE Mode 3 Biology.[67] Both these forms of assessment were carefully moderated by the examining board. This finding is consistent with that reported by Eggleston and Newbould[68] in their study in assessing attainment in physics (theory and practical) at the CSE level. In this study cumulative assessment marks were compared with marks attained by pupils in the moderating test (which was externally set and marked) and the final CSE marks awarded by the examining board.

Kelly and Lister[69] in assessing practical ability in Nuffield A-Level Biology found that as a method of measuring pupils' attainment in practical work in biology, an overall assessment procedure (i.e. where the teacher gathers information on the performance of pupils in the final year of their study and uses this to make a judgement on their attainment on a five point scale at the end of the course) is comparable in accuracy to a series of practical tests (which involve real investigations) which are externally set but marked by teachers. They also found that:[70]

(i) marks awarded by teachers through overall assessment and for practical tests require moderation;

(ii) overall assessment conducted by the teacher is a better means of reflecting the aims of the course when compared with practical tests;

(iii) factors like time, apparatus and uncertainty about availability of materials at schools limited the topics that were assessed in the practical tests;

(iv) test conditions created stress situations for some students because some experiments failed to work or small mistakes were crucial to results;

(v) the abilities involved under laboratory conditions are distinct from the same abilities involved on a pencil and paper test.

As a result of this investigation, practical outcomes such as laboratory procedures, recording and handling of results in the Nuffield A-Level Biology are assessed through overall assessment by teachers.[71] This teacher assessment is externally moderated by introducing into the written examination, questions which require pupils to deal with procedures, recording and handling of results. The Nuffield A-Level written examinations also include the practical abilities that are not assessed by the teacher, namely, hypothesis construction, experimental design and analysis of data.[72][73]

Tamir and Jungwirth[74] in their analysis of the 1970 "BSCS Matriculation Examination in Israel" (where external practical examinations are conducted) found that "correlations between such skills as interpretation of data, hypothesis formulations and experimental design when measured by written examinations have low correlation with the same skills in a laboratory real situation". Therefore Tamir distinguishes the practical mode as a distinct mode of performance and states that to measure practical abilities "practical testing situations are mandatory"[75] and the practical tests should involve pupils in real investigations. The findings by Kelly and Lister,[76] and Tamir and Jungwirth[77] support the conviction that practical work involves abilities both manual and intellectual, which are, in some measure, distinct from those used in non-practical work. This is consistent with the findings of Head,[78] Abouseif and Lee,[79] and Robinson.[80] Research work by Abouseif and Lee,[81] Tamir and Glassman,[82] and Brown, Hitchman and Yeoman[83] provides evidence that different practical tests (oral tests, plant identification tests, tests on experimental work, etc.) produce different measurements.

The moderation of teacher assessment of practical work through written examination and also the substitution of written examination to measure attainment in hypothesis construction, experimental design, and analysis of data (which are laboratory activities) in the Nuffield A-Level Biology is questionable from the above research evidence. The achievement tests (paper and pencil tests) used in the United States of

America to measure the outcomes of laboratory-orientated biology courses, such as the BSCS,[84][85] also seem to be inappropriate.

In addition to overall assessment of practical work in biology, the pupils are also assessed on project work that they undertake in the Nuffield A-Level Biology.[86] These projects are assessed as a total investigation, and are "carried out by the student , largely on his own initiative, involving experimental enquiry into some aspect of biology which has interested him".[87] Eggleston and Kelly under= took an investigation into "The Assessment of Project Work in A-Level Biology".[88] After applying statistical techniques (in order to check if teacher assessment of projects met with the stipulated criteria), these investigators came to the conclusion that the "results of the experiment suggest that project work in biology can be assessed with adequate objectivity".[89] This investigation also revealed several problems experienced by the teachers in assessing project work. These problems are: "halo effects"; the difficulty of giving help and assessing at the same time; disruptions in work and inadequate time for scrutinising individual work in large classes.

The present writer carried out an investigation on "Practical work in Biology at the Senior Secondary Level in Indian High Schools in Natal", and included in this study was the nature of practical work assessment.[90] This investigation revealed that:

(i) there was discrepancy between the teachers in their methods of assessing the final attainment of pupils in practical work, i.e., some used the final practical tests while others used the practical record of pupils for assessment;

(ii) the majority of the teachers (over 50 percent of the teachers) were dissatisfied with the practical control test as a form of moderating procedure. The reasons advanced for this dissatisfaction were: ill-equipped laboratories which placed pupils at a disadvantage in these tests, fear and stress situations during the tests, testing pupils on work not completed, and testing a few pupils only in the test;

(iii) the practical control tests were having an undesirable backwash effect on the nature of practical work that was being conducted at schools.

In view of these findings the writer recommended that teacher assessment of practical work should be guided and supervised for standards by moderators and not examiners.

The research studies reviewed in this study can be grouped in three broad categories:

(i) those concerned with the development of external practical examinations;

(ii) those concerned with the development of teacher assessments;

(iii) enquiries into moderation of teacher-awarded marks.

These topics reflect the uncertainty that exists about the procedures that should be adopted in assessing practical work in biology. Innovations such as cumulative assessment, project work assessment, overall assessment and practical tests involving real investigations, have undergone trials and are still areas of research. Although there is sufficient evidence to indicate that practical work could not be assessed through written examinations there is no uniform plan to guide either the teachers or the examining boards, in the use of assessment procedures to measure attainment in practical work and how teacher-awarded marks ought to be moderated.

This has been a decade of increased willingness to develop "new" courses and "new" methods in biological science. A similar willingness to experiment and to carry out systematic research in the field of assessment in practical work is also desirable.

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CHAPTER TWO

THE NATURE AND PURPOSE OF THE PRESENT STUDY AND RESEARCH PROCEDURES TO BE FOLLOWED

2.1 NATURE AND BACKGROUND OF PROBLEMS TO BE STUDIED

The "new" trends in biological science education have re-emphasised practical work as an essential integral part of high school biology courses.[1][2] There is little disagreement with this trend and/or with the view that there should be some measurement of the pupil's attainment in practical work.[3]

The review of research studies on assessment of practical work in this study has indicated that the method of measurement of practical work in biological sciences, within the context of the "new" trends, has been the subject of intense discussion for some time. In respect of the assessment of practical work, the main issues have been, "how to assess and what to assess". Within this context assessment of practical work is closely interwoven with the other components of the curriculum, i.e., objectives and the learning experiences provided in practical work.

The materials developed by the two major curriculum projects in high school biology, namely, the Biological Sciences Curriculum Study in the United States of America,[4] and the Nuffield A-Level Biological Science Project in the United Kingdom,[5] have taken into account some of the questions raised above. In general these projects have listed outcomes[6][7] (which are neither aims nor objectives as described in this study) of biology education and they have used these outcomes to guide them, in the development of materials for the teaching and learning situation - the emphasis is on inquiry - and in assessing attainment of these outcomes. For example, the developers of the Nuffield A-Level Biological Science Project, use a variety of assessment procedures (i.e., overall assessment of practical work, assessment of project work, and written examinations) in order to assess the attainment of the outcomes specified for the course.[8] Each of these procedures is suited to measure only certain outcomes of the course and, taken together, they measure all the outcomes.

In the Republic of South Africa, the Joint Matriculation Board, in line with the new approaches of biology teaching and learning, indicates in the core biology syllabuses (Higher Grade and Standard Grade) that, "Instruction should, in the main, be based on pupil's own observation within their environment";[9] and also that pupils should be given practice in the procedures of the scientific method. Although the "core" biology syllabuses make mention of the Senior Certificate theory examination in biology (i.e., the written paper), no mention is made of assessment of practical work. This presupposes that biology can be examined purely on a written paper, which is contrary to research evidence. It needs to be pointed out that practical tests measure abilities that are markedly different from those that are measured by written papers.

Where Departments of Education have deemed it desirable to include marks for practical work as part of the Senior Certificate Examination, the Joint Matriculation Board has not objected, provided that such marks are subjected to moderation by the respective education departments.[10][11]

In 1966, assessment of practical work was introduced in the Indian high schools.[12] The marks allocated by the teacher are moderated by examiners appointed by the Division of Education, Department of Indian Affairs, and this moderated work forms a part of the total marks allocated for the Senior Certificate biology examination. The maximum mark for the Senior Certificate biology examination is 400 for the Higher Grade and 300 for the Standard Grade, while the maximum practical marks are 70 and 50 respectively. The examiners who moderate teacher awarded marks for practical work are not the same as those who are responsible for the marking of the written papers in the Senior Certificate Examination.

As indicated on page 10 of this study, the writer found in his investigation in 1971 that practical work at the senior secondary level in Indian high schools in Natal was assessed by the teachers either through special formal practical examinations or scrutinizing the pupils' practical record books.

The practical control tests used to moderate the marks awarded by teachers are devised externally (i.e., by biology inspectors), and are administered and marked by the examiners. Although those tests are external in nature, they are not really external examinations, because the individual performance of pupils is not under scrutiny. It is the overall standards of awarding marks by teachers that is being appraised. In spite of this being the purpose of practical control tests, it was found by the writer, in his investigation in 1971, that teachers viewed it as an external examination, and they prepared their pupils for it.(13) There was also evidence in this investigation that pressure of completing the practical work indicated in the syllabus before the practical control test, "led most teachers to do practical work of the verificatory type and this was of limited educational value".(14) Within this context the moderation procedure was having an undesirable backwash effect on the nature of practical work in biology in Indian high schools.

Implicit in the findings, is that a good moderating procedure will promote correct teaching and learning methods and also the attainment of desirable objectives of practical work. The designer of the moderating procedure must firstly know "what to assess". This question leads one to the objectives of practical work which can give direction to moderation. Of equal importance is a quantitative specification of the content and objectives of the course to give guidance on the relative importance of various aspects of the course. The objectives should also indicate to the designer of a moderating procedure the techniques that could be developed to assess practical work. This stems from the belief that the kinds of activities which candidates undertake during the moderation procedure should not be radically different from those which they undertake while learning.

The information of "what to assess", "how to assess" and "what quantities to assess" of that which is to be assessed, is as important to the teacher as it is to the designer of the moderating test; because it is the teacher who must translate it into the teaching situation. While "training in the scientific method" is a worthwhile outcome of science teaching, and to "assess the practical ability of each student continuously" is a worthwhile procedure to assess practical work, it is questionable whether this outcome and procedure of assessment, as indicated in the syllabuses is as clear to the classroom teacher as it may be to specialists. The fact that these senior secondary biology syllabuses contain vague statements which are called "general aims" and "objectives", and a single statement on the internal assessment of practical work (i.e., practical work should be assessed through cumulative assessment), raises several problems. The first problem is whether the practical work is conducted in a traditional way by using the confirmatory instead of the inquiry approach. The second problem is whether assessment of practical work is limited to aspects of practical ability which emphasise identification and manipulative skills. This points to a need for clearly defined objectives of practical work which will give direction to the type of learning experience to provide in practical work and in assessing attainment in practical work. It is also generally agreed that such objectives must be formulated before any meaningful assessment in practical work can take place.(15) Unless objectives of practical work are clearly defined and assessment and moderating procedures are reviewed, laboratory activities are unlikely to go much beyond the "training in techniques, measuring things and getting the right answer".(16) Since there appears to be no published research in this area in this country, it is hoped that this investigation will produce several possibilities.

In the light of the above discussion, the following problems have been identified for investigation:

(i) stating objectives for use in practical work in biology;

(ii) exploring the procedures that can be used in measuring attainment of pupils in practical work;

(iii) exploring ways to maintain standards between pupils across all the schools.

2.2 PURPOSE OF THIS STUDY

The purpose of this investigation is:

(i) to identify and suggest objectives for practical work in biology at the senior secondary level;

(ii) to identify procedures of assessment which provide the most efficient and appropriate measure of attainment in practical work in biology at the senior secondary level;

(iii) to explore suitable ways of maintaining standards in performance in practical work in biology between pupils across all the schools;

(iv) to discover the attitudes of teachers towards various procedures of assessing attainment in practical work in biology, and towards practical control tests.

2.3 ASSUMPTIONS AND LIMITATIONS

2.3.1 Assumptions

The following assumptions were made to establish a basis of procedure for this investigation:

(i) The teachers, biology inspectors and examiners responded without bias to questions in the questionnaires that were administered to them.

(ii) The overall standard of awarding marks by the biology inspector can be taken to represent the national standard.[17]

(iii) The teacher can put his own pupils in an order of merit more accurately than any other assessor.[18]

(iv) Only a moderator is in a position to compare the standards between schools.[19]

(v) The presence of difficulties or problems in devising or administering any procedure of assessment in practical work, even by a few teachers or examiners, would undermine the acceptability of that form of assessment.[20]

(vi) The operational definition of an "objective" is stated in terms of pupil behaviour, i.e., "what, as a result of the learning experiences provided, it is expected pupils will be able to do (or do better) which can be measured".[21] This definition assumes the view that education is a process for changing behaviour and that this behaviour or outcome is measurable. At the same time, no assumption is made, that what cannot be measured is not attained by pupils.

(vii) It is assumed that evidence of performance indicates a measure of attainment of the defined objectives. However, "no assumptions are made concerning either how learning takes place or the nature of the learning process".[22]

(viii) It is assumed that an overt expression of each objective may require an interaction of the cognitive affective and/or psychomotor domain.[23]

(ix) The defined objectives of practical work are assumed to be necessary for the understanding of practical work within the context of activities undertaken during the course.[24]

(x) It is assumed that views expressed by Indian teachers will not differ remarkably from school to school because of a common syllabus, similar facilities, supervision by the same biology inspectors, and the same examination require= ments.

2.3.2 Limitations

The present investigation was designed and implemented within the limits prescribed below:

(i) Since the materials with regard to assessment of practical work were collected during 1977, the findings of this investigation will reflect the position at schools during this period. However, any changes in assessing attainment in practical work since 1977 by the Division of Education, Department of Indian Affairs, will be indicated in appropriate sections of this study.

(ii) The investigation is limited to assessment of practical work of standard-ten pupils that offer biology at the Standard Grade and Higher Grade at Indian schools. It is limited to standard-ten pupils because they are the only group that ought to have completed a range of practical work that is specified in the practical syllabus for biology in the senior secondary level. This is also the only group that will be assessed internally by the class biology teachers whose marks will be moderated by the examiners.

(iii) The teaching and learning of biology during the standard-ten year places numerous demands on the time of the biology teachers and pupils that offer biology. The standard-ten year is also important to the pupils because they will be writing their Senior Certificate Examination at the end of the year. Therefore, the investigation was planned in such a way that there was no disruption of the biology programme at schools and there were no undue demands placed on the teachers.

(iv) Since the investigation had to be based on current practical work that was in turn based on a specified syllabus and on current assessment procedures, the scope of this investi= gation became limited, i.e., the investigation had to be based on what was being done at school and not on trying out any new procedures of assessment; because this would have interfered with the work at school.

(v) Some of the most vital information required for an investigation of this nature was only available at schools during the last term of the school year when internal assessment of practical work was over and the practical control tests were completed. This is also the busiest time for the standard-ten pupils because they are either preparing for, or writing, the Senior Certificate Examination. This is also a busy period for teachers in terms of devising, administering and marking the final internal examination papers. Therefore, the pupils could not be disturbed and the availability of the teachers to provide information was dependent on their having the time to spare for discussions with the writer. If they did spare the time for discussions they had to be at times suitable to the teachers and the writer. This limited the number of schools that could be visited by the writer in the fourth term of the school year for the purpose of discussions with teachers and administering questionnaires.

2.4 OUTLINE OF DESIGN AND MATERIAL USED IN THE STUDY

To achieve the aims of the investigation the design had to be practicable in terms of limited time available to the investigator, teachers, examiners and biology inspectors; and also in terms of the sample with which one researcher had to cope. The research design and materials used in the study are stated below under specific headings. The materials that were used and the procedure that was followed in using them is given in Appendix A, pp. 346-393.

2.4.1 Biology Teachers at the Fifth National Convention for Teachers of Science and Mathematics

"National Conventions for Teachers of Science and Mathematics" are organised biennially by the Foundation for Education, Science and Technology in conjunction with the Division of Education, Department of Indian Affairs and other Education Departments. Each Indian high school offering biology as a subject is normally represented at this Convention by a senior biology teacher. The writer conducted a workshop, on worksheets during one of the sessions (14th July, 1977) of the Fifth National Convention which was held at the Springfield College of Education. Questionnaire A (see Appendix A, pp. 376-379) and B1 (see Appendix A, p. 380) were administered by the writer to fifty-two senior biology teachers from forty-seven Indian high schools at this session. These teachers were also provided with the first draft scheme of the outcomes of practical work (see Appendix A, pp. 362-365) for discussion and comments and for use as an aid to fill in questionnaire B1.

2.4.2 Practical Control Tests

The writer was appointed as an examiner to conduct practical control tests in biology in 1977. A meeting for all examiners appointed by the Director of Indian Education to conduct practical control tests was conducted by the biology inspectors at the Springfield College of Education (19 September, 1977) a day prior to the commencement of the practical control tests. This meeting centred on the planning of tests and the procedure to follow in conducting the test. The following information was gathered by the writer at this meeting and subsequently during the practical control tests which were conducted from the 20th of September to the 5th of October, 1977:

(i) the outcomes of practical work that ought to be assessed in the practical control tests (see Appendix A, p. 352);

(ii) the procedure to be followed in developing questions for practical control tests (see Appendix A, pp. 351-353);

(iii) the procedure to be followed in choosing candidates for the practical control tests (see Appendix A, p. 351);

(iv) schedule followed by the writer for practical control tests at the nine schools that he visited (see Appendix A, p. 358);

The writer also had discussions with nineteen standard-ten biology teachers at the nine schools where he conducted practical control tests, with regard to the second draft scheme (see Appendix A, pp. 366-369) of outcomes of practical work. The comments of teachers on this draft scheme were recorded by the writer.

The following materials were also used at the meeting of examiners (19 September, 1977) at the Springfield College of Education:

(i) Questionnaire B2 (see Appendix A, p. 381) was administered to the eleven examiners by the writer.

(ii) The second draft scheme (see Appendix A, pp. 366-369) of the outcomes of practical work was provided to these examiners for discussion and comments and also for use as an aid to fill in questionnaire B2.

(iii) The writer provided each examiner with an "examiner's report" (see Appendix A, pp. 359-360) which had to be filled in and returned to the writer after the completion of the practical control tests.

2.4.3 Visits to Schools

The writer was appointed to conduct practical control tests in nine schools. During these visits the writer made arrangements with the principals and standard-ten biology teachers to revisit them. The period of these revisits was from the 25th of October to the 14th of November, 1977 (see Appendix A, p. 392). At each school, the writer administered questionnaires B2 and C to the standard-ten biology teachers. There was a total of nineteen standard-ten biology teachers at nine of these schools. These were also provided with the third draft scheme (see Appendix A, pp. 369-372) of the outcomes of practical work for discussion and comment and also for use as an aid to fill in questionnaire B2. A record was kept of comments by teachers and personal observations by the writer during these visits.

2.4.4 Biology Inspectors

The three biology-inspectors (two from the Division of Education, Deaprtment of Indian Affairs, and one from the Natal Education Department) and the writer met on the 24th of October, 1977. This meeting was jointly arranged by the biology inspectors and the writer so that the writer could gather information about assessment of practical work at the senior secondary level.

Questionnaire B2 was administered by the writer to the biology inspectors. The second draft scheme of the outcome of practical work was also provided for discussion and comments and as an aid to filling in questionnaire B2.

Discussion and comments on the second draft scheme, questionnaire B2 and assessment of practical work in Indian schools and White schools (controlled by the Natal Education Department) were recorded by the writer. The biology inspector from the Natal Education Department came in his private capacity and not as a representative of his Department.

2.4.5 Examiners

Four examiners with more than two years of experience in conducting practical control tests were selected by the writer to give weightings (i.e., in terms of percentage) to each operational division that appeared in the third draft scheme (see Appendix A, pp. 369-372). They indicated this weighting on a special form (see Appendix A, p. 373) in the presence of the writer who visited them individually from the 28th of November to the 12th of December, 1977. Their comments about the third draft scheme were also recorded by the writer.

2.4.6 Division of Education, Department of Indian Affairs

The following information was collected by the writer in January 1978, from the Division of Education, Department of Indian Affairs:

(i) Senior Certificate Examination Regulations;

(ii) the marks that were awarded to Senior Certificate biology candidates (i.e., teacher-awarded marks; practical control test marks; the adjusted marks for practical work; the Senior Certificate theory marks);

(iii) the procedure that was followed in appraising the standard of teacher-awarded marks and in adjusting teacher-awarded marks for practical work;

(iv) the number of schools that had Senior Certificate biology candidates and the number of standard-ten biology teachers in the Republic.

2.4.7 Biology Subject Committee

The "Biology Subject Committee" is made up of biology teachers, subject inspectors, college of education lecturers, education planners (as observers) and university lecturers. Each member of the Committee is appointed by the Director of Indian Education for a period of two years. The functions of the Committee are to make recommendations to the Director in respect of: syllabuses; laboratory equipment and chemicals; refresher courses; selection of textbooks; and methods of teaching.

The first draft scheme of the outcomes of practical work (see Appendix A, pp. 362-366) was handed personally by the writer to the Committee members during the Fifth National Convention for Teachers of Science and Mathematics (i.e., 14th of July, 1977) which was held at the Springfield College of Education. They were asked to make comments on these outcomes of practical work.

2.5 THE SAMPLES USED IN THE STUDY

2.5.1 The Teachers Sample

There were two groups of teachers that took part in this investigation: the group of fifty-two senior biology teachers who attended the Fifth National Convention; and the group of nineteen standard-ten biology teachers (nine of these were among the fifty-two teachers that attended the National Convention in 1977 while the remainder had attended similar Conventions in previous years) who were visited at the nine schools by the writer.

2.5.1.1 Biology Teachers at the Fifth National Convention for Teachers of Science and Mathematics

From forty-seven high schools there were in all fifty-two senior biology teachers who responded to questionnaires A and B1. An analysis of questionnaire A with regard to personal information provided by these fifty-two teachers and from information collected from the Division of Education, Department of Indian Affairs, (i.e., the number of standard-ten biology teachers in the Republic which was gathered from the merit lists for practical work in biology that were supplied by the schools and the number of schools that had Senior Certificate biology candidates which was gathered from the practical control test mark sheets that were supplied by examiners) indicated the following:

(i) these fifty-two teachers were from forty-one of the fifty-four schools (i.e., 75,92 per cent of the schools) that had entered biology candidates (full-time) for the Senior Certificate Examination in 1977 in the Republic of South Africa;

(ii) the distribution of these forty-one schools according to the provinces is indicated in Table 2.1

TABLE 2.1

DISTRIBUTION OF THE FORTY-ONE SCHOOLS THAT WERE REPRESENTED AT THE CONVENTION AND HAD SENIOR CERTIFICATE BIOLOGY CANDIDATES (1977)

PROVINCE	Distribution of the 41 schools that were represented at the National Convention		Distribution of the 54 schools in the Republic that had Senior Certificate biology candidates	
	Number	Percentage	Number	Percentage
Natal	34	82,93	42	77,78
Transvaal	7	17,07	11	20,37
Cape Province	0	0,00	1	1,85
TOTAL	41	100,00	54	100,00

According to Table 2.1, with the exception of the Cape Province (which had only one school with Senior Certificate biology candidates), the Transvaal (seven out of the eleven schools) and Natal (thirty-four out of the forty-two schools) were generally well represented at the Convention. A sound opinion with regard to the outcomes of practical work at the senior secondary level at Indian schools in the Republic can be gathered from the group.

2.5.1.2 Nineteen Standard-Ten Biology Teachers Visited at Schools by the Writer with Regard to this Investigation

Table 2.2 indicates the distribution of standard-ten biology teachers in Indian high schools in the Republic of South Africa. This information was gathered from the merit lists for practical work in biology that were supplied by the schools to the Division of Education, Department of Indian Affairs.

TABLE 2.2

DISTRIBUTION OF STANDARD-TEN BIOLOGY TEACHERS IN THE REPUBLIC OF SOUTH AFRICA (1977)

PROVINCE	Teachers	
	Number	Percentage
Natal	75	85,23
Transvaal	12	13,64
Cape Province	1	1,14
TOTAL	88	100,00

According to Table 2.2 the bulk of the standard-ten biology teachers in the Republic of South Africa are from Natal. The nineteen standard-ten biology teachers visited by the writer represent 21,59 per cent of the population (i.e., of standard-ten biology teachers in the Republic of South Africa). They represent 25,33 per cent of the standard-ten biology teachers in Natal. They also represent all the standard-ten biology teachers that were at schools where the writer conducted practical control tests. Since all these schools were included there was no need for sampling.

2.5.2 Schools Sample

To gather information for this study all the nine schools where the writer conducted practical control tests were included. Table 2.3 indicates the distribution of the nine schools in Natal.

TABLE 2.3

DISTRIBUTION OF THE NINE SCHOOLS WHICH WERE INCLUDED IN THE STUDY IN RELATION TO THE OTHER SCHOOLS IN NATAL WITH SENIOR CERTIFICATE BIOLOGY CANDIDATES

AREAS IN NATAL	Number of schools in each area of Natal where practical control tests were conducted	Number of schools in each area of Natal included in this study
Durban (Municipality)	24	3
North Coast	4	3
South Coast	4	1
Midlands	4	1
Northern Natal	6	1
TOTAL	42	9

According to Table 2.3 each major area of Natal was represented by at least one school that was visited by the writer to gather information for this investigation. These nine schools represent 16,67 per cent of the total number of schools (nine out of fifty-four schools) where practical control tests were conducted (i.e., which had Senior Certificate biology candidates) in the Republic of South Africa. They represent 21,43 per cent or nine out of forty-two schools in Natal.

2.5.3 Examiners' Sample

All the examiners who conducted the practical control tests were included in this investigation. Of a total of twelve examiners (including the writer), two were from the Transvaal and ten were from Natal. Table 2.4 indicates the experience of these examiners in conducting practical control tests in terms of years.

TABLE 2.4

EXPERIENCE OF EXAMINERS IN TERMS OF THE YEARS THEY HAVE BEEN CONDUCTING PRACTICAL CONTROL TESTS

E X P E R I E N C E	Examiners	
	Number	Percentage
No experience	5	41,67
One year's experience	3	25,00
Two or more year's of experience	4	33,33
T O T A L	12	100,00

According to Table 2.4 there were 33,33 per cent of the examiners who had two or more years experience in devising and administering the practical control tests. Because of their experience these four examiners were selected to give weightings (out of a total of 100) to the operational divisions in the third draft scheme of outcomes of practical work.

2.5.4 Biology Inspectors' Sample

All the Biology inspectors from the Division of Education, Department of Indian Affairs and the Natal Education Department were included in this investigation. There were two biology inspectors from the Division of Education, Department of Indian Affairs and one from the Natal Education Department.

2.5.5 General Comments about Samples used in this Investigation

For the purposes of this study the writer included:

(i) all the schools he visited during the practical control tests;

(ii) all the standard-ten biology teachers that were in the schools that he visited during the practical control tests;

(iii) all the fifty-two senior biology teachers that attended the National Convention;

(iv) all the biology inspectors and examiners.

When the sample of standard-ten biology teachers (21,59 per cent) and schools sample (16,67 per cent) are compared with the total number in the Republic of South Africa, they appear to be small. The writer had to work within the framework of the nine schools, which was the maximum allocated for each examiner for the practical control tests, by the Division of Education, Department of Indian Affairs. The number of schools was interrelated with the number of teachers from whom information was gathered. The following factors precluded any attempt by the writer to increase the size of the sample.

(i) limited time between the practical control tests and closure of the schools at end of the year when the most vital information for this study could be collected from teachers;

(ii) visits of the writer to schools at a time which suited the teachers, because this is the busiest time for them in terms of devising, administering and marking the final internal examination papers.

Studies of this kind do not lend themselves to the use of large samples. Indeed, a perusal of the literature indicates that research workers in related fields of study also used small sizes of samples because of restrictions similar to those which were experienced by the writer.

Brown, Hitchman and Yeoman[(25)] carried out an investigation with regard to oral examining in practical work in chemistry at the CSE-level (reported in Schools Council, Examinations Bulletin 21) and they used a sample of 171 candidates from twelve schools. Although they do not indicate the size of the sample, it is obviously extremely small when viewed against the entry of 90 838 candidates for the CSE examinations by a single examining board.[(26)] Eggleston and Newbould[(27)] in their investigation in assessing attainment in science at CSE level relied on the comments of twenty-five teachers with regard to outcomes assessed in practical work. They also used thirteen teachers and 218 pupils in their investigation on assessment and moderation in physics at the CSE level.[28] These samples when viewed against the total number of candidates that enter for the CSE examination, appear to be extremely small. The National Foundation for Educational Research in England and Wales commissioned by the Schools Council carried out an investigation on the standard of awarding marks through cumulative assessment and final examinations at CSE level - Mode 3.[29] The sizes of samples of candidates were 28,66 per cent, 28,21 per cent and 23,94 per cent for biology, chemistry and physics respectively. Nicodemus[30] in a major investigation on "Why Science Teachers Adopt New Curriculum Projects" (i.e., the Nuffield, Schools Council and other projects) sponsored by the Social Science Research Council of the United Kingdom, used 25 percent of the sample in the population of science teachers. Only 51 per cent of this 25 per cent responded to the questionnaires used in this investigation.

In the United States of America, Lisonbee and Fullerton,[31] in investigating the "Comparative Effect of BSCS and Traditional Biology on Student Achievement", used a sample size of 3,77 per cent of tenth-grade biology students. George,[32] who carried out an investigation on "The Effect of BSCS and Conventional Biology on Critical Thinking", used a sample of 391 students out of a population of 66 000[33] students, all of whom were using BSCS materials. He also used ten teachers who were using these materials as a part of their teaching programme.

From the foregoing discussions it could be stated that the schools sample and the sample of standard-ten biology teachers included in this investigation are in line with the sizes of samples used in related fields of study by research workers in the United Kingdom and United States of America.

According to Tables 2.1 and 2.2, Natal - when compared with other provinces - has the largest percentage of schools where practical control tests were conducted (77,78 per cent) and the highest percentage of standard-ten biology teachers (85,23). Table 2.3 indicates that all the main areas of Natal are represented in this investigation. The information gathered from the schools in Natal ought to represent a reliable cross section of the situation prevailing not only in Natal Indian high schools, but also in the Republic because:

(i) all schools follow a common biology practical syllabus;

(ii) all the pupils are prepared for a common examination, i.e., the Senior Certificate Examination in biology;

(iii) all schools have been provided with basic laboratory equipment and facilities do not differ remarkably from school to school;

(iv) the same biology inspectors visit all these high schools in the Republic in order to guide the biology teachers;

(v) the biology teachers meet at least once in two years from throughout the Republic at the National Science Convention for Teachers of Science and Mathematics where ideas about biology education are exchanged.

The points enumerated above indicate that there ought to be no great differences between schools with regard to information that can be gained from teachers about outcomes and assessment of practical work.

From discussion with examiners, biology inspectors, senior biology teachers at National Conventions and from the writer's personal knowledge, this appears to be the case.

The point of view that is taken in this study is:

(i) that any conclusions made on the views expressed by this sample of nineteen standard-ten biology teachers (i.e., 21,59 per cent of the total number of standard-ten biology teachers) must be considered with great caution;

(ii) the views expressed by this sample must be used only as "pointers" to the multiplicity of factors that must be taken into account in assessing attainment in practical work.

In addition to the responses of these nineteen teachers, the responses of the fifty-two senior biology teachers, examiners, biology inspectors, members of the Biology Subject Committee and the views extracted from the literature will be considered.

An analysis of the marks (i.e., practical control test marks, teacher awarded marks, Senior Certificate marks for practical work in biology - for all Indian schools in the Republic of South Africa) will be made in order to establish:

(i) if it was necessary to moderate teacher-awarded marks;

(ii) the pattern followed in moderating teacher-awarded marks;

(iii) if there was consistency in awarding marks to the same candidates by the teachers and examiners.

The nineteen standard-ten teachers to whom reference has been made are considered to constitute a random sample, taking into account the procedure followed in the allocation of examiners to schools. The allocation of pairs of examiners to schools to conduct practical control tests was not tied down to character= istics of schools or the examiners. The only factors that were taken into account in allocation of examiners to schools were:

(i) examiners were to be allocated in pairs to conduct the practical control tests;

(ii) each new examiner (i.e., with no experience in conducting practical control tests) was to be accompanied by an experienced examiner;

(iii) two examiners sent to outlying areas (like parts of Northern Natal, Eastern and Western Transvaal) had to conduct practical control tests in all the schools in that area.

The procedure followed in allocating examiners to schools was as follows:

(i) For each day a number of schools (according to the number of pairs of examiners that were available) were selected at random by the biology inspectors from a list of schools where practical control tests had to be conducted in the Republic of South Africa.

(ii) Two examiners (a new examiner always being accompanied by an experienced examiner) were allocated to each of these schools at random.

In this way the writer (with a co-examiner) was allocated nine schools (which had a total of nineteen standard-ten biology teachers) by the Division of Education, Department of Indian Affairs, to conduct practical control tests. It must also be noted that nothing could have prevented the writer from being allocated to any of the remaining forty-five schools in the Republic of South Africa where practical control tests were conducted.

The standard-ten biology teachers from each of the fifty-four schools also had an equal chance of being visited by the writer during the practical control test and of subsequently taking part in this investigation. Within this context, and from the point of view that the samples (i.e., the teachers and schools) do not differ appreciably from the population (i.e., in terms of characteristics discussed on page 31 of this study) inferences could be made about the population from these samples.

Ferguson states that, "because the sample shows no bias on a number of known characteristics, that is, it may not differ from a random sample as far as these characteristics are concerned, the investigator may be prepared to regard it as a representative of the larger group or population and treat it as if it were a random sample".[34] It is in this context that the nineteen standard-ten biology teachers will be treated in this study in order to make inferences about the population, e.g., estimating population parameters from sample values. This will serve as a "pointer" (for reasons explained earlier) with regard to the proportion of responses that could be expected in the population in terms of the same responses made by this sample of teachers.

2.6 TERMS USED IN THE STUDY

Much of the confusion in regard to the analysis and discussion of assessment may be attributed to the inconsistent use of certain terms. It is essential to identify, define and distinguish a list of terms which are generally accepted and used in this study. This is done at the outset to prevent a lack of clarity in communicating ideas associated with assessment of attainment. The following list is presented in alphabetical order, with those terms which appear in the definitions and are themselves defined elsewhere being indicated in italics:

ability: An expression overtly of particular aspects of pupil *attainment*, e.g., recording and handling results.

aim: General statement or declaration of intent which attempts to give both shape and direction to education.

assessment: Placing of an individual upon some given or accepted scale intended to portray his *attainment* or *ability* at the end of a course of study as accurately as possible, e.g., awarding a pupil a symbol "A" in biology.

assessment by direct observation: This is an *assessment technique*, i.e., watching a pupil carrying out a particular task, such as microtechnique, and assessing this task on a predetermined mark scheme.

assessment procedures: Umbrella descriptive terms which use a variety of *techniques* to assess *attainment* in a course of study, e.g., *cumulative assessment*.

assessment techniques: Measuring instruments used in each method of *assessment*, e.g., oral questioning during *current practical work* or use of the practical record book.

attainment: (also referred to as achievement). An individual's attainment is his degree of *mastery* of information and *abilities* and the development of *attitudes* which pupils ought to have acquired in practical work in biology.

attitudes: Consistent *behaviour* in those attributes which are essential to practical work, e.g., persistence, enthusiasm, co-operation.

backwash: The effects of an educational process (including *syllabus*, *examinations*) on teachers and pupils. This backwash effect can be desirable or undesirable.

behaviour: Any human activity involving thinking, feeling or doing.

biology: A synonym for *biological science*. "Biology" is a term more commonly used in South Africa while "biological science" is used in Britain and United States.

biology course: Used as a synonym for *biological science curriculum* or biology curriculum.

biological science: This is a collective term to include all the branches of life science, such as, ecology, cytology, genetics, physiology, biochemistry, embryology, anatomy and morphology.

biological science curriculum: (also referred to as biology curriculum or biological science programme). This is planned experiences in the field of *biological science* or *biology* that is offered to the learner by the school.

common standard: The same mark allocated by different teachers to different candidates at schools must represent the same level of *attainment* in *practical work*, i.e., a pupil who has 70 marks in one school or from a teacher should represent the same level of *attainment* as that of another candidate with 70 marks in the same school or another school.

core syllabus: (also referred to as common basic syllabus). A minimum listing of subject matter as prescribed by the Joint Matriculation Board of South Africa (J.M.B.), which is an examination board that controls syllabuses and standards of matriculation examinations.

course work assessment: This is a procedure in which work done during the course is stored and then assessed at the end of the course.

cumulative assessment: (also referred to as continuous assessment). Systematic collection of marks over a period of time and their aggregation into a final mark.

current practical work: Performing tasks in *practical work* for the first time as a part of their course of study or present practical work at schools.

curriculum: The planned experiences offered to the learner under the guidance of the school.

discrimination: This is effectiveness in separating the better candidates (i.e., those with higher *attainment* and *ability*) from the weaker candidates or spreading the candidates out adequately according to their ability.

evaluation: Collection and use of information as a basis for decisions about an educational programme, like the biological science programme.

examination: Any series of tasks that together provide an *assessment* of a given trait for an individual. Examinations are used to measure *attainment* at end of the year for the purposes of promotion and certification. In addition the word, 'examination' is used as a generic term (e.g., Senior Certificate Examinations) and as a specific term (e.g., biology examination).

external examination: *Examination* controlled by the Education Department, e.g., Senior Certificate Examination.

final practical test: Assessment procedure which is devised and administered by the school at the end of the course of study in *practical work* in biology. The final practical test is based on the course of practical work covered in the senior secondary level and is a terminal test at the end of the matriculation year.

internal examination: *Examination* controlled by the school.

intellectual skills: With the exception of "knowledge", it refers to all levels of Bloom's Taxonomy in the cognitive domain.

manipulative skills: (also referred to as manual skills) Refers to the skill of the hand where manual dexterity is an important feature, e.g., dissection and handling apparatus.

mastery: An individual's performance that is judged against a set of predetermined criteria. It does not refer to complete mastery and variation of performance between individuals is taken into account.

measurement: Assignment of numerical values to pupils on the basis of some well defined procedure or set of rules. The various *techniques* incorporated in tests or *examinations* perform the function of a measuring instrument.

moderation: This is the procedure whereby the marks allocated by the teachers for practical work are aligned with an accepted *common standard*, e.g., the marks allocated internally by the teacher for practical work in biology are aligned with the marks allocated, by examiners in the *practical control test*.

methods of assessment: Refer to the three main ways of measuring attainment, i.e., oral, practical and written.

objectives: Intended *behaviours* or descriptions of expected *outcomes* of what learners will be able to do at the end of a specified course of study. An *objective* in this research is seen as a *skill*, *ability* or *behaviour*.

operational divisions: umbrella descriptive terms of broad *outcomes* of *practical work* which are neither *aims* nor *objectives*.

outcomes: Used as a synonym for *abilities* and *attitudes* developed through *practical work*.

overall assessment: (also referred to as global assessment) is a procedure of assessing *attainment* in *practical work* whereby a pupil is awarded a mark at the end of a term's work or course of study on a five-point scale according to specified criteria. This type of assessment does not involve a final manipulation of marks but is a global estimation by the teacher of final attainment of pupils according to specified criteria.

practical skills: This is a collective term to include *skills* like manual, observational and recording.

practical control tests: *Moderation* procedure used by the Division of Education, Department of Indian Affairs, to scrutinize the overall standard of awarding marks by individual teachers at schools.

practical tests: *Assessment procedure* which is devised and administered by the school at various stages of a course of study in a school.

practical work: Means experiments performed by the teacher as demonstrations, co-operative demonstrations by groups, as well as experiments and observational exercises carried out by pupils. These activities may take place in the laboratory (called laboratory work) or elsewhere.

senior biology teachers: Teachers who are engaged in teaching biology at the senior secondary level.

skill: *Practical* and *intellectual* skills

syllabus: A listing of *subject matter* in broad outline, e.g., Syllabus for Biology (Higher Grade) in Indian schools in South Africa.

weighting: The percentage of the total marks that is allocated to each component of the *syllabus* and each *operational division* of *practical work*.

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CHAPTER THREE

ASSESSMENT OF ATTAINMENT IN PRACTICAL WORK

3.1 ATTAINMENT IN TERMS OF OBJECTIVES

Ebel,[1] Tyler[2] and Lewis[3] state that the most crucial decision to make in any assessment situation is what to assess. Implicit in this is that one cannot assess attainment without clarifying what the pupil is supposed to attain. For the purpose of this study, attainment will be regarded in terms of the objectives that are formulated for practical work in biology. For example, if the objectives require such activities as recording, hypothesising and predicting then these must be translated into assessment situations which will provide evidence of attainment of these activities. Implicit in this example is that attainment will be measured in terms of abilities or behaviours which are considered as necessary outcomes of practical work in the senior secondary level. Since an ability is exercised within the context of subject matter, cognizance is also taken of the practical syllabus in assessing attainment in practical work. It is against this background that attainment in practical work has been defined here as the degree to which a pupil has mastered the specified objectives of practical work in biology. The term "attainment" as used in this study is a synonym for "achievement"; the former term is more commonly used in Britain and the latter in the United States of America.

A distinction should be made between aims and objectives because some authors[4][5][6] and examining boards[7] tend to confuse aims with objectives. These terms are clarified in the following sections.

3.1.1 Aims

From the standpoint of Dewey[8] and Wheeler,[9] "aim" in this study will be broadly defined as a general statement or declaration of intent which attempts to give both shape and direction to practical work. Richmond[10] states that, "to profess an aim is more in the nature of an act of faith; it presupposes an intention which carries with it no guarantee of it being fulfilled". For example, "To enable pupils to grasp the scientific method of approach and to cultivate habits of logical and systematic thinking", which is indicated as an objective in the biology syllabuses (i.e., Biology syllabuses of the Division of Education, Department of Indian Affairs)[(11)] will be regarded as an aim in this study. This aim is broad and general. "Generality, at any rate is a part of their nature, and this property should be seen as a reality to their function, rather than as a basis for criticising their lack of precision".[(12)]

The aims do not indicate as to what constitutes attainment and therefore its attainment could not be measured. Within this context, they are not the immediate day to day concern of the teachers and examiners but nevertheless they give direction to practical work and its assessment. For example, "The development of assessment objectives from the main aims of the curriculum in the Nuffield Advanced Level Biology course was seen as the important device in securing a proper implementation of the curriculum through the prescriptive effect of a public examination".[(13)]

3.1.2 Distinction between Aims and Objectives

To obviate the confusion between aims and objectives the following model is proposed:

Aims $\underset{\dashleftarrow}{\longrightarrow}$ Objectives

Key: ⟶ represents derivatives of objectives from aims

<--- represents attainment of aims through the attainment of objectives

This model brings out clearly the distinction and relationship of aims and objectives. It represents a two-way approach, i.e., derivation of objectives from aims and the attainment of objectives leading to the attainment of aims. The aims originate from philosophical, sociological and psychological considerations.[(14)] The aims which are broad and general and which are regarded in this study as an ideal or aspiration lie at one end of the continuum, while objectives which are specific (i.e., observable behaviours or descriptions of expected outcomes of what learners will be able to do at the end of some specified course of study) lie at the other end of the continuum. In this respect, although objectives are a great deal more precise than the aim from which they are derived, they are still inferred statements of expected outcomes.

The relationship between aims and objectives is brought out by this model because the interactive rather than the discrete character of this relationship is emphasised and it indicates that aims and objectives lie in the same continuum. This model provides a useful framework for teachers and examiners because it indicates the relationship between aims and objectives and the derivation of objectives. The expression of objectives in behavioural terms gives direction to what to assess when assessing attainment.

Since this study is concerned with assessment in practical work, attention will be given to objectives only. These objectives will reflect the aims in terms of the proposed model.

3.1.3 Objectives

Attention must be focussed on the format in which objectives must be formulated. A number of formats have been suggested for writing objectives. Furst,[15] Adams,[16] Mager,[17] Tyler[18] and Bloom[19] form one school of thought and they want the format of objectives to be specified in terms of what the learner is expected to do in order to demonstrate his attainment of objectives. Atkin,[20] Hirst,[21] Stenhouse[22] and Eisner[23] form another school of thought and they are opposed to formulation of objectives arguing that predetermined objectives reduce the content of education to a prescriptive and instrumental role. Furthermore they argue that our behaviour embraces the whole person and is not comprised of isolated reactions. A way of redressing this argument is by assessing attainment of objectives through cumulative assessment which takes into consideration the teachers image of the pupil as a person and includes analytic process which helps towards this end (i.e., assessing attainment of objectives over a period of time and using this to judge the overall performance of the pupil at the end of the course).

The writer believes that objectives must be spelt out in behavioural terms, i.e., describing what the teacher expects the pupil to be able to do at the end of the course of study; because it aids instruction and ultimately assessment. Objectives:

(i) provide guidance for the selection of content and development of instructional procedures,

(ii) provide valid criteria for assessing pupil attainment by stating in advance the expected accomplishment.

In terms of this study objectives will aid in clarifying what attainment in practical work in biology is, so that pupils could be placed into assessment situations which will provide evidence of attainment. Within this context objectives in this study will be stated in behavioural terms, i.e., observable abilities and attitudes. The significance of describing the abilities and attitudes in this operational form (i.e., behavioural or overt form) is that no assumptions are made concerning the learning process to which the pupil was exposed. The evidence that is provided by a pupil's performance in an assessment measure is taken at its face value as a measure of attainment of that ability or attitude.

The term "ability" is used to denote, "the actual power to perform an act, physical or mental",[24] acquired predominantly through learning experience in practical work in biology. In this context, ability signifies the present performance of a pupil in practical work. An attitude is usually defined as settled behaviour or manner of acting.[25][26] "Attitude" in this study will be taken to mean consistency in those attributes which are essential to practical work, e.g., persistence, enthusiasm, co-operation, etc. For example, persistence is an important attitude which shows up in an attribute like determination to see work through to a successful conclusion by trying again with a suitably modified technique or changed procedure where initial attempts are unsuccessful.

It is against this background that attainment in practical work in this study is defined as the degree of mastery of objectives (i.e., in terms of development of abilities and attitudes specified in the objectives) that have been specified for practical work.

The biology syllabuses of the Joint Matriculation Board,[27] Departments of Education[28] and Division of Education, Department of Indian Affairs[29] provide no guidance to assessors (i.e., both the teachers and examiners) in terms of objectives as defined in this study. The absence of clearly defined objectives for practical work in biology in high schools in South Africa precludes valid and reliable assessment in this area. One of the aims of this study then must revolve around the formulation of objectives for practical work

3.2 METHODS OF ASSESSMENT OF PRACTICAL WORK

The term "assessment" in this study refers to placing a pupil on some given or accepted scale intended to portray his attainment as accurately as possible.[30] Listening to pupils, observing them in action or reading what they have written can form the basis of assessment.

3.2.1 General Position in the Republic of South Africa

The Education Departments of Natal and the Orange Free State, and the Division of Education, Department of Indian Affairs, are the only examining bodies in the Republic of South Africa that assess practical work in biology *per se* for the Senior Certificate biology examination.[31][32][33] These examining bodies allocate 17,50 per cent and 16,67 per cent of the total marks allocated to Senior Certificate biology examination for practical work in the Higher Grade and Standard Grade respectively. Assessment of practical work is carried out by the class biology teachers through cumulative assessment, and each candidate is awarded a mark for practical work. This teacher-assessed component of the Senior Certificate biology examination is moderated.

These three examining bodies state broad outcomes of practical work - none of them aims or objectives as defined in this study - which are to be assessed by teachers in practical work. Outcomes common to all of them are: recall of knowledge, manipulative skills, observation and recording, and interpretation.

The Natal[34] and the Orange Free State[35] Education Departments spread the period of cumulative assessment over two years (i.e., over the standard 9 and 10 years) whilst the Division of Education, Department of Indian Affairs requires teachers "to assess the practical ability of each student continuously throughout the course". (i.e., over the standard 8, 9 and 10 years).[36] In addition to this, the Natal Education Department specifies that 40 per cent of the total of practical marks must be from the standard 9 work whilst the remaining 60 per cent must be on standard 10 work.[37]

The Natal Education Department suggests the use of tests, assignments and assessment of practical drawings (i.e., in practical record books or files) as techniques to be used in cumulative assessment. With regard to tests, this Department states that each school must submit two practical test papers and marking memoranda for standard 10 to the moderator for moderation. "Each of these practical test papers must be the result of a team effort of all the teachers responsible for biology in standards 9 and 10, in the school".[38] These tests are then conducted by the teachers for standard-ten candidates, one in the second term and the other in the third term. Circular Minute No 6/1979[39] stipulates that each of the practical test papers should include questions covering at least four of the following aspects of the prescribed practical work. The approximate minimum percentage of the total mark to be allocated to each of these sections of the practical work is also indicated thus:-

(i) Knowledge of and setting up of a microscope ($\pm$ 5 percent).

(ii) Preparation of wet mounts ($\pm$ 5 per cent).

(iii) Drawing from a microscope slide and/or from a 35 mm slide and/or from practical material ($\pm$ 15 per cent).

(iv) Classification with visible reasons; the ability to point out and discuss visible distinguishing characteristics and adaptations on specimens prescribed in the section on animal and plant diversity (± 40 per cent).

(v) Recognition and pointing out of systems, organs and structures in a freshly dissected mammal and/or on fresh mammalian organs and/or on prescribed models and/or on microscope slides and/or on 35 mm slides; the ability to point out and discuss visible characteristics and adaptations on such organs and tissues (± 10 per cent).

(vi) The ability to give an accurate but brief description of the ecological habitat which was studied; the recognition of plants and animals from such an ecosystem; the ability to point out and discuss visible characteristics and adaptations on plants and animals from such an ecosystem; the ability to discuss inter-relationships observed in such a habitat; the ability to discuss experiments carried out on and the influence of the prescribed abiotic factors on the ecosystem; practical work on pollution (± 10 per cent).

(vii) The ability to cut and draw half-flower sections of the flowers of the prescribed angiosperm families (Higher Grade). The ability to dissect and to draw the flowers as seen in longitudinal section of the prescribed angiosperm families (Standard Grade). The ability to point out and use visible characteristics to classify the flower; recognition of parts of the flower; the ability to distinguish between mono- and dicotyledonous flowers (± 5 per cent).

In addition to the above sections (which reflect work covered in standards 8, 9 and 10) handling of apparatus, handling of specimens and materials, leaving work-place neat and tidy are also assessed.[40] Each test is planned for a double period. The test contains some questions which are common for the Higher Grade and the Standard Grade and other questions which are specific for either the Standard Grade or Higher Grade. To bring about a balance in the paper, the Natal Education Department recommends that the Standard Grade should be awarded 70 per cent of the total marks for recall of knowledge and 30 per cent for comprehension and application of knowledge. The recommendation for the Higher Grade is 50 per cent of the total marks for recall of knowledge and 50 per cent for comprehension and application. This recommendation seems to be inappropriate because assessment of practical work cannot be confined to assessing knowledge, comprehension and application which are categories or levels of the cognitive domain. Practical tests as suggested by the Department should include manipulative skills (e.g., handling of apparatus) and attitudes (e.g., leaving the work place neat and tidy). These fall outside the cognitive domain and yet no provision is made for this in the distribution of marks in the test paper.

These two tests that were described are the minimum number that a teacher is required to conduct in the standard 10 year. However, the Natal Education Department does not restrict teachers on the maximum number of tests that they could set for assessing the pupils. Besides the practical tests, the Natal Education Department requires teachers to assess at least two practical drawings (i.e., drawings reflected in the practical books or files) from each section of the syllabus, per pupil, per year (i.e., two in standard 9 and two in standard 10).[41] When making this assessment the teachers have to pay special attention to:

(i) correct and accurate representation;
(ii) general neatness, shape and size of diagram;
(iii) correct labelling of visible structures only;
(iv) correct, specific, descriptive heading.

Although assignment is suggested by the Natal Education Department as a technique in the cumulative assessment of practical work, no reference is made about the type of assignments that should be assessed and how it should be assessed.

The Orange Free State Education Department, besides indicating the compulsory practical work that must be undertaken by students, outcomes of practical work that are to be assessed, and the use of tests in the standard 9 and 10 years in collating marks for practical work, gives no further guidance in the assessment of practical work. The guidance given to teachers by the Division of Education, Department of Indian Affairs, in terms of assessment of practical work, is similar to that indicated by the Orange Free State Education Department, except that the period of cumulative assessment is spread over the three years of the senior secondary phase and no techniques of assessment are suggested.

From this review of assessment of practical work in the Republic of South Africa the following is evident:

(i) Although all the examining bodies (i.e., Departments and Divisions of Education) use more or less a common syllabus (i.e., based on the core biology syllabus of the Joint Matriculation Board) there is a discrepancy among them in terms of assessment in biology. Some bodies conduct written examinations and also assess practical work *per se* for the Senior Certificate biology examination; while other bodies conduct only written examinations. This presupposes that the three examining bodies that assess practical work *per se*, do so, because abilities measured through practical work are markedly different from those that are measured by written papers. This is consistent with research findings.[42][43] It may be logical to argue that the marks awarded by examining bodies that conduct only written examinations are not comparable (in terms of abilities measured) to the marks awarded by other examining bodies that conduct written examinations and practical assessment.

(ii) Cumulative assessment is the common procedure used by examining bodies that assess practical work. However, there is variation between the examining bodies in terms of techniques used in cumulative assessment. The Natal Education Department suggests the use of tests, assign= ments and practical records of pupils whilst the Orange Free State Education Departments recommends the use of tests only. The Division of Education, Department of Indian Affairs does not suggest any particular technique to be used in cumulative assessment.

(iii) The beginnings of attempts to indicate what to assess (outcomes of practical work) and in what proportions they should be assessed (weightings) are now becoming evident in the guidance given to teachers by the Natal Education Department. This is a prerequisite to ensure that the marks awarded by teachers are comparable. There is no evidence of similar attempts by the Orange Free State Education Department and the Division of Education, Department of Indian Affairs.

(iv) There is a discrepancy among the examining bodies in terms of the period of spread of cumulative assessment. Some bodies spread it over 2 years while others over 3 years.

Against this background, the writer is of the opinion that the Joint Matriculation Board must ensure that all examining bodies in the Republic of South Africa assess attainment in practical work. If cumulative assessment is the procedure that is to be used for assessment of practical work, then teachers must be given adequate guidance (which must be uniform for all examining bodies) on this assessment procedure. These aspects will be discussed in relation to assessment of practical work in Indian schools in relevant sections of this study.

3.2.2 General Position in Some of the Overseas Countries

In the Advanced-Level Biological Sciences in Britain, the majority of the examining boards still emphasise external practical examinations.[(44)] The Southern Examining Board base their assessment of practical work solely on the practical record book submitted by the candidates[(45)] while the Welsh Joint Examining Board uses the practical record book in addition to its external practical examination.[(46)] The Northern Ireland Examining Board, in addition to its external practical examination, requires candidates to submit a compulsory dissertation (not more than 5 000 words) on an experimental project.[(47)] The Scottish (Higher) Examining Board and the Associated Examining Board do not assess practical work *per se*, but written examinations contain questions designed to test a candidate's experience of field and laboratory work.[48] The Joint Matriculation Board (London) replaced practical examinations by teacher assessment of practical work and 20 per cent of the total marks is allocated for this.[49]

The Joint Matriculation Board (Nuffield)[50] assesses pupils on a written project based on a practical investigation selected by individual students and this is allocated 10 per cent of the total marks for biology. Practical work of pupils over the last three terms of the year is assessed by teachers through overall assessment and this is allocated 15 per cent of the total marks for biology. It also assesses through written examinations such practical abilities as hypothesis construction, experimental design and analysis of data.[51] The Nuffield A-Level assessment of practical work will be discussed in some detail here because of its impact overseas and also because it is related to the present study. Assessment of project work is an integral part of the Nuffield A-Level Biology assessment.[52] These projects are assessed as a total investigation, and they are "carried out by the student, largely on his own initiative, involving enquiry into some aspect of biology which has interested him".[53] The stages of the project which is to be assessed by the teacher are:[54]

(i) statement and consideration of problems in the area of special interest;
(ii) selection of a limited topic for practical investigation;
(iii) investigation of the background knowledge;
(iv) planning the experiment or investigation;
(v) recording the data;
(vi) interpretation of the data;
(vii) relating the interpretation of data to the background knowledge, and suggestions for further investigations;
(viii) bibliography and acknowledgements.

Teachers are asked to judge most of the stages on a relative five-point scale from 'well above average' to 'well below average' (i.e., Grades 5 to 1 respectively). However, the teachers are asked to use a three point scale (Grades 3 to 1) for those stages which were concerned as less important, namely, stages ii, v, and

viii. The teacher's score for each project is the sum of grades awarded for each stage. Further information is provided for teachers and pupils on project work in form of a guide by the producers of the Nuffield A-Level Biology.[55]

The Joint Matriculation Board (Nuffield) provides guidance to teachers for the internal assessment of class practical work.[56] The teachers have to award each pupil a grade (which ranges from 5 to 1) through an overall assessment procedure in which the final grade is allocated on a five-point scale according to specified criteria. The final grade is based on information that has been collected about pupils' performance in practical work over the last 3 terms of the senior secondary level. The grades are allocated on a five-point scale according to the following criteria:

Grade 5 is to be awarded to a candidate considered capable of performing the investigations encountered in the Nuffield A-level scheme and of carrying out any further investigations based on similar principles and techniques.

Grade 3 is to be awarded to a candidate considered capable of performing the investigations encountered in the scheme with the minimum of assistance but who requires help with any further investigations based on similar principles and techniques.

Grade 1 is to be awarded to a candidate who requires a great deal of help both when performing investigations in the scheme and when carrying out any further investigations based on similar principles and techniques.

Grade 2 and 4 are to be determined by interpolation between standards of the other three grades.

Grade 5 is equivalent to a mark of 80 per cent or over, Grade 3 approximates to 50 per cent and Grade 1 corresponds to 20 per cent and less. The information sent out to teachers on overall assessment stipulates that:

> *"Assessment should be of a candidate's work in investigation as a whole. The assessment should be made under the three 'Operational Divisions' described below. The relative importance of these three 'Operational Divisions' will vary in different investigations but they should be given equal weighting overall".* (57)

These operational divisions are:

(i) Procedure: The activities under this heading embrace all those which can be seen as the candidate is in action at the laboratory bench or in the field. These include the care and ingenuity shown in selecting a suitable approach and in carrying out operations and in the care and competence with which observations are made. A reasonable overall efficiency should be sought rather than the develop= ment of special manual skills.

(ii) Recording: Methods used for recording observations and experimental results should be taken into account, e.g., short notes, sketches, diagrams, tabulation of results, graphs. The extent to which candidates' records correspond to their observations should also be considered. The candidate should have indicated possible errors resulting from the materials and methods used.

(iii) Handling of results: This is the essential goal of an investigation. Assessment should be made of a candidate's ability to draw conclusions from observations and data and, where required, to formulate a relevant hypothesis.

The final judgement of grading is deferred until late in the course so that performance in a range of work (indicated in Nuffield A-Level Biological Science Projects) can be considered and full account be taken of improvement in performance. Further guidance is provided for teachers in assessing the three "Operational Divisions" in current practical exercises in order to collect information for the overall assessment.[58]

(i) Procedure

Grade

5 Exemplary; shows no difficulty in following or interpreting the instructions. The exercise was completed.

4 A little extra help was required but the exercise was completed.

3 The main object of the exercise was achieved but minor errors of technique were observed.

2 A considerable amount of aid was required. Without this the main object(s) would not have been achieved.

1 Without help at all stages the student would have been quite lost.

(ii) Recording

Grade

5 Excellent. These results could have been used as an example for the class to follow.

4 No serious faults. These results could have been understood by an outside observer.

3 Adequate, but an outside observer would have needed some additional information in order to understand these records.

2 Additions or corrections had to be made before these records could serve as a means of communication.

1 Inadequate. This work had to be done again.

(iii) Handling of results

Grade

5 Perfect and exemplary.

4 All the essential points were grasped. Some minor misunderstandings or omissions.

3 On the right lines. One major fault.

2 Major misunderstandings but some perception was shown.

1 The student failed to grasp any of the main points of interpretation.

Some detailed suggestions for collecting further information for overall assessment are provided in the Teachers' guide.

One of the most interesting features of the Mode 3 CSE examinations in Britain is the use of cumulative assessment in biology as in other subjects.[59] In the West Yorkshire and Lindsey Regional Examining Board, which has the largest number of CSE Mode 3 candidates, cumulative assessment is described as: "continuing awareness by the teacher, of the development and knowledge of his pupils; is a process which extends over a period of time; the gradual build up of a cumulative judgement about performance".[60] Cumulative assessment is interpreted as the systematic collection of marks over a period of time and their aggregation into a final mark. Cumulative assessment involves a number of techniques to measure attainment in practical work. These are, oral questions, direct observation of pupils carrying out particular tasks in the laboratory, project work, pupils' practical record books, etc. Guidance is given to teachers by the examining boards on matters such as objectives, criteria for awarding marks and on techniques of assessment.[61]

Another pattern of assessment is evident in assessing practical work in biology at the senior secondary level in the United States of America. In the United States achievement testing for internal credits is the responsibility of the schools. Attainment in practical work is not assessed *per se* but through written papers which contain questions that require practical work experience in their answers.[62] Although final assessments by teachers at schools are usual, institutions at the tertiary level may set their own requirements for admission.[63] Many of these institutions use the Educational Testing Service which provides assessment in biological sciences. For example, the College Entrance Examination Board (CEEB) prepares Advanced Placement (AP) programmes in biological science for secondary schools.[64] An analysis of the AP programme in biology reveals that assessment in biology is based solely on "paper and pencil tests".[65] Tamir and Glassman state that, "...while laboratory centred activities are perhaps the most significant aspect of the BSCS

Curriculum (i.e., in the United States of America) they have received little attention in terms of evaluation".[66]

Upon the completion of the 12th grade, Israeli high school pupils take a matriculation examination which is similar to the A-Level examinations in Britain.[67] The biology examination in Israel consists of a written examination which consists of 70 per cent of the total marks and a practical which counts for the rest, i.e., 30 per cent.[68] Fifty per cent of the practical marks are awarded through a final practical examination and the other 50 per cent by the teacher for project work. The final practical examination consists of:[69]

(i) Plant identification with the aid of a key - 15 per cent of the total score;
(ii) oral examination on animals and plants - 35 per cent of the total score;
(iii) problem to be solved by experiment - 50 per cent of the total score.

Guidance is provided for teachers on abilities to be developed through practical work, approach to practical work (based on BSCS approach) and on techniques of assessment. Tamir and Glassman state that, "practical laboratory examination (i.e., in Israel) reflects the spirit of inquiry and constitutes a novel approach in evaluating the BSCS instructional outcomes".[70]

It is evident from this review of assessment of practical work in some of the overseas countries that a remarkable variety of assessment methods are used. These assessment methods differ among examining boards in the same country and among countries. Assessment of practical work is based on formal practical examinations in some cases to no assessment, other than questions included in the theory papers, to situations of teacher assessment (of project work, practical records, or through cumulative assessment or overall assessment). Some of the examining boards have a combination of some of the methods in assessing practical work. There are several problems that have been encountered by overseas examining boards in conducting formal practical examinations. The Biological Education Committee (United Kingdom) states, "formal practical examinations are expensive to conduct and more prone to fallibility than written papers".(71) There are also added difficulties in terms of devising and administering practical examinations when large numbers of pupils are involved.(72) In view of this logistical problem some of the examining boards in Britain are considering alternative forms of assessment other than formal practical examinations. Research findings indicate the undesirable backwash effects that these practical examinations can have on pupils(73) and the nature of practical work in schools.(74)

The problem of relying on practical record books of pupils as the only means of assessment by examining boards is the undesirable backwash effect that it may have on the work done by pupils. "The teaching-learning situation ought not to discourage pupils who make mistakes and the records kept by pupils during the course should be working records reflecting problems encountered and progress made. If pupils are aware that such records are going to be used for assessment purposes it is probable that they will be prepared with that objective in view, being written-up for assessment rather than to meet the needs of the particular educational situation; 'clean copies' will be used to compile the pupil's dossier rather than the 'real' records of work". (75) There is also the problem of establishing whether the work reflected in the practical books is the original work of the pupil or that copied from other sources (i.e., colleagues or text-books).

Tamir(76) attacks the "pencil and paper" tests used in assessing attainment in practical work. There is research evidence that written examinations have low correlations with the same skills assessed under laboratory conditions.(77) Within this context written examinations cannot easily substitute practical assess= ment under laboratory conditions as is being done by some examining boards. For various reasons mentioned in this discussion, serious attempts are now being made by examining boards in the United Kingdom to move towards teacher assessment of practical work, i.e., through overall assessment, cumulative assessment or project work assessment or a combination of these.[78] The Biological Education Committee (United Kingdom)[79] states that teacher assessment will become common practice with the disappearance of formal practical examinations. The Schools Council hopes that the outstanding characteristics of the assessment procedures devised by teachers will be, "freshness and vitality and they will reflect and not inhibit the originality of the work being done in the schools".[80]

3.3 MODERATION OF TEACHERS' ASSESSMENT

"Moderation" in this study refers to the procedure whereby the internal assessment standards are brought into line with a common national standard (i.e., the standard of the examining board). Moderation brings under scrutiny the overall standard (i.e., leniency or severity of awarding marks; conformity or consistency of awarding marks; discrimination of pupils of various abilities) of awarding marks by individual teachers to the group (i.e., the sample that is selected for moderation) and not to individual pupils. Individual performance that is assessed during a moderating test (e.g., practical control test) is only incidental in this process of adjudicating the standard of teacher-awarded marks. If for an individual candidate, the moderator's mark is different from that of the teacher's, the teacher's mark will stand, provided that the statistical measures indicate that there is a reasonable degree of agreement between the teacher's and moderator's marks for the group or sample. The purpose of moderation is to ensure that the teacher-awarded marks are fair and comparable for all candidates. That is, a uniform standard (i.e., the same level of attainment by candidates being awarded similar marks) of awarding marks is maintained.

Against this background, a clear distinction is made in this study, between the method of assessment followed by the teacher in awarding marks to individual pupils and the procedure of moderation conducted by moderators. The former is the responsibility of the teacher and the school guided by the education authorities (e.g., Division of Education, Department of Indian Affairs); while the latter is the function of the examining board.

3.3.1 General Position in the Republic of South Africa

The Joint Matriculation Board issues certificates of matriculation exemption to holders of the Senior Certificate in the Republic of South Africa provided that the candidates meet with the minimum requirements laid down by the Board.(81) The Joint Matriculation Board has the responsibility to ensure that equivalent standards are maintained in schools throughout the Republic by a system of moderation. This system of moderation by the board involves the scrutiny of examination papers and scripts with regard to the Senior Certificate Examinations in biology (written papers). Assessment of practical work by the class teacher also forms a component of the Senior Certificate Examination in biology. The Natal and Orange Free State Education Departments and the Division of Education, Department of Indian Affairs (which are the only examining bodies in the country that assess practical work as a component of the Senior Certificate Examination) are entrusted with the responsibility by the Joint Matriculation Board to ensure that the overall standard of awarding marks for practical work by teachers is fair and comparable for all candidates. To ensure that these requirements of the Joint Matriculation Board are met, these examining bodies appoint a panel of moderators or examiners to moderate the marks awarded by teachers for practical work by the use of control tests.(82)(83)(84) Since the mechanics of moderation procedure followed by the Natal Education Department are not identical to the ones followed by the Division of Education, Department of Indian Affairs and the Orange Free State Education Department, the procedure followed by these examining bodies will be discussed under separate headings.

3.3.1.1 Moderation Procedure Followed by the Natal Education Department

The moderation procedure followed by the Natal Education Department is specified in Circular Minute No. 62/1979(85) and information sent by moderators to teachers.(86) The local biology teachers play an important role in moderating teacher-awarded marks. The high schools in Natal offering biology are divided into ten centres according to location. Each centre has three to five schools that have Senior Certificate biology candidates. A local senior biology teacher or a lecturer from a college of education is appointed as a moderator for a centre by the Department. This moderator is in charge of all the schools in the centre. In his own school the moderator from a neighbour=ing centre will be the moderator.[87] The senior biology teachers from each school in the centre must submit two practical test papers and marking memoranda for standard 10, per school, per year to the moderator (appointed for the centre) to be moderated. This has been fully discussed from pages 44 to 46 of this study. These moderated test papers are then returned to the school. The two tests are then conducted by the teachers, i.e., one in the second term and one in the third term. The test in the third term must take place by the middle of August. The moderator attends at least one of the practical tests at each school. He is notified by the school of the dates of the test. On the day when the moderator is present he:

(i) discusses the test (i.e., organisation, administration and candidates to be tested, etc.) with the senior teacher;

(ii) may ask to see the practical scheme of work as well as the practical books and files of the pupils concerned;

(iii) will be present at the test and may question individual pupils on their work.

The purpose of this visit by the moderator is to gain an impression of the standard of the marks awarded by teachers at the school. After the test is completed the test papers are marked by the teachers. They then forward to the moderator these marked test papers together with two question papers, two mark sheets and the marking memoranda in duplicate. A similar procedure is followed by the teachers for the test when the moderator is not present. The moderator, after moderation of the scripts returns these and one marking memorandum and mark sheet of each test to the school. If any adjustment of the marks awarded by teachers is thought necessary, this is discussed with the senior teacher when the scripts are returned. One of the mark sheets and marking memorandum for each test and a report on the impression gained from visiting the school are submitted by the moderator to the biology inspector.

The final Senior Certificate biology practical marks (i.e., one mark per pupil) are filled in by teachers on mark lists provided by the Department in September. When compiling the final marks the following factors must be taken into account:

(i) Standard 9 (40 per cent of the total marks) and standard 10 (60 per cent of the total marks) marks are to be used.

(ii) These marks may include tests, assignments and marks allocated to drawings in practical books.

(iii) The final mark should be a true reflection of the pupil's practical mark in biology. Any noticeable deviations from the moderated test marks should be discussed by the senior teacher with the moderator.

According to the information contained in the mark sheets (2 per school) and report submitted by the moderator for each school, the biology inspector appraises the standard of awarding marks by teachers at each school. The mean of the 2 test marks are compared with the mean of the teacher-awarded marks per school. If there is any severe deviation between these mean marks then the teacher-awarded marks are adjusted.

3.3.1.2 Moderation Procedure Followed by the Division of Education, Department of Indian Affairs and the Orange Free State Education Department

To ensure that the marks awarded by teachers are uniform the Division of Education, Department of Indian Affairs and Orange Free State Education Department appoints examiners to moderate these marks by means of control tests. These tests are externally set and marked, and are administered by the examiner on a sample of Senior Certificate biology candidates at each school in the third school term. The marks awarded by the examiner to the sample selected for the control test represent the national standard (i.e., standard of the examining body). The mean mark of the examiner for the sample is then compared with the mean mark of the teacher for the same candidates. If there is a great discrepancy between these mean marks then the teacher-awarded marks for the Senior Certificate biology candidates are adjusted accordingly. Since the mechanics of moderation followed by the Division of Education, Department of Indian Affairs is directly related to this study, it is discussed in detail below.

3.3.1.2.1 <u>The Mechanics of Moderation by the Division of Education, Department of Indian Affairs</u>

3.3.1.2.1.1 <u>Appointment of Examiners to Conduct Practical Control Tests</u>

In terms of paragraph 18(5) of the Senior Certificate Examination Rules of Procedure,[88] the Director of Indian Education appoints examiners to assist the biology inspectors in conducting the practical control tests in schools in the Republic of South Africa. The examiners appointed are experienced biology educators from high schools, Springfield College of Education and the Faculty of Education, University of Durban-Westville. In 1977, there were twelve examiners appointed to assist the two biology inspectors to conduct practical control tests. The writer was one of the twelve. The details of these examiners are given in Chapter 1 (pp. 27-28). The examiners are allocated in pairs by the biology inspectors to visit the schools with Senior Certificate biology candidates. Those who are actually teaching the subject at a particular school are not allowed to examine their own pupils and where an examiner is appointed for the first time, he is paired with an examiner with previous experience. An itinerary is drawn up by the biology inspectors for the examiners to follow when conducting the practical control tests.[89] This indicates the date, the school and the pair of examiners that are to visit the school. Each pair of examiners spends a day at a school. The date of the practical control test at a school is conveyed to the principal via circulars by the Division of Education, Department of Indian Affairs.[90]

Once appointed the examiner conducts the practical control test and awards marks to the sample. These marks, together with the teacher-awarded marks for the same candidates, are submitted to the biology inspectors who adjudicate the teacher-awarded marks as they deem fit. There are no criteria laid down for their guidance in making judgements about which marks are to be accepted and which are to be adjusted.[91] The various aspects stated in this section are discussed in detail in the following sections of this study.

3.3.1.2.1.2 Division of Practical Control Tests into Two Sessions

The practical control test at each school is split into two sessions, i.e., session A and session B. Session A is the group test and session B is the laboratory test.

In the group test the pupils selected for the practical control test (i.e., the sample) have to be assessed at the same time. The pupils respond to oral questions in a written form. The oral questions are based on slides and transparencies (of specimens, experiments, etc.) which are projected onto a screen.

In the laboratory test, pupils are to carry out individual investigations. Some questions are in a written form while others are asked orally. Oral questions are asked individually. Some of the responses of candidates are in a written form (e.g., recording, handling of results, etc.); while others are oral. Manipulative skills are to be assessed individually by direct observation. The content areas that are assessed in this session are experiments, animals, plants, dissection, microscope work and ecology.

3.3.1.2.1.3 The Outcomes of Practical Work that are Assessed

The following outcomes of practical work are to be assessed for both sessions of the practical control test. The distribution of marks (i.e., in terms of weighting) for each outcome (for the Higher Grade and Standard Grade) are to be as follows:[92]

	Higher Grade	Standard Grade
Level I	25%	35%
Level II	35%	40%
Level III	30%	25%
Level IV	10%	0%
	100%	100%

Levels I, II, III and IV refer to Bloom's Taxonomy[93] of "Knowledge", "Comprehension", "Application" and a combination of "Analysis" and "Synthesis" respectively.

3.3.1.2.1.4 Practical Control Test Papers

In 1977, when information for this investigation was collated, the examiners who conducted practical control tests were required to devise questions for the tests. Information in devising these questions was provided for examiners a day prior to the commence= ment of the practical control tests. The examiners had to generally devise questions a day prior to conducting the test at a school. Examiners have made comments with regard to this and their comments are indicated from pages 160 to 162 of this study.

In 1978 and 1979, ten practical control test papers and a marking memorandum for each test were devised by the biology inspectors and used by the examiners. On any one day the same test paper was used by all examiners. However, each day a different test was used - different in terms of subject areas and the abilities that were assessed. These test papers were not equal and parallel tests. Each test is for a duration of 5 hours and 45 minutes. Work covered in standards 8, 9 and 10 is assessed in these tests. Each test contains some questions which are common to the Higher Grade and Standard Grade and other questions which are specific for either the Higher Grade or Standard Grade.

3.3.1.2.1.5 Procedure Followed in Selecting Candidates for the Practical Control Test

Each standard-ten biology teacher draws up a merit list for his pupils based on the final practical marks that he awarded to them. A separate merit list is prepared for the Higher Grade and Standard Grade candidates. An examiner then draws a representative sample of pupils from this merit list in such a way that a good cross section of all pupils (and their teachers) is obtained. A total of ten Higher Grade and Standard Grade pupils are selected for the practical control test in each school. The following instructions are given to examiners in selecting this sample:

> *"Select test candidates of each teacher from the merit list from the top, middle and bottom range of marks to get a representative sample of Higher Grade and Standard Grade candidates proportionately. The sample selected will be involved in doing a complete test, i.e., the darkroom (group test) and the laboratory sessions".* (94)

This procedure followed in selecting a representative sample of pupils (based on teacher-awarded marks) is referred to as "purpose sampling" by Guilford and Fruchter.[95] In 1977, when information for this investigation was collated, a maximum of twenty Higher Grade and Standard Grade pupils (instead of the present ten pupils) was selected per school for the practical control test in a way similar to the one described above.

3.3.1.2.1.6 <u>Procedure Followed by Examiners in Allocating Marks for Candidates in the Practical Control Test and in Entering the Marks onto Mark Lists</u>

The total marks for the test is 100. Each of the two examiners is required to award marks for different sections of the test. No two examiners ever assess the same work done by any one pupil. The marks are to be awarded directly for oral responses and direct observation of manipulative skills and by marking written responses after the test has been completed.

After the marks have been allocated to individual candidates that are selected for the test, they are then entered on mark lists that are specially provided for this purpose by the Division of Education, Department of Indian Affairs. A copy of this mark list is given on page 64.

DEPARTMENT OF INDIAN AFFAIRS - EDUCATION DIVISION

MARK LIST FOR PRACTICAL TESTS IN BIOLOGY AT ______________________ SCHOOL

GRADE ______________________ DATE ______________________

	CANDIDATES	TEST QUESTIONS											TOTAL	MARKS OUT OF 50/70	
	NAME & EXAM. NO.		1	2	3	4	5	6	7	8	9	10	100	SCHOOL	EXAMINER
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															

EXAMINING OFFICER ______________________

The following procedure is followed by examiners in filling this mark list:

(i) The names and examination numbers of candidates selected for the practical control test are entered in the first column. Entry of names is according to the teacher's merit list.

(ii) Separate mark lists must be submitted for the Higher Grade and Standard Grade candidates.

(iii) A total mark obtained by the candidate for the group test and a total mark awarded to him for the laboratory test must be reflected in the second column. Examiners are not required to fill in the mark obtained by the candidate for each question.

(iv) A total mark obtained by the candidate for the test is entered in the third column (i.e., a mark out of 100).

(v) The teacher-awarded marks (i.e., maximum of 70 for the Higher Grade and 50 for the Standard Grade) are entered in the fourth column (which is headed as "school" marks).

(vi) The total mark of the examiner-entered in the third column (which is a mark out of 100)-must now be converted into a total mark out of 70 for the Higher Grade and 50 in the same way for the Standard Grade. This converted mark must be entered into the fifth column (which is headed as "examiner's" mark).

(vii) The mean of the examiner's marks and the teacher-awarded marks entered on each mark list must be computed and entered at the base of the respective columns.

These mark lists, together with the merit lists (of each standard-ten biology teacher in a school) are submitted by the examiners to the biology inspectors. This information provided by the examiners is used by the biology inspectors in moderating teacher-awarded marks per school in respect of all candidates from that school. An analysis of the procedure used by the biology inspectors in judging whether the marks awarded by the teachers require adjustment or not will be discussed in Chapter 7 of this study.

3.3.1.3 Deductions Arising from the Foregoing Discussion on Moderation

(i) Although the Joint Matriculation Board entrusts the examining bodies with the responsibility of ensuring that the overall standard of awarding marks for practical work by teachers are fair and comparable for all candidates, there is no evidence of its providing guidance as to how this should be done.

(ii) There is variation among the examining bodies in terms of the procedure followed in moderating teacher-awarded marks.

(iii) The examiners or moderators are selected on the basis of their experience in biology education and not on their overall standard of awarding marks in practical work. It is crucial that there shall be a uniform standard of awarding marks among the examiners of an examining body. Research evidence indicates that there is variation between markers in awarding marks for the same set of practical work even when a structured marking memorandum is used.

(iv) Practical control tests include the assessment of manipulative skills (e.g., the use of the microscope, etc.) which falls under the psychomotor domain. Therefore, the weightings suggested only in terms of the cognitive domain in construct=ing a control test paper are inappropriate.

(v) The marks awarded to Senior Certificate biology candidates in control tests must be comparable, i.e., the marks awarded in the control test should represent the national standard and equal attainment of pupils should be awarded similar marks. This is not possible unless equal and parallel tests (i.e., assessing the same abilities and content areas, etc.) are used. The tests used by each examining body are not equal and parallel and therefore the marks awarded within each examining body are not comparable.

(vi) The maximum number of pupils selected for the practical control test in Indian schools is ten. It is not possible to select a good cross section (i.e., a representative sample) of Higher Grade and Standard Grade candidates for each teacher in a school because some schools have as many as four standard-ten biology teachers.

(vii) No clear guidelines or criteria are provided to biology inspectors in using the practical control test marks to moderate teacher-awarded marks.

3.3.2 General Position in Some of the Overseas Countries

The moderation procedure followed by the Joint Matriculation Board (Nuffield) for project work, and by the West Yorkshire and Lindsey Regional Examining Board for cumulative assessment of practical work, represent the general trend in some of the overseas countries.(96)(97) In addition to moderating marks awarded to projects, the Joint Matriculation Board (Nuffield) also moderates marks awarded by teachers through overall assessment. This type of moderation is carried out only by this Board. Against this background, the moderation procedures followed by these two Examining Boards are discussed in this section of the study.

The Joint Matriculation Board (Nuffield) has introduced in its A-Level Biological Science, an overlapping moderating procedure where written papers are used to moderate abilities assessed in practical work by teachers through overall assessment.(98) To this end, a section containing questions which involve pupils dealing with procedures, recording and handling of results (i.e., abilities which were assessed by the teachers in practical work), was introduced into the written examination. With regard to this type of moderation, Kelly and Lister state, "This was an attempt to construct written questions which come near to being practical without involving pupils directly in manipulative procedures other than those, such as for simple measurements, needed to interpret second-hand evidence, e.g., photographs and drawings".(99) Lister provides the following hints in testing practical activities in written questions:(100)

(i) the use of diagrams or photographs to test observation, measurement, identification and knowledge of apparatus (observation, manipulation, recall of knowledge);

(ii) asking for reasons for methods used in investigation (procedure);

(iii) translating data from tabular to graphical form (recording);

(iv) involving deductions and inference from the results that are provided (handling of results).

The problem of using written examinations to assess practical work had been discussed on page 9 of this study. Similar problems arise in using written questions in moderating teacher-awarded marks in practical work.

The Joint Matriculation Board (Nuffield) also requires a written project on a practical investigation as a component of the Nuffield A-Level Biology Examination.[(101)(102)] About two months before the written examination in the final year of study the project reports of all pupils are sent to the moderator appointed for the school. These are accompanied by grades which the teacher has awarded to each pupil for each operational division of the project (see pages 8 and 9 of this study) together with a total grade for the project. The teacher's grade is then moderated for standard, discrimination and conformity on the following assumptions:

(i) only a moderator is in a position to compare the standards between schools;

(ii) only a moderator is in a position to determine the proportion of different grades that is appropriate for one school when compared with others;

(iii) the teachers are in as good a position (or better) than the moderator to rank pupils within their own class.

If there is a difference of one grade between the moderator's grade and a teacher's grade; the teacher's grade is accepted. If there is a difference of more than one grade, the student's report is re-examined by the moderator and if he cannot see any reason for altering his grade, then the moderator obtains further information from the teacher and student by means of a questionn= aire. The moderator uses this information to make his final decision on the grade to award to the student, i.e., to accept the teacher's grade or to award his own grade.

The procedure adopted by the West Yorkshire and Lindsey Regional Examining Board[103][104][105] in moderating marks awarded by teachers through cumulative assessment for CSE (Mode 3)[106] is directly related to this study and will therefore be discussed in detail. The three aspects that will be discussed are:

(i) the body responsible for moderation;
(ii) selecting moderators;
(iii) mechanics of moderation.

The West Yorkshire and Lindsey Regional Examining Board has placed the responsibility for ensuring uniform standards on local groups. The schools for which the Examining Board is the examining body, are grouped into fifteen subdivisions called local groups. Each local group has twenty or thirty schools. The head teacher of each school in a local group is a member of the local group committee which has the responsibility for the efficient organisation and administration of moderation in accordance with the principles laid down by the Board. The local group is also made up of subject panels, and subject teachers in schools entering candidates for the CSE are expected to become members of the respective subjective panels. "These subject panels are the forum for the exchange of ideas and the focal point for training and practice in assessment. It is at this level that the Board seeks to safeguard grade standards by involving teachers and increasing their awareness of the standards generally required".[107] From the ranks of all teachers in the subject panels, the local group committee appoints inter-school assessors for each subject. Each inter-school assessor is allocated a few schools in the local group and is delegated the responsibility for appraising the standard of awarding marks by the candidate's own teacher.

Inter-school assessors are selected in local agreement trials supervised by the Chief Moderator from the Board but organised by the local subject panels for each subject.[108] The purpose of the agreement trials is to select "like-minded" inter-school assessors so that a uniform standard of awarding marks could be maintained. During this agreement trial, three qualities which are essential for moderation are identified. These three qualities are:[109]

(i) Discrimination:
they must discriminate adequately between pupils of various abilities. An assessor "who regards all candidates as mediocre is too timid, and one who perceives merits and defects that are invisible to his colleagues is too reckless".[110]

(ii) Standards:
they must be agreed on standards, i.e., the assessors must not be lenient or severe in awarding marks.

(iii) Conformity:
they must assess the same qualities in students.

Usually about twenty teachers from a subject panel participate in this trial. Each teacher is issued with an identical set of scripts or whatever other pieces of work are to be assessed, chosen to represent work across all grades to be awarded. The chief moderator from the Board then details the principles on which the work is to be graded, and suggests those qualities that should influence the markers. Each teacher then independently grades the work of each of the twenty candidates (sample usually used in the agreement trial) upon a 1 to 6 scale which corresponds to the five grades of CSE (1-5) and to the ungraded category (6). The gradings decided upon by all assessors for each of the candidates are then written out on a validation sheet (Table 3.1 is an example of this sheet). The pupils' names should not be entered on this validation sheet in order of merit, but in a random order (e.g., in the alphabetical order of the candidates' surnames). Candidates' names must be entered in blocks of four (i.e., five blocks of four each). This procedure in entering the names of candidates is essential because "it ensures that the five (blocks) sub-samples of four into which the samples of twenty are divided are random sub-samples. It is only subject to this condition that the range methods advocated to simplify the arithmetic will give reliable estimates".[111] This statistical procedure is fully discussed from pages 257 to 260 of this study. After entering all the names (as specified above) and the grades awarded to each candidate by all the assessors on the validation sheet, the average grade for each pupil, the grand total and the grade range for each subgroup for each assessor are calculated. In its turn these details are used to complete the grand total of the grades awarded by each assessor. The ranges are then summed and averages worked out for both grade totals and sum of ranges. The mathematics involved in this computation is minimal and they take probably longer to describe than to do. All that has been described here is shown in Table 3.1 (p. 72).

From this Table it is possible to test the discrimination and standards (i.e., the severity and leniency) of the assessors. The criteria used for these tests are:[112]

(i) Discrimination: the sum of ranges of each assessor must not be less than half the average sum of ranges.

(ii) Standard: the grand total of the assessor must not lie outside a central range of 10 points (i.e., five points either side) of the average grand total.

According to Table 3.1:

(i) Assessor "*l*" fails the discriminating test (because 5 is less than half of 11) while the rest pass this test (because none of their sum of ranges is less than 11).

(ii) Assessors "*b*", "*j*" and "*l*" fail the standards test (because their grand totals, i.e., 58, 77 and 71 respectively fall outside a central range of 10 of the average grand total, i.e., outside the range of 59 to 69).

The remaining assessors pass the standards test since their grand totals fall within 59 to 69.

(iii) Besides assessors "*b*", "*j*" and "*l*" the remaining assessors pass the tests of discrimination and standards.

TABLE 3.1 : THE GRADINGS AWARDED BY ALL ASSESSORS FOR EACH OF THE PUPILS IN AN AGREEMENT TRIAL

NAME OF CANDIDATES	GRADES AWARDED BY ASSESSORS a-l												AVERAGE
	a	*b*	c	d	e	f	g	h	i	*j*	k	*l*	
A	4	4	4	3	4	4	3	1	4	5	6	4	4
B	2	2	2	2	2	2	1	1	2	5	5	4	2
C	6	5	5	5	5	5	5	5	5	2	1	3	4
D	2	1	1	2	3	3	3	2	2	5	2	3	2
TOTAL	14	12	12	12	14	14	12	9	13	17	14	14	12
RANGE	4	4	4	3	3	3	4	4	3	3	5	1	2
E	3	3	3	4	3	5	3	3	3	2	1	1	3
F	1	1	1	1	1	1	1	1	1	2	1	1	1
G	5	6	6	6	5	5	6	6	6	3	2	1	5
H	3	4	4	4	3	4	3	4	4	5	4	2	4
TOTAL	12	14	14	15	12	15	13	14	14	12	8	5	13
RANGE	4	5	5	5	5	4	4	5	5	3	3	1	4
I	2	2	2	2	4	3	2	3	3	4	3	4	3
J	2	1	2	1	3	2	2	2	2	6	5	5	3
K	5	5	5	6	5	5	5	6	5	2	3	4	5
L	1	2	2	1	2	2	2	3	2	6	6	5	3
TOTAL	10	10	11	10	14	12	11	14	12	18	17	18	14
RANGE	4	4	3	5	3	3	3	4	3	4	3	1	2
M	4	2	3	4	3	4	5	5	5	5	5	5	4
N	4	3	4	4	4	5	4	4	4	1	1	4	3
O	5	4	4	3	4	3	4	4	4	5	3	4	4
P	5	6	5	5	5	5	5	5	5	5	3	4	5
TOTAL	18	15	16	16	16	17	18	18	18	16	12	17	16
RANGE	1	4	2	2	2	2	1	1	1	4	4	1	2
Q	1	2	1	1	1	1	1	1	1	3	2	4	2
R	1	1	2	1	1	2	1	1	1	4	2	5	2
S	3	3	2	3	3	2	2	3	3	4	5	4	3
T	2	1	2	1	2	2	1	2	2	3	2	4	2
TOTAL	7	7	7	6	7	7	5	7	7	14	11	17	9
RANGE	2	2	1	2	2	1	1	2	2	1	3	1	1
GRAND TOTAL	61	*58*	60	59	63	65	59	62	64	*77*	62	*71*	64
SUM OF RANGES	15	19	15	17	14	13	14	16	14	15	18	*5*	*11*

The figures and letters indicated in italics are discussed in the text

To measure conformity another validation sheet (similar to the one indicated in Table 3.2) is completed upon which are entered the differences between the grades awarded to each candidate by each of the assessors and the average of all the assessors' grades for every candidate (the grade for each candidate and the average grade is indicated in Table 3.1). These differences are then totalled for each sub-group for each assessor and a sum of ranges for each assessor is also recorded. An example of this format is given in Table 3.2 (p. 74).

The range of each sub-sample indicates how far apart are the extreme entries of that sub-sample. For example, if the entries in a sub-sample (see Table 3.2, assessor "*k*" for sub-sample A, B, C and D) are 2, 3, -3 and 0, then the extreme entries are -3 and 3 and the range is 6. From Table 3.2 it is possible to test for conformity. The criterion used for this test is that the assessor's sum of ranges should not exceed the value of 12.(113) This is explained on page 415 of this study. According to Table 3.2, assessors "*j*", "*k*" and "*l*" fail the conformity test because their sums of ranges exceed the value of 12. This indicates that these three assessors are not assessing the same qualities of pupils as those that are assessed by the other assessors. Assessors "*a*"-"*i*" pass the conformity test.

When Tables 3.1 and 3.2 are examined, it is evident that:

(i) assessor "*b*" fails the standards test;
(ii) assessor "*j*" fails the standards and conformity tests;
(iii) assessor "*k*" fails the conformity test;
(iv) assessor "*l*" fails the discrimination, standards and conformity tests.

The assessors that passed the tests of discrimination, standards and conformity are provisionally appointed inter-school assessors. The "most normal member", i.e., the member whose grades are nearest the average, goes forward from this local agreement trial to the regional agreement trial (where one member from each local agreement trial is represented).(114) This regional agreement trial is organised and conducted by the chief subject moderator of the Board and takes the same form as the local agreement trial. All the local group's inter-school assessors

TABLE 3.2 : DIFFERENCES BETWEEN THE GRADES AWARDED BY EACH ASSESSOR AND THE AVERAGE OF ALL ASSESSORS' GRADES FOR EACH PUPIL

NAME OF CANDIDATES	DIFFERENCES BETWEEN THE GRADES AWARDED BY EACH MODERATOR a-l AND THE AVERAGE OF ALL MODERATORS' GRADES FOR EACH CANDIDATE											
	a	b	c	d	e	f	g	h	i	*j*	*k*	*l*
A	0	0	0	-1	0	0	-1	-3	0	1	2	0
B	0	0	0	0	1	0	-1	-1	0	3	3	2
C	1	0	0	0	0	0	0	0	0	-2	-3	-1
D	0	-1	-1	0	0	1	1	0	0	3	0	1
RANGE	1	1	1	1	1	1	2	3	0	5	6	3
E	0	0	0	1	0	2	0	0	0	-1	-2	-2
F	0	0	0	0	0	0	0	0	0	1	0	0
G	-1	0	0	0	-1	-1	0	0	0	-2	-3	-4
H	-1	0	0	0	-1	0	-1	0	0	1	0	-2
RANGE	1	0	0	1	1	3	1	0	0	3	3	4
I	-1	-1	-1	-1	1	0	-1	0	0	-1	0	-1
J	0	-1	0	-1	1	0	0	0	0	3	2	2
K	0	0	0	1	0	0	0	1	0	-3	-2	-1
L	-1	0	0	-1	0	0	0	1	0	3	3	2
RANGE	1	1	1	2	1	0	1	1	0	6	5	3
M	0	-2	-1	0	-1	0	1	1	1	1	-1	1
N	0	-1	0	0	0	1	0	0	0	-2	-2	1
O	1	0	0	-1	0	-1	0	0	0	1	-1	0
P	0	1	0	0	0	0	0	0	0	0	-2	-1
RANGE	1	3	1	1	1	2	1	1	1	3	2	2
Q	0	1	0	0	0	0	0	0	0	1	0	2
R	0	0	1	0	0	1	0	0	0	2	0	3
S	0	0	-1	0	0	-1	-1	0	0	1	2	1
T	0	-1	0	-1	0	0	-1	0	0	1	0	2
RANGE	0	2	2	1	0	2	1	0	0	1	2	3
SUM OF RANGES	4	7	5	6	4	8	6	5	1	*18*	*18*	*17*

The figures and letters indicated in italics are discussed in the text.

are confirmed in their appointments for that subject provided that the "most normal member" passes the tests of discrimination, standards and conformity at the regional trial. In cases in which the "most normal member" deviates from the regional average, it is the duty of the chief subject moderator to visit the local subject panel to discuss the reasons so that the standards can be brought into line. Another local agreement trial is held and the material used at the regional agreement trial is assessed and graded. Each assessor's grading in the local agreement trial is then compared with the average of the assessors' gradings. The assessors who pass the tests of conformity, discrimination and standards are appointed as inter-school assessors. In this way the standard of the inter-school assessor is kept in line with that of the Board. This ensures that the grades awarded by the Board are fair and comparable for all candidates.

After the inter-school assessor has been appointed he is delegated the responsibility of appraising the standard of awarding marks of teachers in a few schools in the local group. He pays three visits per school in the final year of the CSE course (i.e., the fifth year). During the first visit (in the first term) he familiarizes himself with the purpose of the course and with the assessment techniques that are used by the teacher. On the second visit the "assessor looks at the work done, in pursuit of the declared aims by a sample of candidates, and makes his own assessment (a sample is chosen for careful inspection: this is preferable to a cursory glance at the work of all pupils)".[115] This assessment is compared with the teacher assessment for the same sample and discussion takes place on the standard of awarding marks by the respective teachers. This second visit in the second term is followed by the third visit in the third term, during which the following procedure is followed:

(i) He chooses a representative sample of the whole range of grades awarded by the school. Precise instructions are given by the Board about which candidates should be chosen so that the sample can be representative. The number of candidates chosen are twenty but all candidates are included if there are fewer than twenty.

(ii) All the work of the sample is assessed independently by the inter-school assessor without any pre-knowledge of the grades already awarded by the school.

(iii) On completion of marking and the award of a grade to each candidate, the inter-school assessor compares statistically (by using the range estimates) the teacher's grades for that sample with his own by means of the discrimination, conformity and standards test. The procedure followed in using these tests is similar to that described for agreement trials, the only difference being that in the agreement trial each assessor's grade is compared with the average of all the assessors' grades; while in the moderation process the moderator's grades are compared with the teacher's grades.(116) The criteria for acceptance and validation of the school's grades are defined by the Board for a sample of twenty candidates (criteria are also provided for samples from four to twenty) as follows:(117)

(a) Discrimination: if the sum of the ranges of the inter-school assessor is not less than half but not more than twice that of the school.

(b) Conformity: if the sum of the ranges in the "difference" between school and inter-school assessor does not exceed 12.

(c) Standards: if the difference between the grand total of the inter-school assessor and the school does not exceed 10.

The above criteria differ from the ones specified for the agreement trial in the following respects:

(a) The maximum limit for discrimination is fixed, i.e., the sum of the ranges must not be more than twice that of the school.

(b) The school grades are accepted if they fall within the limit of 10 for the standards test.

(iv) If the criteria are met, all the grades awarded by the school are validated and sent via the subject moderator to the Board for confirmation.

(v) In cases where the tests for discrimination, conformity and standards show disagreement the teacher and the inter-school assessor consult together. If the teacher considers that the inter-school assessor is more reliable in his opinion, then the whole of the school grades must be adjusted to reflect the changes that have been agreed upon in the sample.

(vi) Failing agreement the grades are referred in the first instance to a panel of inter-school assessors who again assess a sample from the school. If no agreement is still reached, the matter is referred to the subject moderator and in the last resort to the Board.

Through this moderation procedure the West Yorkshire and Lindsey Regional Examining Board ensures a uniform standard of awarding marks by teachers.

It is evident from this review of moderation procedures in the United Kingdom (representing the general trend of moderation in some of the overseas countries) that:

(i) In order to involve teachers in moderation, they require training and practice in assessment and moderation. This could best be achieved if there is liaison between the examining board and local groups of teachers.

(ii) Qualities essential for moderation must be identified in advance and only those that possess these qualities (within predetermined limits set by the board) should be appointed as moderators. The appointment of "like-minded" moderators is essential for maintaining a uniform standard of awarding marks.

(iii) Statistical measures to establish whether the teacher-awarded marks should be validated or not form an integral part of the moderation procedure.

The moderation procedure, especially that followed by the West Yorkshire and Lindsey Regional Examining Board, could be used as a guide in formulating a viable procedure of moderation by

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Mode 1 : external examinations set and marked by the Board's Examiners based upon syllabuses and specimen papers prepared by the "Regional Subject Panels"

Mode 2 : external examinations set and marked by the Board's Examiners based upon syllabuses and specimen papers submitted by the "Local Groups".

Mode 3 : moderation of the grades recommended by the schools after these have been assessed internally and validated by an inter-school assessor.

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CHAPTER FOUR

ANALYSIS OF RESPONSES AS RECORDED BY TEACHERS TO OUTCOMES OF PRACTICAL WORK THAT COULD BE ATTAINED BY PUPILS THROUGH CURRENT PRACTICAL WORK

4.1 GENERAL POSITION WITH REGARD TO OUTCOMES OF PRACTICAL WORK

The research literature indicates that there is as yet no generally accepted classification scheme of objectives for practical work. Ramsey and Howe[1] state that the development of practical skills has been almost completely ignored by researchers in science education. A similar view is expressed in the Schools Council Examination Bulletin 27.[2] There are no defined aims or objectives for practical work indicated in biology syllabuses sent out to high schools in the Republic of South Africa. An analysis of the biology syllabuses,[3] practical syllabuses,[4][5][6] and circulars[7][8] indicate the following six qualities of practical work which appear consistently:

(i) knowledge of materials, apparatus, terms and concepts;
(ii) manipulative skills;
(iii) skill in observation and recording of observation;
(iv) interpretation of results;
(v) ability to plan and prepare for experiments;
(vi) development of favourable attitudes.

The above qualities are neither aims nor objectives but are referred to as "behaviour systems" by Kelly;[9] and as "operational divisions" by Lister.[10] The term that will be used in this study to indicate the categories of this nature will be "operational divisions" of practical work because each category as it stands denotes the type of behaviour that a pupil will be involved in while doing practical work. "Outcomes" is used as a synonym for abilities and attitudes developed through practical work, e.g., to record, to show enthusiasm, etc. "Outcomes" is a broad category and includes operational divisions and objectives of practical work. When this list of operational divisions is compared with specifications for practical work in research studies,[11][12] national projects,[13][14] papers presented at international conferences[15] and in works of authors in this field of study,[16] there is a remarkable similarity. Within this context the writer used these operational divisions as a guide to formulate objectives for practical work.

4.2 THE QUESTIONNAIRES TO TEACHERS, EXAMINERS AND BIOLOGY INSPECTORS

In the formulation of objectives it was necessary to determine the outcomes of practical work in the senior secondary level, common to and identified by teachers, examiners of practical control tests and biology inspectors who are closely associated with current practical work done in schools. Four questionnaires (i.e., questionnaire A, B1, B2 and part of C - see Appendix A, pp. 376-387) were used to serve the following purposes:

(i) Questionnaire A (section B) was used to elicit from biology teachers an open response in the form of unprompted statements the outcomes of practical work that are exercised by pupils during practical work in biology at the senior secondary level.

(ii) Questionnaires B1 and B2 were used to get biology teachers, examiners and biology inspectors to identify (from the operational divisions that were stated) those operational divisions which pupils ought to attain through current practical work at school.

(iii) Questionnaire C (part of it) was used to get standard-ten biology teachers to identify (from the outcomes that were listed under each operational division) those outcomes that could be attained by pupils through current practical work and those that are at present being taken into account when they assess the final attainment of pupils in practical work for the Senior Certificate Examination.

Questionnaire A was administered to fifty-two senior biology teachers from forty-seven high schools in the Republic of South Africa at the "Fifth National Convention for Science and Mathematics Teachers" (see page 19 of this study). Questionnaire B1 was also administered to the same group of teachers. Questionnaire B2 was administered to three biology inspectors (two from the Division of Education, Department of Indian Affairs and one from the Natal Education Department), eleven examiners who conducted the practical control tests and nineteen standard-ten biology teachers from the nine schools in which the writer conducted practical control tests. Questionnaire C was also administered to these nineteen standard-ten biology teachers. These were administered by the writer personally. The samples that were used for this questionnaire survey are discussed from pages 23 to 28. The questionnaires that were used are included in Appendix A (pp. 376-387). The administration of the questionnaires are discussed in Appendix A (pp. 391-393).

4.3 ANALYSIS AND DISCUSSION

The analysis of responses made in questionnaire A, B1, B2 and the relevant section of C are divided into four parts for the convenience of discussion.

4.3.1 The Responses by Teachers to Questionnaire A

Fifty-two senior biology teachers who attended the National Convention filled in questionnaire A. This questionnaire contained three sections:

(i) Section A required information about each teacher's school, teaching experience, qualification and sex. This information was used for classification purposes.

(ii) Section B required open responses from these teachers with regard to the outcomes of practical work that they felt are being attained by pupils during current practical work at the senior secondary level. These responses were analysed and are discussed in this section of the study.

(iii) Section C required responses from teachers with regard to assessment of practical work. These responses were analysed and are discussed in Chapter 5.

Fifty-one questionnaires were analysed instead of the fifty-two, because one was a spoilt questionnaire.

Classification into predetermined discrete categories presents problems with any kind of free responses and in this case (i.e., responses to section B of the questionnaire) semantic problems precluded such a classification. However, a measure of the strength of the opinion was obtained by measuring the frequency of responses. The responses of the fifty-one teachers with regard to the outcomes that they felt are being attained by their pupils during current practical work and the frequency of the responses are indicated in Table 4.1.

TABLE 4.1

OPEN RESPONSES MADE BY FIFTY-ONE SENIOR BIOLOGY TEACHERS WITH REGARD TO OUTCOMES OF PRACTICAL WORK IN BIOLOGY AT THE SENIOR SECONDARY LEVEL

Responses (Outcomes of Practical Work)	Frequency of Response by Teachers	
	Number	Percentage
(a) To use practical techniques correctly	29	56,86
(b) To observe appropriately	28	54,90
(c) To record accurately	26	50,98
(d) To interpret observations/ results/data	17	33,33
(e) To identify biological specimens, apparatus and chemicals.	16	31,37
(f) To link practical work with theory	15	29,41
(g) To make logical deductions	14	27,45
(h) To infer from observations	13	25,49

The other outcomes of practical work which received less support (frequency of response by teachers were less than 5) were: the ability to design experiments; to classify; to answer questions based on results; to arrange work methodically; to give explanations; to predict; to make generalizations; to question; to reason; to take safety precautions in the laboratory. Some of the responses were not considered because they were too generalised or related more to motivation than to outcomes of practical work in biology.

According to Table 4.1, some outcomes of practical work, such as manipulative skills, observation, recording and interpretation are regarded by a large proportion (i.e., over 50 per cent of the teachers) of the teachers as being part of the current practical work at schools. These are basic to practical work in biology. When the responses in Table 4.1 are compared with the operational divisions indicated on page 78 of this study (i.e., from analysis of biology syllabuses, practical syllabuses and circulars to schools) some omissions are revealed in Table 4.1, e.g., "ability to plan and prepare for experiments" and "development of favourable attitudes". It is possible that teachers did recognise the importance of affective outcomes (i.e., attitudes) and designing experiments but could not precisely state it as an outcome.

4.3.2 The Responses by Teachers to Questionnaire B1

Six operational divisions of practical work were listed in column 1 of questionnaire B1 and the same fifty-two biology teachers who responded to questionnaire A were asked to indicate in column 2 by a tick those operational divisions that they felt were being attained by pupils through current practical work. These operational divisions are listed in Table 4.2. Together with questionnaire B1, the first draft scheme of outcomes of practical work (see Appendix A, pp. 362-365) was also provided, to be used as an aid when responding to questionnaire B1 because it elucidated the various activities that pupils will be engaged in under each operational division. These activities represent a range of abilities and attitudes that could be attained by pupils through current practical work. The biology teachers were requested to make oral comments on the activities listed in this draft scheme and this was recorded by the writer. The operational divisions and the activities under each operational division were formulated as a result of information that was gathered from discussions with senior biology teachers and with members of the Biology Subject Committee; personal observations of pupils conducting practical work at schools; from analysing the syllabus; from surveying the literature. This list of operational divisions (listed in questionnaire B1 and the draft scheme) and the activities (listed in the draft scheme) were conceived more as hypotheses than absolutes, i.e., it could be accepted, rejected or modified. Column 3 of the questionnaire B1 was left for general comments.

The danger inherent in prescribing a list of operational divisions for practical work for teachers to respond to was given some consideration. A safeguard was built to diminish the criticism by administering questionnaire A before questionnaire B1 (which was formulated without taking into account the open-ended responses to questionnaire A) to the fifty-two senior biology teachers at the National Convention, so that responses made in questionnaire A could be used to validate the responses made in questionnaire B1.

The responses of the fifty-two biology teachers in questionnaire B1 (in column 2) are indicated in Table 4.2.

TABLE 4.2: RESPONSES OF FIFTY-TWO SENIOR BIOLOGY TEACHERS TO A LIST OF OUTCOMES ATTAINED BY PUPILS THROUGH PRACTICAL WORK CURRENTLY BEING DONE AT SCHOOLS

A list of six major operational divisions of practical work	Teachers who stated that the operational divisions are attainable by pupils	
	Number	Percentage
(a) Knowledge of techniques and materials (i.e. apparatus, chemicals, specimens and models) which are basic to the course	52	100
(b) Ability to use techniques and materials which are basic to the course	52	100
(c) Ability to make appropriate observations and accurate recording of observations	52	100
(d) Ability to interpret results and to make appropriate deductions and inferences	52	100
(e) Ability to solve practical problems	0	0
(f) Inculcating desirable attitudes	52	100

The results in Table 4.2 indicate that fifty-two teachers (100 per cent of the teachers) representing forty-seven Indian high schools in the Republic of South Africa are unanimous in identifying the following outcomes of practical work as being attained by pupils through current practical work.

(i) Knowledge of techniques and materials which are basic to the course.

(ii) Ability to use techniques and materials which are basic to the course.

(iii) Ability to make appropriate observations and accurate recording of observations.

(iv) Ability to interpret results and make appropriate inferences (not deductions).

(v) Inculcating desirable attitudes.

There were forty-seven of these fifty-two teachers who commented (in column 3 of the questionnaire) that "deduction" is one ability that could not be attained by pupils through current practical work. Therefore this is omitted from the list above. The fifty-two teachers were also unanimous that the, "ability to solve practical problems", was not attainable by pupils through current practical work. This problem-solving ability (as was indicated to this group of teachers in the first draft scheme of the outcomes of practical work - see Appendix A, pp. 364-365) incorporates activities (i) to (v) listed above, plus identification of the problem to be solved, hypothesis construction and designing an experiment to solve the problem. Problem-solving is not repetitive work but requires the use of all the pupils' practical experience and skill in order to plan and execute a new investigation based on familiar principles and techniques. It ought also to inculcate a scientific attitude in pupils. Biology involves the method of experimentation and inquiry which is at the heart of problem-solving. Problem-solving activities for this reason ought to be attained by pupils engaged in current practical work. It is evident, therefore, that investigatory approach to practical work (which involves problem-solving) is still not a part of practical work at most Indian schools in the Republic of South Africa.

It is evident from the responses in Table 4.2 and the comments that were made by the forty-seven teachers about "deduction making" that the teachers were able to discriminate between those outcomes that could be attained and those that could not be attained through current practical work.

Table 4.3 compares the free responses by fifty-one teachers (one questionnaire was spoilt) as is indicated in Table 4.1 and the responses made by the same teachers to the operational divisions in Table 4.2. The number in brackets next to the outcomes refers to the number of teachers who indicated the attainment of that outcome through current practical work.

TABLE 4.3: A COMPARISON BETWEEN THE FREE RESPONSES OF TEACHERS AND RESPONSES OF THE SAME GROUP OF TEACHERS TO A LIST OF STATEMENTS ON OUTCOMES OF CURRENT PRACTICAL WORK IN BIOLOGY AT THE SENIOR SECONDARY LEVEL

Outcomes of current practical work indicated in six major operational divisions (as indicated in Table 4.2). The number of responses of teachers is indicated in brackets.	Open responses of teachers indicating the outcomes of current practical work (as indicated in Table 4.1). The number of responses of teach= ers is indicated in brackets.
(a) Knowledge of techniques and materials (apparatus, chemicals, specimens and models) which are basic to the course (52)	5. To identify biological specimens, apparatus and chemicals (16)
(b) Ability to use techniques and materials (apparatus, chemicals, specimens and models) which are basic to the course (52)	1. To use practical techniques correctly (29)
(c) Ability to make appropriate observation and accurate recording of observations (52)	2. To observe appropriately (28) 3. To record accurately (26)
(d) Ability to interpret results and to make appropriate deductions and inferences (52)	4. To interpret observations/ results/data (17) 8. To infer from observations (13) 6. To link practical work with theory (15) 7. To make logical deductions (14)
(e) Ability to solve practical problems (0)	———
(f) Inculcating desirable attitudes (52)	———

According to Table 4.3, it is evident that no matter whether the teachers had to make an open response or respond to structured statements with regard to outcomes of practical work, there was a substantial number of teachers who recognise the basic outcomes of practical work, e.g., operational divisions (b) and (c) and open responses 1, 2 and 3.

The same four operational divisions which the sample of teachers indicated could be attained through current practical work (i.e., a, b, c, and d) were also reflected in the open responses made by the same teachers. When operational divisions d and e are considered there are discrepancies in what the teachers indicated in the open responses and their responses to statements. In the open response, fourteen teachers indicated that "to make deductions" can be developed through current practical work while in their response to statements forty-seven of the teachers indicated that this ability could not be developed through current practical work. A similar discrepancy arises when responses to operational division f is analysed. It may be that the doubts that the teachers had with regard to expressing explicitly the outcomes of practical work in their free responses may have been clarified by the first draft scheme which they used as an aid in filling in questionnaire B1. If this happened, it could account for this discrepancy and for the discrepancy that occurred in terms of the number of responses that were recorded for each outcome of practical work in the open response and in the response to statements in questionnaire B1. The oral comments made by the teachers on the first draft scheme were also recorded by the writer.

4.3.3 The Responses of Standard-Ten Biology Teachers, Biology Inspectors and Examiners to Questionnaire B2

Questionnaire B2 was a slight modification of questionnaire B1. Except for operational division e which was substituted by "ability to plan or design new investigations based on familiar principles and techniques", and the responses being separate for Higher Grade and Standard Grade in column 2, questionnaire B2 was similar to questionnaire B1 in all respects. Operational division e was changed because none of the fifty-two teachers (according to Table 4.2) were of the opinion that "the ability to solve problems", is attained through current practical work done at schools. The practical syllabus emphasises that "students should, as far as possible, be guided to plan and investigate on their own, e.g., in designing their own experiments".(17) Since this ability was expected of pupils, according to the practical syllabus, it was necessary to establish if it is attainable by pupils through current practical work in biology. Therefore, "ability to plan or design new investigations based on familiar principles and techniques", was used to replace operational division e which appeared in questionnaire B1. This ability was interpreted as the ability of the pupil to use all his practical experience and skill in order to plan or design new investigations based on familiar principles and techniques rather than executing the plan (see Appendix A, p. 372).

There was also the possibility that the same outcomes of practical work were not expected from pupils offering biology at the Higher Grade, as from those offering it at the Standard Grade. In order to establish this, provisions were made in column 2 of questionnaire B2 for separate responses for Standard and Higher Grades.

Questionnaire B2 was administered to:

(i) the eleven examiners who conducted practical control tests;

(ii) the three biology inspectors;

(iii) the nineteen standard-ten biology teachers at nine schools where the writer conducted practical control tests.

Together with questionnaire B2, the examiners and the biology inspectors were provided with the second draft scheme (see Appendix A, p. 369) which was a modification of the first draft scheme (see Appendix A, pp. 366-368). The nineteen standard-ten biology teachers were provided together with questionnaire B2 the third draft scheme (see Appendix A, pp. 369-372) which was a modification of the second draft scheme. The first draft scheme was modified as a result of oral comments by the fifty-two biology teachers and the second draft scheme was modified as a result of written comments (which was indicated in column 3 of questionnaire B2) by the examiners and biology inspectors. These draft schemes elucidated the operational divisions indicated in questionnaire B2 in terms of the activities that were incorporated under each operational division. Within this context it was used as a guide to fill in questionnaire B2. However, written comments based on it were requested by the writer from the respondents.

The responses of the eleven examiners, three biology inspectors and nineteen standard-ten biology teachers to questionnaire B2 are recorded in Table 4.4.

TABLE 4.4

RESPONSES OF ELEVEN EXAMINERS, THREE BIOLOGY INSPECTORS AND NINETEEN STANDARD-TEN BIOLOGY TEACHERS TO A LIST OF OUTCOMES (OF PRACTICAL WORK) ATTAINED BY PUPILS THROUGH PRACTICAL WORK CURRENTLY BEING DONE AT SCHOOLS

A list of six operational divisions (a) to (f) with regard to outcomes of practical work.	Responses with regard to whether the operational divisions are attainable by pupils through current practical work.					
	Higher and Standard Grades					
	Examiners		Biology Inspectors		Standard-ten Biology Teachers	
	Number	Percentage	Number	Percentage	Number	Percentage
(a) Knowledge of techniques and materials	11	100	3	100	19	100
(b) Ability to use techniques and materials	11	100	3	100	19	100
(c) Ability to make appropriate observations and accurate recording of observations	11	100	3	100	19	100
(d) Ability to interpret results and to make appropriate deductions and inferences	11	100	3	100	19	100
(e) Ability to plan or design new investigations based on familiar principles and techniques	0	0	0	0	0	0
(f) Desirable attitudes	11	100	3	100	19	100

The results in Table 4.4 indicate that the eleven examiners, three biology inspectors and the nineteen standard-ten biology teachers were unanimous in identifying outcomes a, b, c, d and f as being attained through current practical work by pupils offering biology at the Higher Grade and Standard Grade. They were also unanimous in their decision that outcome e which read as, "ability to plan or design new investigations based on familiar principles and techniques", was not attained by pupils through practical work currently being done at schools. The following comments based on the outcomes of practical work listed under each operational division on the draft schemes were made by the examiners, biology inspectors and standard-ten biology teachers on questionnaire B2 (i.e., in column 3).

(i) Deduction (operational division d)
Nine examiners and sixteen standard-ten biology teachers indicated that "making appropriate deductions" were not developed by pupils doing practical work in biology at the senior secondary level. The three biology inspectors were of the opinion that this ability was attained by pupils through current practical work.

(ii) Prediction (operational division d)
Two inspectors made comments on the "ability to make predictions" and the following comment made by one of them sums up their view:
"Only few pupils at Higher Grade could develop the ability to make predictions".

(iii) Responding to problem questions (operational division d)
The following comment made by one of them sums up the views of two inspectors with regard to responding to problem questions:
"The ability to respond to problem questions based on results and the ability to respond to problem questions based on broader theory could not be developed by pupils offering biology at the Standard Grade".

(iv) Ability to plan investigations (operational division e)
One biology inspector commented that, "at present the activities listed under operational division e was beyond the ability of our pupils since it was too demanding".

(v) Attitudes (operational division f)
One teacher stated that attitudes were incidentally developed and no conscious effort was made to develop it. One inspector stated, "Time factor and insight may be a problem to develop resourcefulness".

Another inspector made the comment that, "resourcefulness and enthusiasm could not be developed for Standard Grade pupils".

When Tables 4.2 and 4.4 are examined together with the comments made by the respondents, the following pattern emerges:

(i) The following operational divisions are attainable for pupils doing practical work (Higher Grade and Standard Grade) in biology at the senior secondary level:

(a) Knowledge of techniques and materials.
(b) Ability to use techniques and materials.
(c) Ability to make appropriate observations and accurate recording of observations.
(d) Ability to interpret results (including inference but excluding deduction making).
(e) Inculcating desirable attitudes.

(ii) Doubt was expressed about the attainment by pupils of prediction making, responding to problem questions, resourcefulness and enthusiasm. Some of these activities were felt to be attainable at Higher Grade rather than at Standard Grade.

4.3.4 The Responses of Standard-Ten Biology Teachers to Questionnaire C (section 1, B, e)

The third draft scheme (see Appendix A, pp. 369-371) was used as a basis to construct questionnaire C (section 1, B, e). This section of the questionnaire contains various activities under each operational division (the operational divisions are the same as listed in questionnaire B1 and B2). These activities are referred to as "dimensions" in this study.

In order to establish if the dimensions listed under each operational division were attained by pupils through current practical work, the nineteen standard-ten biology teachers (who already responded to questionnaire B2) had to indicate:

(i) by a tick each dimension that is attained by pupils through current practical work. This tick had to be placed in a block preceding each dimension and the response had to be separate for the Higher Grade and Standard Grade.

(ii) by a tick each dimension that was taken into account when assessing the final attainment of candidates in practical work. This tick had to be placed in a block following each dimension and the response had to be separate for the Higher Grade and Standard Grade.

The statistical analysis of the teachers' responses is dealt with elsewhere in this chapter. The dimensions under each operational division to which the teachers had to respond are listed below.

(A) Knowledge of techniques, processes and materials

(i) Identifying an apparatus or a chemical by pointing out or stating its name and describing its purpose in terms of use.

(ii) Identifying processes, specimens and models and stating the functions of the parts of the specimen or model.

(iii) Describing various laboratory techniques that are basic to practical work (e.g., describing orally or in a written form the procedure followed in testing a green leaf for starch).

(B) <u>Ability to use techniques and materials which are basic to practical work</u>

(i) Selecting materials from those that are provided for a particular experiment or investigation.

(ii) Ability in the skills of using various techniques and materials, e.g., preparation of a wet mount, use of the microscope, setting up experiments.

(iii) Ability to explain the implications of the materials and procedures used.

(C) <u>Ability to make appropriate observation and accurate recording of observation</u>

(i) Recording microscopic observations appropriately in the form of a diagram and labelling it correctly. The criteria upon which this form of recording will be assessed are: Correct representation, accuracy and proportion.

(ii) Recording microscopic observations appropriately in the form of notes or describing these observations orally. The criteria upon which this form of recording will be assessed are: Accuracy, comprehensiveness and the degree of discrimination used.

(iii) Recording macroscopic observations in the form of a diagram and labelling it correctly. The criteria upon which this form of recording will be assessed are: Correct representation, accuracy and proportion.

(iv) Recording macroscopic observations appropriately in the form of notes or describing these observations orally. The criteria upon which this form of recording will be assessed are: Accuracy, comprehensiveness and the degree of discrimination used.

(v) Recording observation accurately in the form of tables, illustrations or graphs.

(D) Ability to interpret observations (including to make appropriate deductions and inferences)

(i) Ability to explain in their own words from their observations: Biological processes, changes, properties, structural features, classification and relationship.

(ii) Ability to make inference from direct observation, e.g., to interpret the function of an organ from observing its structure.

(iii) Ability to deduce (arrive at conclusions) from results that are obtained.

(iv) Ability to formulate generalizations and principles.

(v) Ability to make predictions.

(vi) Ability to respond to problem questions based on results/observation.

(vii) Ability to respond to problem questions based on broader theory or principles (covered in the course) related to the present result, observation, explanation and/or deduction, e.g., starch with salivary amylase of man was kept at 40 degrees Celsius - must starch with saliva from an amphibian or a locust be also kept at the same temperature? Why?

(E) Ability to plan or design new investigations based on familiar principles and techniques

The pupil must use all his practical experience and skill in order to plan or design new investigations based on familiar techniques and principles. The emphasis is on planning rather than executing the plan. The following skills are involved:

(i) To identify the problem to be solved.
(ii) Provide a testable, tentative explanation (hypothesis) of his observation of the practical exercise or

experiment, in relation to the problem.

(iii) To describe the materials that will be used in the investigation.

(iv) To describe the procedures and techniques that will be used in the investigation. Wherever possible a description of a control must also be included.

(v) Provide an explanation of how the results would be presented or recorded and analysed.

(F) Showing desirable attitudes to practical work

If a pupil has acquired desirable attitudes through practical work, he should show the following qualities when in action in the laboratory:

(i) Persistence: in the determination of the pupil to see his work through to a successful conclusion.

(ii) Resourcefulness: in improvising, in searching out relevant information and in seeking advice.

(iii) Co-operation:
1. In following safety regulations in the laboratory.
2. In the careful and economic use of materials.
3. In leaving their work place neat and tidy.
4. In willing to work with peers in a group.
5. In collecting and bringing in material for investigatory work when asked to do so.

(iv) Enthusiasm: in initiative, in new ideas and in suggestions for further investigations.

(v) Sensitivity: in willingness to handle living things with care and taking proper care of living things.

(vi) Fair-mindedness and tolerance:
1. In withholding judgement until careful analysis of all evidence.
2. In suspending judgement in light of new evidence.
3. In making honest and objective observations.
4. In willingness to listen attentively to opposing viewpoints.

4.3.4.1 Statistical Analysis of the Teachers' Responses

The responses of the nineteen teachers to questionnaire C (section 1, B, e) were analysed and the detailed results are indicated in Appendix C, p. 420 (i.e., Table C.1). In order to establish if there was any significant difference between the proportions of responses made by the nineteen teachers to two different items (i.e., attained and assessed) a test of significance was made for each dimension where there was no unanimous agreement.[18][19] In order to make this test of significance the responses indicated in Table C.1, (p. 420) had to be rearranged in terms of the number of teachers that stated that a dimension could be:

(a) attained but not assessed;
(b) attained and assessed;
(c) neither attained nor assessed;
(d) not attained but assessed.

Each of the above letters (i.e., a, b, c and d) and the same letters indicated in Table 4.5 refer to a cell of a 2 x 2 table. An example of a 2 x 2 table is indicated below:[20]

		Assessed	
		No	Yes
Attained	Yes	a	b
	No	c	d

The response of the nineteen teachers to each of the dimensions had to be analysed individually and these responses were recorded in the appropriate cells of 2 x 2 tables. For example, a response of attained and not assessed would be entered into cell a. The total responses indicated in each cell for a dimension is indicated in Table 4.5. For the dimensions where the sum of cells a and d was 10 or greater[21] the "z test" (developed by McNemar for testing the difference between proportions for correlated data)[22] was computed. Where the sum of cells a and d was lower than 10, then the X^2 could be applied provided that none of the cells have a frequency of lower than 5.[23][24][25] According to Table 4.5, dimensions where there was unanimous agreement and dimension D (iii) (Higher Grade), have $a + d < 10$ and the cells of these dimensions have frequencies less than 5. In this case the p was calculated directly by using the "Fisher Exact Probability Test."[26] In the calculation of p Tocher's modification of the Fisher Test was not used because the frequencies of cells a and d already had extreme values of zero.[27][28] The alpha value for the Fisher Exact Probability Test was fixed at 0,01 level. This level of significance was chosen in order to prevent rejecting the null hypothesis (H_o) when in fact it is true (i.e., to prevent type 1 error). The null hypothesis was that there is no significant difference between the proportion of responses to the two items of each dimension of practical work by the nineteen teachers. If the computed z value was greater than 2,58 the null hypothesis was rejected at the 0,01 level of significance and the research hypothesis (H_1 = significant difference between the proportions of responses) was to be accepted.[29] If the exact probability calculated by the Fisher Test is equal to or less than 0,01 then the null hypothesis was to be rejected.[30] The results of the responses of the nineteen teachers to questionnaire C (section 1, B, e) with appropriate test of significance is indicated in Table 4.5.

TABLE 4.5: STATISTICAL FINDINGS TO ESTABLISH IF THERE IS A SIGNIFICANT DIFFERENCE BETWEEN THE PROPORTION OF RESPONSES OF THE SAME GROUP OF NINETEEN TEACHERS TO TWO DIFFERENT ITEMS (IETM 1 - ATTAINED; ITEM 2 - ASSESSED) BASED ON EACH DIMENSION OF PRACTICAL WORK

Dimensions of practical work. Letters A to F refer to operational divisions and the numbers refer to dimensions as indicated on pages 94-98 of this study. (S = Standard Grade only and H = Higher Grade only)	Frequency of responses of teachers — Cells of a 2 x 2 table				Significance of the difference between the proportions of responses to 2 different items (i.e. attained and assessed) by the same group of 19 teachers. Hull hypothesis: There is no significant difference between the proportions of responses to the 2 items of each dimension.		
	Attained but not assessed a	Attained and assessed b	Not attained and not assessed c	Not attained but assessed d	The obtained value of p or z (i.e. z scores)	Points of rejection: (i) If z score is greater than 2,58 (ii) If p value is equal to or less than 0,01	Accept or reject null hypothesis (H_o) at α = 0,01
A i and ii	0	19	0	0	p = 1,00	> 0,01	Accept H_o
A iii	13	6	0	0	z = 3,60	> 2,58	Reject H_o
B i	10	5	4	0	z = 3,16	> 2,58	Reject H_o
B ii and iii	0	19	0	0	p = 1,00	> 0,01	Accept H_o
C i and ii	10	9	0	0	z = 3,16	> 2,58	Reject H_o
C iii and iv	0	19	0	0	p = 1,00	> 0,01	Accept H_o
C v	17	1	1	0	z = 4,12	> 2,58	Reject H_o
D i S	11	8	0	0	z = 3,32	> 2,58	Reject H_o
H	0	19	0	0	p = 1,00	> 0,01	Accept H_o
D ii S	11	5	3	0	z = 3,32	> 2,58	Reject H_o
H	0	19	0	0	p = 1,00	> 0,01	Accept H_o
D iii S	0	0	19	0	p = 1,00	> 0,01	Accept H_o
H	0	3	16	0	p = 0,00	< 0,01	Reject H_o
D iv and v	0	0	19	0	p = 1,00	> 0,01	Accept H_o
D vi and vii S	10	3	6	0	z = 3,16	> 2,58	Reject H_o
H	0	19	0	0	p = 1,00	> 0,01	Accept H_o
E i - vii	0	0	19	0	p = 1,00	> 0,01	Accept H_o
F i	11	1	7	0	z = 3,32	> 2,58	Reject H_o
F ii H	10	2	7	0	z = 3,16	> 2,58	Reject H_o
F iii 1 to 3	0	19	0	0	p = 1,00	> 0,01	Accept H_o
F iii 4 and 5	18	0	1	0	z = 4,24	> 2,58	Reject H_o
F iv	0	0	19	0	p = 1,00	> 0,01	Accept H_o
F v	16	0	3	0	z = 4,00	> 2,58	Accept H_o
F vii 1 to 4	13	0	6	0	z = 3,60	58	Accept H_o

All the z scores [illegible]

An analysis of Table 4.5 indicates the following:

(i) In terms of some dimensions of practical work, there was unanimous agreement by the teachers with regard to their responses to the 2 items (i.e., attained and assessed for that dimension). These responses (which indicate unanimous agreement) can be accepted with considerable confidence because statistical measures indicate no significant difference between the proportion of responses to the 2 items (i.e., the null hypothesis was accepted).

(ii) In terms of other dimensions of practical work (i.e., where there was no unanimous agreement) the statistical measure indicates that teachers disagree significantly as to whether these dimensions are attained and/or assessed (i.e., the null hypothesis was rejected). However, the z scores and the p value for those dimensions where the null hypothesis was rejected, are significant at the 1 per cent level (i.e., $p \leq 0.01$). This indicates that the chances are 99 in 100 that these responses of teachers had not occurred by chance.

(iii) In terms of the responses of the nineteen teachers in columns a and b, the majority of the teachers (i.e., over 50 per cent of the teachers) felt that besides dimensions D iii to v (i.e., deduction making; formulation of principles and generalizations; prediction making), E i to vii (i.e., abilities involved in designing an experiment) and F iv (i.e. attitude - enthusiasm), all other dimensions are attained by pupils through current practical work.

In summary it could be stated that the statistical measures indicate that reliance could be placed on the responses of these nineteen teachers as to whether a dimension was attained through current practical work or not because:

(i) there was no significant difference between the proportion of responses as to whether a dimension is attained and/or assessed in cases where there was unanimous agreement.

(ii) Where the teachers disagree significantly as to whether a dimension is attained and/or assessed the z scores and p values are significant at the one per cent level.

The nineteen standard-ten biology teachers from the nine schools are regarded as a random sample in this study (pp. 32-34). On the basis of this, inferences about the population values (i.e., in terms of proportion of responses) from the sample values could be made.[31] For example, fifteen of the nineteen teachers stated that dimension B1 (see Table 4.5) can be attained through current practical work. How much confidence can we have that this proportion of 0,79 (i.e., 15 out of 19 teachers) who responded in the affirmitive to dimension B1 represents the population of standard-ten biology teachers very closely. In order to make this inference confidence limits can be set up for proportions from the statistics (i.e., sample values). The procedure to set up these limits is fully discussed in Appendix B, pp. 406-409. A detailed table of confidence limits constructed according to this procedure by the writer for probability levels of 1 per cent ($p < 0,01$) and 5 per cent ($p < 0,05$) for $N = 19$, $a = 0$ to 19 and $n = 88$ is indicated in Appendix B, p. 410. These confidence limits make possible an unbiased estimation of the population proportion. For example, if the sample proportion is 0,84 (i.e., according to Table C.1, sixteen out of the nineteen teachers stated that dimension F v could be attained through current practical work), with repeated random samples of the same size (i.e., nineteen teachers) from the population (i.e., eighty-eight standard-ten biology teachers) the chances are 99 in 100 that the sample proportions will fall within the limits of 0,57 and 0,96 ($p < 0,01$). The lower limit of 0,57 (which is a proportion greater than 50 per cent) also indicates that the chances are 99 in 100 that the majority of the teachers with repeated random sampling in the population will respond in the affirmative in terms of dimension F v.

Table 4.6 indicates the confidence limits (extracted from Table B.4 Appendix B, p. 410) for responses of the nineteen standard-ten biology teachers to questionnaire C (section 1, B, e) in terms of the dimensions that could be attained and assessed through current practical work.

TABLE 4.6: THE CONFIDENCE LIMITS FOR THE RESPONSES OF THE NINETEEN STANDARD-TEN BIOLOGY TEACHERS IN TERMS OF ATTAINMENT AND ASSESSMENT OF DIMENSIONS OF PRACTICAL WORK

Dimensions of practical work (Letters and figures are the same as indicated in Table 4.5)	Column 1						Column 2					
	Frequency of responses	Proportion of responses	Confidence limits				Frequency of responses	Proportion of responses	Confidence limits			
			$p<0,01$		$p<0,05$				$p<0,01$		$p<0,05$	
			Lower limit	Upper limit	Lower limit	Upper limit			Lower limit	Upper limit	Lower limit	Upper limit
A i and ii	19	1,00	0,81	-	0,87	-	19	1,00	0,81	-	0,87	-
A iii	19	1,00	0,81	-	0,87	-	6	0,32	0,12	0,59	0,15	0,54
B i	15	0,79	0,51	0,94	0,57	0,92	5	0,26	0,09	0,55	0,11	0,48
B ii and iii	19	1,00	0,81	-	0,87	-	19	1,00	0,81	-	0,87	-
C i and ii	19	1,00	0,81	-	0,87	-	9	0,47	0,22	0,73	0,27	0,68
C iii and iv	19	1,00	0,81	-	0,87	-	19	1,00	0,81	-	0,87	-
C v	18	0,95	0,70	0,99	0,76	0,99	1	0,05	0,01	0,30	0,01	0,24
D i S	19	1,00	0,81	-	0,87	-	8	0,42	0,19	0,69	0,23	0,64
H	19	1,00	0,81	-	0,87	-	19	1,00	0,81	-	0,87	-
D ii S	16	0,84	0,57	0,97	0,63	0,95	5	0,26	0,09	0,55	0,11	0,48
H	19	1,00	0,81	-	0,87	-	19	1,00	0,81	-	0,87	-
D iii H	3	0,16	0,04	0,43	0,05	0,37	3	0,16	0,04	0,43	0,05	0,37
D iv	0	0,00	-	0,19	-	0,13	0	0,00	-	0,19	-	0,13
D v	0	0,00	-	0,19	-	0,13	0	0,00	-	0,19	-	0,13
D vi S	13	0,68	0,40	0,89	0,46	0,85	3	0,16	0,04	0,43	0,05	0,37
H	19	1,00	0,81	-	0,87	-	18	0,95	0,70	0,99	0,76	0,10
D vii S	10	0,53	0,27	0,78	0,32	0,73	7	0,37	0,15	0,65	0,19	0,59
H	19	1,00	0,81	-	0,87	-	19	1,00	0,81	-	0,87	-
E i - vii	0	0,00	-	0,19	-	0,13	0	0,00	-	0,19	-	0,13
F i	12	0,63	0,36	0,85	0,41	0,81	1	0,05	0,01	0,30	0,01	0,24
F ii H	12	0,63	0,36	0,85	0,41	0,81	2	0,16	0,02	0,37	0,02	0,31
F iii 1 - 3	19	1,00	0,81	-	0,87	-	19	1,00	0,81	-	0,87	-
F iii 4 and 5	18	0,95	0,70	0,99	0,76	0,99	0	0,00	-	0,19	-	0,13
F iv	0	0,00	-	0,19	-	0,13	0	0,00	-	0,19	-	
F v	16	0,84	0,57	0,97	0,63	0,95	0	0,00	-	0,19	-	0,13

An analysis of Table 4.6 indicates the following:

(i) The majority of the dimensions of practical work in column 2 (which indicates the dimensions assessed by the teacher) have a lower confidence limit of 0,51 and below at probability level of 1 per cent and 0,57 and below at probability level of 5 per cent. However, in the case of the majority of the dimensions (in column 2) the teachers were either in unanimous agreement or agreed by a majority as to whether a dimension was assessed by them or not.

(ii) The majority of the dimensions listed in column 1 have a lower confidence limit of 0,51 and higher at a probability level of 1 per cent and 0,57 and higher at probability level of 5 per cent. This indicates that with repeated random sampling of nineteen teachers from the population of eighty-eight standard-ten biology teachers, the chances are 99 in 100 ($p < 0{,}01$) or 95 in 100 ($p < 0{,}05$) that the sample proportions for the majority of the dimensions will be above 50 per cent.

Considering the reasons given on page 31 of this study (i.e., all teachers use a common practical syllabus; pupils are prepared for a common examination; laboratory facilities and equipment do not differ greatly from school to school; biology teachers attend National Conventions where ideas about biology education are exchanged) and results indicated in Table 4.5, the writer on intuitive grounds is of the opinion that the nineteen standard-ten biology teachers included in this study represent a reliable cross section of the population, and that their opinions ought to be used as pointers in the development of objectives for practical work. Added to this, the statistical findings (based on the responses of the nineteen teachers) in Table 4.6 show that more than 50 per cent of the standard-ten biology teachers in the population ought to indicate that the majority of the dimensions listed from pages 94 to 98 of this study are attainable by pupils through current practical work. Within this context, reliance could be placed on the responses of these nineteen teachers in producing information for the development of objectives for practical work. Research studies by Eggleston and Newbould,[32] Whitfield,[33] Eggleston and Lobel[34] indicate that teacher's opinions as a basis for objective construction are important. In this way objectives towards which their teaching is not directed are not imposed on teachers.

In terms of the above discussion, the responses made by the nineteen standard-ten biology teachers (including that of the biology teachers at the Convention, biology inspectors and examiners) will be taken into account in developing objectives for practical work.

4.3.4.2 Discussion on the Responses of the Teachers

This discussion will be under each of the operational divisions indicated in Table 4.5.

A. Knowledge of techniques, processes and materials

It is evident from Table 4.5 that all the dimensions or outcomes of practical work (i.e., knowledge of apparatus, chemicals, specimens, models, processes and techniques) listed under this operational division are attained by pupils through current practical work at schools in the view of teachers. With the exception of "knowledge of techniques", these dimensions were also assessed by all the teachers. Only six out of the nineteen teachers assessed "knowledge of techniques". The majority of the teachers did not assess this dimension. The reason for this could be that "knowledge of techniques" involves "knowing" and not "doing" and this could be easily assessed in a theory paper. It is considered to be important that all the dimensions listed under this operational division be attained by pupils. Research studies [35][36][37] indicate that this operational division and its dimensions form an important component underlying success in practical work.

B. <u>Ability to use techniques and materials which are basic to the course</u>

This operational division involves the pupils in not only selecting materials for a particular purpose and using it for that purpose, but also in explaining the implications of the materials and procedures that were used. It is evident from Table 4.5 that these dimensions could in the view of the teachers be attained by pupils through current practical work at schools. These dimensions were also assessed by the teachers. The dimensions listed under this operational division form an important aspect of investigatory work in biology as is indicated by many research workers. From the response of teachers and from evidence of research studies[38][39] the dimensions listed under this operational division are important for practical work at the senior secondary level.

C. <u>Ability to make appropriate observations and accurate recording of observations</u>

The skill in accurate recording could not be separated from making appropriate observations. Observations are normally communicated either in a written form or orally. The skill in recording microscopic and macroscopic materials in various ways is included under this operational division, i.e., diagrams, notes, reporting orally, tables, illustrations and graphs. According to Table 4.5 all the dimensions that were listed under this operational division in the view of teachers could be attained by pupils through current practical work. In view of this and from evidence of research studies,[40][41][42] the dimensions listed under this operational division should form an integral part of practical work at the senior secondary level.

D. <u>Ability to interpret observations and to make appropriate deductions and inferences</u>

It is evident from Table 4.5 that the teachers were able to discriminate between those dimensions that were attainable and those that were not attainable by pupils through current practical work under this operational division. These nineteen standard-ten biology teachers were unanimous in their responses that dimensions iv and v which are the "ability to formulate generalizations and principles" and the "ability to make predictions" respectively, were not attainable by pupils through current practical work in schools. The majority of the teachers (84,21 per cent or 16 teachers) also indicated that the "ability to make deductions based on observations or results" (dimension iii) was not attainable by pupils through current practical work in schools.

"Generalization and principle" is used in this study to refer to any statement of relationships which are of broad applicability. An example of a generalization is that "temperature affects the rate of breathing in fish". The pupils arrive at this generalization after experimenting with fish of different types, size, sex and age in different temperature (e.g., subjecting the fish to temperatures of 5°, 10°, 15° etc.). The term "principle" is used to denote the main areas of knowledge and ideas that emerge from a study of a particular topic. An example of a principle is "The skeletal system in vertebrates provides for support, protection, leverage and for stability". The pupils arrive at this principle from observing many skeletons of vertebrates, experimenting with models of skeletons and observing the actual organisms in motion, etc. These were the explanations that were given orally to the nineteen teachers about these two terms before they filled in the questionnaire. In order to formulate generalizations and principles in the context of practical work pupils ought to repeat a practical exercise or experiment with similar materials (e.g., fish or skeletons, etc.). Practical work in biology at Indian schools, which is based on a fixed syllabus, hardly lends itself to this type of repetitive work because of large class units, insufficient time in completing the syllabus and insufficient facilities for this type of investigatory work. Therefore it was not surprising that this dimension was excluded by the standard-ten biology teachers from their list of outcomes of practical work that was attained by pupils through current practical work. This ability was not assessed by teachers. Research studies[(43)(44)] do not include this dimension as an outcome that is to be attained or assessed *per se* in practical work. Within this context and the findings in this study it is felt that the "ability to formulate principles and generalizations" is not an important component underlying practical work at the senior secondary level.

The "ability to make a prediction" is used in this study to denote a statement of what is likely to happen under specific conditions. The specific condition is "new" or unfamiliar to the pupil. For example, "Predict what would happen in this closed balanced aquarium if the number of snails is increased". To solve this problem the pupil ought to apply previous knowledge (e.g., balance in nature, interdependence, food web, etc.) to a balanced aquarium which is a new situation to him. This was the explanation that was given about "prediction making" to the nineteen standard-ten biology teachers before they filled in the questionnaire. Prediction is not used in this study to refer to the "If...then" logic which is linked with hypothesis making and is an important component of problem solving.[45] The "ability to make predictions" is essential in investigatory work in biology. The Biological Sciences Curriculum Study project[46] and the Schools Council Integrated Science Project[47] make provision for the development of this ability in pupils through practical work. Considering the importance of "prediction making" in investigatory work, this dimension should form an integral part of practical work at schools.

Research studies[48][49] and biological science projects[50][51] indicate that "deduction making" is an essential activity that underlies practical work in biology in schools. "Deduction" refers to "conclusions" drawn from investigations. Since conclusion suggests finality and there is no finality (which implies scientific truths) in science, "deduction" instead of "conclusion" is used in this study. A "deduction" is a concise statement formulated after assessing the results or findings in relation to the objective of the investigation. For example, if the problem that was investigated was to establish the relationship between temperature and the rate of respiration in a fish, then the deduction that may be made from the findings is: "temperature affects the rate of respiration in the fish". The majority of the standard-ten biology teachers indicated that this ability was not attained by pupils through current practical work and it was not assessed by them. Against the background of this discussion "deduction making" should be included as an important

According to Table 4.5 the majority of the teachers (over 50 per cent) were of the opinion that dimensions i (i.e., to explain from observation), ii (to infer from observation), vi (to respond to problem questions based on observation), vii (to respond to problem questions based on broader theory that is related to present result or observation) are attained by pupils through current practical work. However, the teachers were divided in their view as to whether these abilities are attained by pupils offering biology only at the Higher Grade or by all pupils irrespective of the grade in which biology was offered. A similar disparity is indicated in the teachers' assessment of these dimensions. It is evident from research studies[52][53] that explanation from direct observation, inference from direct observation or results, responses to questions based on results, and the responses to questions based on broader theory (field of biological knowledge) related to results, are an integral part of practical work in biology at the senior secondary level. Within this context and from the findings in this study the dimensions that reflect these activities (i.e., dimensions i, ii, vi, and vii) should form an important component of practical work.

In summary, it could be stated that with the exception of dimension iv (i.e., to formulate generalizations and principles in practical work *per se*) all other dimensions listed under this operational division are important in contributing to successful practical work in biology at the senior secondary level.

E. Ability to plan or design new investigations

This ability entails the use of such skills as: identifying problems to be solved; hypothesis construction; and the planning of experimental procedure. The emphasis is on planning an investigation rather than executing the plan. According to Table 4.5, the dimensions listed under this operational division are not attainable by pupils through current practical work at schools. Therefore in the view of the teachers these dimensions were not assessed.

The dimensions indicated under this operational division together with the skills involved in execution of the investigation associated with the problem and analysis and presentation of the results form an important aspect of the Nuffield A-Level Biological Sciences and the Biological Sciences Curriculum Study projects. One way in which these skills are developed is through project work which forms an essential part of the Nuffield A-Level Biology Course and the Nuffield A-Level Physical Science Course.[54] These projects are assessed as a total investigation carried out by pupils, largely on their own initiative, and involving experimental enquiry into some aspect of biology or physical science which has interested them. Assessment of project work has already been discussed on pages 49 and 50 of this study. Pupils' performance in project work in the Nuffield A-Level Biology and Nuffield A-Level Physical Science in 1973 and 1974 indicate that the mean (out of a total of 5 for each skill) for the teacher-assessed skills in project work varied between 2,50 to 3,17 for biology and 2,70 to 3,38 for physical science.[55] These mean marks indicate that the skills indicated for this operational division are well within reach of average pupils at the senior secondary level. Science teachers in Britain were also of the opinion that the development of problem-solving skills were important outcomes of science teaching in schools.[56] It is therefore undesirable that the skills involved in designing new investigations should be neglected in practical work in Indian schools. However, the point of view taken in this study is that objectives of practical work should reflect the abilities and attitudes that pupils will exercise while doing current practical work. There is unanimous agreement between the biology teachers that the abilities listed under this operational division could not be attained by pupils through current practical work. Project work as envisaged in this study is not undertaken by pupils in Indian schools. There are large numbers of pupils per class unit (i.e., 24 to 33 pupils) offering biology in most Indian high schools[57] compared with 7 to 15 pupils per class unit that offer Nuffield A-level Biology in the majority of the British schools.[58] These large numbers of pupils per class unit and the large number of class units per school offering biology could militate against efficient supervision of project work as envisaged in the Nuffield A-Level

Biology. The limited scope of the biology syllabuses for open-ended work, limited laboratory facilities to cater for the large number of candidates, the nature of practical control tests which are used to moderate teacher-awarded marks, could be among the many factors which might have contributed to the above response of teachers. Another important consideration the writer had to take into account was the danger of imposing on the teachers at schools, objectives to which their current teaching was not directed. In view of this multiplicity of factors the writer considered it inappropriate to isolate the skills involved in designing new investigations for development by pupils through current practical work and for assessment purposes. However, this aspect will be discussed in the final chapter of this study.

F. Inculcating desirable attitudes

Attitudes as envisaged in this study is defined on page 35 of this study. It is evident from Table 4.5 that the majority of the teachers (over 50 per cent) were of the opinion that the following dimensions under this operational division were attained by pupils through current practical work:

(i) persistence (dimension i);
(ii) resourcefulness (dimension ii);
(iii) co-operation (dimension iii including its sub-dimensions);
(iv) sensitivity (dimension v);
(v) fairmindedness and tolerance (dimension vi including its sub-dimensions);

The teachers also felt that dimension ii (resourcefulness) could only be attained by pupils offering biology in the Higher Grade. However, the teachers were unanimous in their view that dimension iv (enthusiasm) was not attainable by pupils through current practical work.

This study indicates that current practical work provides scope for the development of desirable attitudes. This development of attitudes is also considered to be important by science teachers in Britain.[59]

It is also evident from Table 4.5 that there was unanimous agreement between the biology teachers in stating that attitudes like: following safety regulations; careful and economic use of materials; leaving the work place neat and tidy (dimension iii, sub-dimension 1, 2 and 3), were assessed by them. Some of these dimensions are also assessed by the Natal Education Department in practical work under test situations.[60] Implicit in this is that certain attitudinal outcomes of practical work lend themselves to assessment in a test situation, while others do not. These attitudes that were assessed are the least important when compared with the broader and more important ones indicated by teachers as being attained through current practical work. If these desirable attitudes to practical work are attained by pupils through current practical work then, it may be argued that assessment of attainment in practical work is incomplete without measuring attainment of these attitudes. Development of attitudes is emphasised in the aims that are listed in the biology syllabuses in Indian schools (Higher Grade and Standard Grade) and it may be in this area that the most valuable information about student attainment in practical work could be found. However, these more important attitudes (i.e., persistence, resourcefulness, sensitivity and fairmindedness) could only be assessed by a class teacher over a period of time and not through "one shot" assessments. This simply draws attention to the shortcomings of the assessment of these more important attitudes in the context of public examinations (i.e., the Senior Certificate Examination) because the marks awarded have to be moderated. It is obvious that very severe difficulties are involved in relation to moderation if the attainment of these attitudes are to be assessed by the teachers, "indeed it is arguable whether moderation in any acceptable objective sense is possible".[61] This does not mean, however, that these important attitudes ought not to be attained by pupils through current practical work, but it does mean that assessing its attainment should not form a component of the marks submitted for practical work for the Senior Certificate Examination. The view taken in this study is that these important attitudes, whether assessed separately or not will be reflected in performance in practical work. This may be so and it seems likely, for example, that a student who is persistent and enthusiastic about practical work will perform better in practical work than one who is not, everything else being equal.(62) But it would be dangerous to assume the converse - that all those who do well in practical work based on intellectual and manipulative abilities alone, are necessarily the most persistent and enthusiastic in their attitudes to practical work.(63)

Against this background, all the dimensions listed under this operational division are important attributes to be developed by pupils through practical work. However, only those dimensions that could be moderated externally (i.e., following safety regulations; careful and economic use of materials; leaving the work place neat and tidy) should be assessed by teachers in the context of the Senior Certificate Examination.

4.4 DEDUCTIONS ARISING FROM THE FOREGOING DISCUSSION

A scheme of outcomes of practical work (i.e., abilities and attitudes) that could be attained by pupils through current practical work emerges from the discussion which was based on research studies and on the responses and comments of members of the Biology Subject Committee, fifty-two biology teachers (at the Convention), three biology inspectors, eleven examiners, and nineteen standard-ten biology teachers. This scheme can be summarised as follows:

(i) Knowledge of techniques, processes and materials - dimensions i (knowledge of apparatus and chemicals), ii (knowledge of specimens, models and processes) and iii (knowledge of techniques).

(ii) Ability to use techniques and materials - dimensions i (selecting materials for use), ii (using techniques and materials) and iii (explanation of implications of materials and procedures used).

(iii) Observation and recording - dimensions i (recording microscopic observations in form of diagrams), ii (recording microscopic observations in form of notes or oral description), iii (recording macroscopic observation in form of diagrams), iv (recording macroscopic observation in form of notes or oral description), and v(recording in the form of tables and illustrations).

(iv) Ability to interpret observations and to make appropriate deductions and inferences - dimensions i (explanation of observations), ii (to make inferences), iii (to make deductions), v (to make predictions), vi (to respond to problem questions related to observation) and vii (to respond to problem questions based on broader theory which is related to the present result).

(v) Showing desirable attitudes to practical work - dimensions i (persistence), ii (resourcefulness), iii (co-operation), iv (enthusiasm), v (sensitivity) and vi (fair-mindedness and tolerance).

The above summary of outcomes of practical work is comparable to those to be attained by pupils offering the Nuffield A-Level Biology,[64] Nuffield A-Level Physical Science[65] or the Biological Sciences Curriculum Study.[66] This summary of outcomes of practical work will be used as a basis for the formulation of objectives for practical work in biology at the senior secondary level (see Chapter 8).

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58. Kelly, P.J., and Lister, R.E.: *op. cit.*, p. 147

59. Nicodemus, R.B.: *op. cit.*, p. 90

60. Natal Education Department: Instructions from moderators of practical work to senior biology teachers at schools, 1979. p. 1

61. Rogers, T.J.: "Course Work and Continuous Assessment", in Macintosh, H.G. (ed.): *op. cit.*, p. 169

62. Schools Council: *Assessment of Attainment in Sixth-Form Science*, Examinations Bulletin 27, Evans/Methuen Educational, London, 1973. p. 22

63. *Ibid.*

64. Kelly, P.J., and Lister, R.E.: *op. cit.*, pp. 126-127

65. Fairbrother, R.W., and Swain, J.R.L.: *op. cit.*, p. 97

66. Schwab, J.J.: *Biological Sciences Curriculum Study*, Biology Teachers' Handbook, *op. cit.*, p. 473

CHAPTER FIVE

ANALYSIS OF RESPONSES AS RECORDED BY TEACHERS TO ASSESSMENT OF PRACTICAL WORK

5.1 GENERAL POSITION WITH REGARD TO ASSESSMENT OF PRACTICAL WORK

Instructions are issued to biology teachers via circulars by the Division of Education, Department of Indian Affairs, that teacher-awarded marks for practical work in biology for Senior Certificate Examinations must be based on cumulative assessment.[(1)] The Division of Education, Department of Indian Affairs, appoints a panel of examiners to moderate these teacher-awarded marks by the use of practical control tests. This test is a form of external examination because it is externally set, administered and marked. It was established by the writer during discussions with senior biology teachers at the National Convention (p. 19) that some teachers awarded final practical marks to pupils exclusively through the use of final practical tests.[(2)] In this chapter, cumulative assessment, practical control tests and final practical tests will be examined in relation to assessment of practical work in biology in Indian schools.

5.2 THE QUESTIONNAIRES TO TEACHERS

Questionnaire C (sections 1, 2 and 3) was administered personally by the writer to nineteen standard-ten biology teachers in nine schools where he conducted practical control tests. Questions in section 1 (with the exception of subsection B, e which dealt with outcomes of practical work, analysed and discussed in Chapter 4), 2 and 3 were related to cumulative assessment, final practical tests and practical control tests respectively. The procedure followed in administering this questionnaire is discussed in Appendix A, pp. 391-393. This questionnaire was used to establish the following:

(i) the current procedures used by teachers to assess attainment in practical work;
(ii) the advantages of these assessment procedures;
(iii) problems encountered in using these assessment procedures;

(iv) outcomes of practical work that were assessed through the use of these assessment procedures;

(v) feasibility of using these assessment procedures in assessing attainment in practical work;

(vi) teachers' views on moderation of teacher-awarded marks.

Questionnaire A (section C - which is related to assessment of practical work) was administered to fifty-two senior biology teachers at the National Convention (see page 19 of this study). Responses of this group of teachers to sections A and B of this questionnaire have already been discussed in Chapter 4. Section C of questionnaire A was used to establish the views of this group of teachers to cumulative assessment, final practical tests and practical control tests.

5.3 ANALYSIS AND DISCUSSION

The analysis of responses made in sections 1, 2 and 3 of questionnaire C is presented in appropriate parts of this chapter under specific headings.

The discussion on assessment of practical work will revolve mostly around the information and opinions that were provided by the nineteen standard-ten biology teachers and research evidence in related fields of study. These teachers represent 21,59 per cent of the population of standard-ten biology teachers. This sample in terms of size is in line with the samples used by other research workers in related fields of study (see pages 29 and 30 of this study). The point of view taken in this study is that the responses of these teachers with regard to assessment of practical work ought to represent a reliable cross section of the population. This assumption is made because of reasons outlined on page 104 of this study. Added to this, confidence limits have been set up for the population from the sample values. This has been along the lines discussed on page 102 of this study. On the basis of these confidence limits valid inference about the population values (i.e., in terms of proportion of responses that could be expected in the population) from the sample values could be made. They are indicated in detail in Table B.4 for a sample of nineteen teachers (see Appendix B, p. 410) and in Table B.5 for a sample of sixteen teachers (see Appendix B, p. 411). Information from these

Tables will be used, wherever necessary, to make inferences about the proportion of responses that could be expected in the population in terms of the same responses made by the sample of teachers.

The writer also takes the view that the conclusions based on the responses of this sample of teachers must be interpreted with caution (see page 104 of this study). Although all responses made by the teachers will be analysed and recorded in the Tables in this chapter, only opinions expressed by the overall majority will be used as "pointers" for discussion and for making deductions.

A further safeguard was built-in by using the responses of fifty-one (one out of the fifty-two questionnaires was spoilt) senior biology teachers in questionnaire A (i.e., section C which dealt with aspects related to assessment of practical work) to substantiate some of the responses made by the overall majority of the nineteen standard-ten biology teachers. These fifty-one senior biology teachers were from forty-one schools out of a total of fifty-four schools in the Republic of South Africa that had Senior Certificate biology candidates (see page 24 of this study).

5.3.1 Cumulative Assessment

The term "cumulative assessment" is used here as a synonym for "continuous assessment". It must also be admitted that this term has not yet such common usage as "continuous assessment" and throughout this study wherever the latter term is used it will refer to cumulative assessment. This can be regarded in the context of assessment of practical work as a constant updating of teacher's judgements about their own pupils, which permits cumulative judgements being made on their performance. Cumulative assessment is interpreted as the systematic collection of marks over a period of time, in practical work in biology and their aggregation into a final mark.

5.3.1.1 Cumulative Assessment as Carried out by Teachers

This section of the study deals with the information that was provided by teachers with regard to cumulative assessment of practical work as carried out by them at schools.

5.3.1.1.1 Type of Internal Assessment Procedure Used by Teachers to Allocate the Final Practical Marks

In order to establish the assessment procedure that was used to award the final marks to pupils in practical work, a question in this regard was included in questionnaire C (Appendix A, section 1, B, a, p. 382). The information provided by the nineteen standard-ten biology teachers is presented in Table 5.1

TABLE 5.1: SOURCE OF FINAL INTERNAL PRACTICAL MARKS IN BIOLOGY

Source of marks	Teachers		Schools		Experience in teaching biology in standard ten				
	Number	Percentage	Number	Schools repres-ented	1 year	2 to 3 years	4 to 5 years	6 to 10 years	Over 10 years
Final Test	3	15,79	2	5;6	-	1	-	1	1
Cumulative assessment	16	84,21	7	1;2;3; 4;7;8;9	-	3	4	6	3
Any other	0	0	0	-	-	-	-	-	-
TOTAL	19	100,00	9	-		4	4	7	4

It is evident from Table 5.1 that irrespective of the years of teaching biology in standard-ten, 84,21 per cent of the teachers based their final marks on cumulative assessment; while 15,79 per cent of the teachers from two schools based their marks only on one final practical test. The statistical analysis of teachers' responses in Table B.4, (p. 410) indicate that more than 56,70 per cent ($p < 0,01$) or above 63,10 per cent ($p < 0,05$) of the standard-ten biology teachers in the population could be expected to indicate that they assess the final attainment of their pupils through cumulative assessment. The responses of teachers in Table 5.1 indicate that the type of internal assessment used by teachers to arrive at a final mark per pupil in practical work is not uniform at Indian schools.

5.3.1.1.2 <u>Assessment Techniques Used in Cumulative Assessment</u>

Three teachers from two schools did not use cumulative assessment for arriving at the final mark in practical work. Therefore, sixteen teachers from seven schools responded to the questions based on the nature of cumulative assessment as carried out by them at schools. In order to establish the techniques that these sixteen teachers used, a question in this regard was included in the questionnaire (Appendix A, section 1, B, b, p. 382). The writer also collected information from these teachers with regard to their interpretation of the various techniques that they used. From this information it was possible to establish that besides the final practical test which included written outcomes of practical work (i.e., written records of observation and interpretation) and direct observation of pupils carrying out manipulative skills, each technique listed in Table 5.2 is an exclusive technique. For example, a practical test did not involve direct observation of pupils while they were carrying out a task in the laboratory. The information with regard to the various techniques that were used by the teachers is presented in Table 5.2

TABLE 5.2: COMBINATION OF TECHNIQUES THAT WERE USED BY TEACHERS IN CUMULATIVE ASSESSMENT

Combination of Techniques used	Teachers		Schools		Experience in teaching biology in standard ten				
	Number	Percentage	Number	Schools represented	1 year	2-3 years	4-5 years	6-10 years	Over 10 years
A Final test, oral test, observing pupils directly at work in the laboratory, practical record books	2	12,50	1	9	-	-	-	1	1
B Final test, practical tests, oral tests	1	6,25	1	7	-	-	-	-	1
C Final test, practical tests, oral tests, observing pupils directly at work in the laboratory, practical record books	6	37,50	3	2;7;1	-	1	2	2	1
D Final test, oral tests	1	6,25	1	7	-	-	-	1	-
E Final test, practical tests, practical record book	1	6,25	1	4	-	1	-	-	-
F Final test, practical tests, oral tests, observing pupils directly at work in the laboratory	2	12,50	1	3	-	-	-	1	1
G Final test, and practical tests	2	12,50	1	8	-	-	2	-	-
H Final test, practical tests, oral tests, practical record books	1	6,25	1	7	-	1	-	-	-
T O T A L	16	100,00	-	-	-	3	4	5	4

Table 5.2 shows that eight different combinations of techniques (first column) were used by the teachers in order to arrive at a mark per pupil through cumulative assessment. Some teachers used two techniques only, while others used as many as five different techniques. When the column, "schools represented" is examined, it indicates that combination of techniques used in cumulative assessment did not only vary from school to school but among teachers in the same school. For example, in school number 7, there were four standard-ten biology teachers and each used a different combination of techniques to arrive at a final practical mark per pupil. The final internal practical test which is purported to measure the final attainment of pupils in practical work at the end of the course was used by all the teachers as a part of cumulative assessment.

5.3.1.1.3 <u>The Standards in which Information was Collected in Order to Arrive at a Final Cumulative Assessment Mark</u>

The information supplied by the teachers in questionnaire C (Appendix A, section 1, B, c, p. 383) with regard to the standards of the senior secondary level in which they collected information for cumulative assessment was analysed and this is presented in Table 5.3.

TABLE 5.3: THE PERIOD OF SPREAD OF THE CUMULATIVE ASSESSMENT IN THE SENIOR SECONDARY LEVEL

Senior secondary level	Teachers		Schools	
	Number	Per cent	Number	Schools represented
Standard 10 year	15	93,75	7	1;2;3; 4;7;8 9
Standard 9 and 10 years	1	6,25	1	1
Standard 8, 9 and 10 years	0	-	-	-
Total	16	100,00	-	-

According to Table 5.3 the majority of the teachers (93,75 per cent) spread their period of assessment over the standard 10 year. Statistical analysis of teachers' responses in Table B.5 (p.411) indicates that over 63,70 per cent ($p < 0,01$) or above 71,40 per cent ($p < 0,05$) of the standard-ten biology teachers in the population could be expected to make a similar response. When the column "schools represented" is examined, it indicates that there was variation among schools and among teachers in the same school with regard to the spread of the period of cumulative assessment. For example, in school number 1, the period of cumulative assessment was spread over two years (standards 9 and 10) by some teachers while others spread it over a period of one year (i.e., standard-ten year only).

The sixteen teachers also made written comments in the same section of the questionnaire with regard to the course work that was assessed. From these comments it was established that:

(i) 87,50 per cent of the teachers who spread the period of assessment over the standard-ten year assessed pupils on course work covered in standards 8, 9 and 10;

(ii) 6,25 per cent of the teachers who spread the period of assessment over the standard-ten year assessed pupils on course work covered in standards 9 and 10;

(iii) 6,25 per cent of the teachers who spread the period of assessment over the standard 9 and 10 years assessed pupils on course work covered in standards 9 and 10.

The responses of teachers in Table 5.3 and the comments made by the teachers indicate that the period of spread and the course work covered in this form of assessment is not uniform in Indian schools.

5.3.1.1.4 Outcomes of Practical Work that were Taken into Account in Cumulative Assessment

Outcomes of practical work (abilities and attitudes) could not be developed by pupils or assessed outside the context of subject matter (content). Although the content of practical work varies for each year of the senior secondary level, the outcomes need not vary from year to year. This is because the same outcomes can be developed over a variety of subject matter.

In order to establish the outcomes of practical work that were taken into account in cumulative assessment, a question in this regard was included in the teachers' questionnaire (Appendix A section 1, B, d, p. 383). Information supplied by the sixteen teachers was analysed and is presented in Table 5.4.

ABLE 5.4: OUTCOMES OF PRACTICAL WORK TAKEN INTO ACCOUNT IN CUMULATIVE ASSESSMENT

Outcomes of Practical Work	Grades	Teachers		Schools	
		Number	Percentage	Number of Schools	Schools represented
1. Ability to identify materials	Higher and Standard	15	93,75	7	1; 2; 3; 4; 7; 8; 9
	Higher	-	-	-	-
2. Ability to use laboratory techniques	Higher and Standard	15	93,75	7	1; 2; 3; 4; 7; 8; 9
	Higher	-	-	-	-
3. Ability to observe and record	Higher and Standard	16	100,00	7	1; 2; 3; 4; 7; 8; 9
	Higher	-	-	-	-
4. Ability to explain from observation	Higher and Standard	14	87,50	7	1; 2; 3; 4; 7; 8; 9
	Higher	-	-	-	-
5. Ability to infer from observation	Higher and Standard	11	68,75	7	1; 2; 3; 4; 7; 8; 9
	Higher	1	6,25	1	2
6. Ability to link practical work with theory	Higher and Standard	8	50,00	4	1; 7; 8; 9
	Higher	4	25,00	3	2; 3; 4

According to Table 5.4 it is explicit that some outcomes of practical work are recognised by the majority of the teachers and these were included in their assessment, e.g., outcomes 1 to 5. Statistical analysis of teachers' responses in Table B.5 (p. 411) indicates that the majority of the teachers in the population could be expected to have included the first 4 outcomes (i.e., knowledge of materials, laboratory techniques, recording and explanation of observations) in their cumulative assessment.

Table 5.4 reveals that there was a discrepancy among teachers in the same school and among teachers in different schools in terms of the outcomes that were assessed through cumulative assessment. For example, all the teachers from the seven schools (i.e., sixteen teachers) assessed the ability to "record", but only eleven teachers from these seven schools assessed the ability "to infer". There was also a discrepancy among teachers in the same school (outcome 5) and among schools (outcomes 5 and 6) in terms of outcomes that were assessed only for the Higher Grade and for both the grades.

In summary it could be stated that there is no uniform pattern that is followed by teachers in Indian schools in the assessment of practical work for the Senior Certificate biology examination. While it is interesting to speculate on all the possibilities for this, one deduction seems clear: the teachers require guidance in terms of what to assess (i.e., objectives and content) and how to assess (i.e., procedures and techniques of assessment). These aspects are discussed in relevant sections of this study.

5.3.1.2 Teachers' Comments with Regard to Cumulative Assessment

From the outset it was apparent that there were a number of areas, such as teacher-pupil relationship, pupil reaction, effect on the curriculum and the maintenance of standards, in which a knowledge of the teachers' opinions would be extremely useful. Survey of the literature and a discussion with the teachers (by the writer during the practical control tests) confirmed this view.

In order to establish the teachers' reactions to cumulative assessment, questions in this regard were included in the teachers' questionnaire (i.e., questionnaire C, section 1, C - a to k, see Appendix A, pp. 387-388). The responses of the nineteen teachers (sixteen teachers who used cumulative assessment plus the three teachers who did not use this procedure) were analysed and the results are indicated in Table 5.5.

TABLE 5.5

TEACHERS' COMMENTS WITH REGARD TO CUMULATIVE ASSESSMENT

RESPONSES	Teachers (N =19)		Schools		Propor-tion of responses	Confidence limits			
						p< 0,01		p <0,05	
	Number	Percent.	Number	Schools represented		Lower limit	Upper limit	Lower limit	Upper limit
1. Effect of cumulative assessment on teachers' workload:									
i Involves a great deal of work and time	19	100,00	9	1 to 9	1,00	0,81	-	0,87	-
2. Teachers' dual role of teacher and assessor:									
i Reluctant to accept the dual role	9	47,37	5	4;5;6;7;8	0,47	0,22	0,73	0,27	0,68
ii Accept the dual role	10	52,63	5	1;2;3;8;9	0,53	0,27	0,78	0,32	0,73
3. Comparability of standards between teachers:									
i No problem in maintaining standards between teachers in the same school	19	100,00	9	1 to 9	1,00	0,81	-	0,87	-
ii No effort is made to maintain standards between schools	19	100,00	9	1 to 9	1,00	0,81	-	0,87	-
4. Value of cumulative assessment:									
i Constant feedback on progress	19	100,00	9	1 to 9	1,00	0,81	-	0,87	-
ii Constant feedback on the teaching and learning effectiveness	19	100,00	9	1 to 9	1,00	0,81	-	0,87	-
iii Diagnostic value	19	100,00	9	1 to 9	1,00	0,81	-	0,87	-
5. Fairness of cumulative assessment to pupils:									
i Chances of success are better than 'one shot' assessments	19	100,00	9	1 to 9	1,00	0,81	-	0,87	-
6. Coursework and techniques:									
i Covers a greater content area than other forms of assessment	19	100,00	9	1 to 9	1,00	0,81	-	0,87	-
ii Variety of objectives are assessed	19	100,00	9	1 to 9	1,00	0,81	-	0,87	-
iii Wide variety of assessment techniques could be used	19	100,00	9	1 to 9	1,00	0,81	-	0,87	-
7. Discrimination between pupils:									
i Pupils could be differentiated according to their ability	19	100,00	9	1 to 9	1,00	0,81	-	0,87	-
8. Pupils' reactions to cumulative assessment as indicated by teachers:									
i Pupils prefer cumulative assessment	12	63,16	7	1;2;3;4;7;8;9	0,63	0,35	0,85	0,41	0,81
ii Pupils prefer final practical tests to cumulative assessment	2	10,53	1	5	0,10	0,01	0,37	0,02	0,31
iii Some prefer final practical tests while others prefer cumulative assessment	3	15,79	1	7	0,16	0,03	0,43	0,05	0,37
iv Did not gauge reactions of pupils to cumulative assessment	2	10,53	2	8;6	0,10	0,01	0,37	0,02	0,31

According to Table 5.5 - with the exception of their comments on "teachers' dual role of teacher and assessor" and "pupils' reactions to cumulative assessment" - there was unanimous agreement among these teachers in indicating the problems and values inherent in this form of assessment. A statistical analysis of the comments where there was unanimous agreement indicates that over 81,00 per cent ($p < 0{,}01$) or above 87,10 per cent ($p < 0{,}05$) of the teachers in the population could be expected to make a similar comment as these teachers (Table B.4 p. 410). The responses of teachers in Table 5.5 will now be analysed and commented upon:

(i) The comments of 100,00 per cent of the teachers with regard to effect of this form of assessment on the teachers' workload is consistent with the views expressed by Wiseman,[(3)] and Chalmers and Stark.[(4)] Cumulative assessment involves a great deal of time and work because the pressure of assessment is transferred from a single assessment to a series of periodic assessments. This involves periodic test construction, organisation, administration, marking and keeping of records. Although this assessment involves a great deal of work and time it is nevertheless a fair form of assessment of pupils' attainment and it can be supported on educational grounds.

(ii) Teachers were divided on this issue of playing a dual role of a "teacher" and an "assessor". This varied response is consistent with the findings of Kelly and Lister in their analysis of responses of teachers who had to assess practical work in the Nuffield A-Level Biology.[(5)] Pupils looking for ways to influence the teacher's judgement may affect teacher-pupil relationship and also assessment. Hoste and Bloomfield state that "there is a danger that individual children may force themselves upon the teacher's attention. Some pupils are determined to impress and so dominate a class to the advantage of their assessment".[(6)] Teachers who were reluctant to accept the dual role of "teacher" and "assessor" stated in their comments in the questionnaire that: they will not accept the responsibility of assessing pupils while they were doing a task for the first time and were receiving assistance from them (e.g., while pupils are carrying out current laboratory work). Implicit in these comments is the fact that this group of teachers was not reluctant to assess pupils after they had mastered their work. When current practical exercises are assessed, help should be given when required. When allocating marks the amount of assistance given to a pupil must be taken into account. Within this context the current practical work of pupils will not be unduly affected by the lack of teacher's guidance.

(iii) The teachers were unanimous in stating that they found no problem in achieving a consistent standard in assessing practical work in a school but what they did not do was to compare their standard of assessment with that of other teachers in other schools. This is consistent with the views expressed by the authors of Examination Bulletin No. 1.[7] There is a discrepancy between what this group of teachers stated and the findings in this study (Chapter 7) when the teacher-awarded marks for the schools in the Republic of South Africa were analysed. This analysis of marks indicated that there are variations among teachers in the same school in the standard of awarding marks. In order to develop competency in the skills of assessment and maintaining uniformity of standards, the teachers require guidance. This is consistent with the views expressed by other research workers.[8][9][10] This aspect will be discussed in relevant sections of this study.

(iv) The teachers were unanimous in realising the educational value of cumulative assessment. These teachers indicated in the form of comments in the questionnaire that this form of assessment provides for constant feedback on the progress of the pupils, not only to the teacher but also to the pupils. They also recognised the value of this form of assessment in terms of it providing a feedback to them on their teaching and learning effectiveness. These comments of teachers are consistent with the views expressed by research workers.(11) The identification of these values is important because it is indicative that the teachers look upon this assessment procedure as not only providing a measurement to use for promotion but also as a means to diagnose pupil difficulty.

(v) The teachers were of the opinion that pupils assessed through cumulative assessment stand a better chance of success than when assessed by a "one-shot" assess= ment. This is consistent with the findings in many research studies.(12)(13)(14) The beneficial effect of this assessment procedure, is that the pupil has many chances to improve his performance. If a candidate's work is not according to an expected standard in one performance, the class teacher can take effective action, and since intermediate results affect the final assessment, the pupil can be persuaded to improve his performance. In this respect, cumulative assessment gives the pupils a fairer chance to pass than a "one-shot" assessment.

(vi) The teachers were unanimous in identifying the value of cumulative assessment in terms of assessing content and objectives adequately. In this regard Hoste and Bloomfield state that the "course is the assessment and the assessment is the course".(15) Kelly and Lister state that provided the teachers are well aware of the objectives of practical work that should be assessed, a cumulative assessment would seem to be a better means of reflecting the outcomes of the course than conventional examinations. This group of teachers also commented that cumulative assessment allows for a great deal of flexibility, i.e., a few objectives can be assessed at a time and all the pupils need not be assessed for the same outcomes on the same day.

(vii) All the teachers stated that pupils assessed through cumulative assessment can be easily differentiated according to their abilities. In the questionnaire this group of teachers made the comment that through this assessment, as in the final practical test, it was possible to distinguish the bright, average and weak pupils. This view expressed by the teachers is consistent with the findings of other research workers.[16] From the responses of the teachers it could be argued that if any scale for rating pupils is constructed, finer distinctions between pupils other than those which distinguish the bright, average and weak may be quite meaningless. This is in line with the views expressed by Duffey,[17] Kelly and Lister.[18]

(viii) The majority of the teachers (63,16 per cent) were of the opinion that pupils preferred cumulative assessment to other forms of assessment. A similar view is expressed by some research workers.[19][20] In the questionnaire this group of teachers made the comment that pupils preferred this assessment because it reduced the risk of failure, and they were assessed on small units of work each time. In general, the pupils' reactions to cumulative assessment, as expressed by the teachers, may very well be the teachers' feelings to this form of assessment rather than those of the pupils. Therefore these responses must be treated with caution.

The comments made by the teachers indicate that cumulative assessment allows for a great deal of flexibility in a variety of techniques used in assessing the coursework comprehensively. Implicit in their comments is the fact that cumulative assessment if used properly, such as coverage of major subject areas and objectives in correct proportions, is fair and valid. In summary, it could be stated that the teachers in this sample were aware of the values inherent in cumulative assessment of practical work and also the problems that are inherent in this form of assessment.

5.3.2 Final Practical Tests

"A final practical test", is interpreted as a measuring instrument devised, administered and marked by the teachers at schools at the end of the course of study (i.e., at the end of the senior secondary level). According to Tables 5.1 and 5.2, 100,00 per cent of the teachers conducted final practical tests. The majority (84,21 per cent) used these tests as part of the cumulative assessment while the remaining 15,79 per cent used these test marks exclusively to indicate the final attainment of pupils in practical work.

5.3.2.1 Reasons for Conducting Final Practical Tests

In order to establish the reasons for conducting a final practical test, a question in this regard was included in questionnaire C (Appendix A, section 2, No. 1, p. 389). The responses of the nineteen teachers are indicated in Table 5.6.

TABLE 5.6: REASONS FOR CONDUCTING A FINAL PRACTICAL TEST

Responses	Teachers		Schools	
	Number	Percentage	Number	Schools represented
(a) To collate marks for pupils to submit to I.A.D. (only marks collated)	3	15,79	2	5;6
(b) To prepare pupils for the practical control test	16	84,21	8	1;2;3;4; 5;7;8;9
(c) To assess the final attainment of pupils	4	21,05	3	1;5;8
(d) Other	-	-	-	-

According to Table 5.6, 84,21 per cent of the teachers conducted final practical tests in order to prepare the pupils for the practical control test. A similar response could be expected from more than 56,70 per cent ($p < 0{,}01$) or above 63,10 per cent ($p \leq 0{,}05$) of the standard-ten biology teachers in the population (Table B.4, p. 410). The final practical test and the practical control test are similar in terms of both being "one-shot" assessments. Although the practical control test is a moderating procedure and its purpose is not to assess individual performance of pupils (i.e., its purpose is to scrutinize the overall standard of awarding marks by teachers, and individual performance of pupils is only incidental within this context of moderation), it seems that the teachers were under the misapprehension that it did and therefore prepared pupils for it. This indicates that the teachers require guidance on the purpose of practical control tests.

5.3.2.2 Advantages of Final Practical Tests Over Other Forms of Assessment

In order to establish what advantages the teachers saw in the final practical tests over other procedures of assessment, a question in this regard was included; in questionnaire C (Appendix A, section 2, No. 2, p. 389). The responses provided by the teachers were analysed and are represented in Table 5.7

TABLE 5.7: ADVANTAGES OF A FINAL PRACTICAL TEST

Responses	Teachers		Schools	
	Number	Percentage	Number	Schools represented
(a) It reflects the final attainment of pupils	3	15,79	2	5;8
(b) It is a comprehensive test because the questions are spread throughout the syllabus	11	57,89	7	1;2;3;4; 5;7;9
(c) Pupils prepare for this test and they are not assessed unexpectedly	10	52,63	5	1;2;7;8;9
(d) It is a means of preparing pupils for the practical control test	16	84,21	9	1;2;3;4;5 6;7;8;9
(e) Saves time and it is less work for the teacher when compared with cumulative assessment	1	5,26	1	6
(f) Far more objective than cumulative assessment	1	5,26	1	7
(g) Maintains uniformity in standard in a school since pupils write a common paper	2	10,53	1	7
(h) Others	-	-	-	-

When Table 5.7 is examined, the majority of the teachers gave the following three reasons for looking upon the final practical test as having advantages over other forms of assessment:

(i) comprehensive sampling of pupils' work at one point in time;

(ii) pupils were aware of the time of assessment and they prepared themselves for it;

(iii) means of preparing pupils for practical control tests.

These three reasons are interrelated. Even if single units of work covered in the course are assessed at a time, through cumulative assessment, finally a greater cross section of the course work can be assessed through cumulative assessment than in the final practical test. It could be that by trying to cover major areas of course work in the final practical test many short questions which highlight "recall of knowledge" and "techniques" at the expense of questions requiring complete investigations, may be introduced because of the time factor. Research evidence indicates this to be the case in "one-shot" assessments.[(21)] Research evidence indicates that when pupils were assessed through cumulative assessment on a piece of work that they were doing for the first time, without being told they were being assessed, it caused many problems. "Students became anxious with the continued possibility of secret assessment".[(22)] There is no reason why pupils should not be told before hand that they are going to be assessed on a piece of work that they are doing for the first time. Cumulative assessment can also be based on a unit of work completed (i.e., through periodic tests) and pupils could be told to prepare for it. The final practical test will not have any educational advantage over cumulative assessment if factors such as, "covering the syllabus comprehensive= ly" and "pupils knowing when they are being assessed", are taken into account. One of the driving forces behind the teachers conducting final practical tests seems to be to prepare the pupils for practical control tests. In fact, the majority of the teachers (84,21 per cent) gave this as an advantage (Table 5.7) and their reason (Table 5.6) for conducting final practical tests.

5.3.2.3 Difficulties Experienced by Teachers in Devising Final Practical Tests

In order to establish some of the difficulties that the teachers faced in devising or constructing final practical tests, a question in this regard was included in questionnaire C (Appendix A, section 2, No. 3, p. 389). The responses of the teachers were analysed and the results are presented in Table 5.8.

TABLE 5.8: LIMITATIONS IMPOSED IN DEVISING A FINAL PRACTICAL TEST

Responses	Teachers		Schools	
	Number	Percentage	Number	Schools represented
(a) Seasonal availability of certain specimens	17	89,47	9	1;2;3;4;5; 6;7;8;9
(b) Insufficient equipment	16	84,21	8	2;3;4;5; 6;7;8;9
(c) Large class units	7	36,84	4	1;3;7;8
(d) Time factor	14	73,68	8	1;2;3;5; 6;7;8;9
(e) Required a large number of invigilators	4	21,05	3	2;7;8
(f) Accommodation in laboratory	1	5,26	1	2
(g) Vastness of syllabus	6	31,58	6	1;3;4;5; 8;9
(h) All outcomes cannot be assessed	4	21,05	3	1;2;4
(i) Others	-	-	-	-

According to Table 5.8, the majority of the teachers experienced the following difficulties in devising these tests:

(i) seasonal availability of certain materials;
(ii) insufficient equipment;
(iii) time factor.

The general indication is that special restrictions were imposed on the nature of practical work assessed in the final practical test. Besides the seasonal availability of specimens (e.g., flowers, ferns, etc.) all other factors indicated in Table 5.8 seemed to be interrelated. For example, it is difficult to isolate insufficient equipment, large class units and the time factor. Restriction of time in a test situation limits the choice of exercises. Some of the topics in the syllabus involve investigation requiring a much longer time than that which was available under test conditions. This is particularly true for topics in ecology and plant physiology. Insufficient apparatus for conducting individual work by pupils presents problems in test situations especially if there are large members of pupils.

Implicit in these responses and from research evidence[23][24][25] is the fact that the final practical test questions that are finally devised (i.e., after excluding questions because of restrictive factors) cover only a limited range of the pupils' course work.

5.3.2.4 Difficulties Experienced by the Teachers in Administering the Final Practical Test

In order to establish if there are any problems experienced by the teachers in administering these tests, a question in this regard was included in questionnaire C (Appendix A, section 2, No. 4, p.389). The responses of the teachers were analysed and are indicated in Table 5.9.

TABLE 5.9: DIFFICULTIES EXPERIENCED IN ADMINISTERING THE FINAL PRACTICAL TEST

Responses	Teachers		Schools	
	Number	Percentage	Number	Schools represented
(a) No difficulties	1	5,26	1	6
(b) Large number of pupils seated next to each other and not strictly according to examination conditions	14	73,68	6	1;3;4; 7;8;9
(c) Large number of invigilators and this disorganised the school time-table	10	52,63	5	2;5;7; 8;9
(d) Limited number of apparatus. Invigi= lators had to see that apparatus were inter= changed and/or pupils took turns in using apparatus	2	10,53	2	1;9
(e) Not able to test all aspects of laboratory technique used by pupils because of large numbers	6	31,58	4	1;2;3;9
(f) Did not assess pupils individually by direct observation in laboratory techniques because of large numbers	6	31,58	6	1;2;4;5; 7;8
(g) Others	-	-	-	-

The main difficulty the teachers seemed to have experienced in administering the test was having large numbers of candidates to assess at "one-shot" or at any one time. This disrupted the school organisation (i.e., in terms of using large number of teachers as invigilators) and made invigilation difficult because pupils were seated close to each other.

5.3.2.5 Outcomes of Practical Work that were Assessed in the Final Practical Tests

In order to establish what outcomes of practical work (i.e., abilities and attitudes) the teachers took into account when framing their questions for final practical tests, a question in this regard was included in questionnaire C (Appendix A, section 2, No. 5, p. 389). An analysis of the responses of the teachers is provided in Table 5.10.

TABLE 5.10: OUTCOMES OF PRACTICAL WORK THAT WERE ASSESSED IN THE FINAL PRACTICAL TEST

Outcomes	Teachers		Schools	
	Number	Percentage	Number	Schools represented
(a) Ability to identify materials	19	100,00	9	1;2;3;4;5;6 7;8;9
(b) Ability to use laboratory techniques	15	78,95	7	1;2;3;5;7;8; 9
(c) Ability to observe	5	26,31	3	2;5;7
(d) Ability to observe and record	12	63,16	6	1;2;3;7;8;9
(e) Ability to explain from observation	11	57,89	7	1;2;4;5;7;8; 9
(f) Ability to infer from observation	11	57,89	7	1;3;4;5;7;8; 9
(g) Ability to make deductions	1	5,26	1	5
(h) Ability to predict	1	5,26	1	5
(i) Ability to link practical work with theory	9	47,37	7	2;3;4;5;7;8; 9

According to Table 5.10, "identification of materials" was assessed by all the teachers. A similar response could be expected from over 81,00 per cent of the teachers in the population (Table B.4, p. 410). According to Bloom's Taxonomy this is classified under "recall of knowledge".[26] This ability is easy to assess in a "one-shot" assessment even if there is a large number of pupils in the class. The responses of pupils in terms of "identification" are usually in a written form.

The ability "to use laboratory techniques" was assessed by 78,95 per cent of the teachers. A similar response could be expected from over 51,00 per cent of the teachers in the population (Table B.4, p. 410). This ability can be assessed:

(i) by observing a pupil carrying out a task, e.g., preparing a slide on the transverse section of a stem;

(ii) by examining the end product of a task, e.g., assessing the completed slide on the transverse section of a stem; results of food tests, etc.

If Table 5.9 is examined it will be observed that there were 31,58 per cent of the teachers who stated that they did not assess pupils individually in laboratory techniques by direct observation because of the large number of pupils. Therefore some of the teachers who indicated in Table 5.10 that they had assessed laboratory techniques, could have assessed them by the end product.

The ability to observe and record, the ability to explain from observation, and to infer from observation can be easily assessed in a final practical test. However, time can act as a limiting factor in the amount of emphasis these various abilities could receive in the final practical test.

According to Table 5.10 there seems to be variation not only among schools, but also among teachers at the same school in assessing outcomes of practical work through final practical tests. For example, "the ability to observe and record" was indicated by 63,16 per cent of the teachers as one of the outcomes that were assessed and these teachers were from schools 1; 2; 3; 7; 8 and 9 which had a percentage of 78,95 of teachers. Therefore, there were 15,79 per cent of teachers from these schools that did not assess this ability in the test.

When Table 5.10 is compared with Table 5.4 the abilities assessed in the final practical test are remarkably similar to the ones assessed in cumulative assessment. However, there was a higher percentage of teachers who assessed the more important outcomes of practical work (i.e., recording, explanation from observation, inference making and linking practical work with theory) in the cumulative assessment than in the final practical test.

In summary, it could be stated that the final practical test was offset by the special restrictions imposed on the nature of practical work which can be assessed. There was the restriction of time, materials, venue for accommodating large numbers of candidates, and personnel. These restrictions had a bearing on the final practical test in terms of the range of course work that was assessed. This is consistent with the findings of other research workers[(27)(28)] in related fields of study. There are indications in these findings that the use of the final practical test is not based on sound educational principles. For example, there is a great deal of emphasis in using these tests to prepare pupils (i.e., in terms of style and content) for the practical control tests. If this is the chief source of motivation for doing practical work, then pupils may look upon practical work as a means of getting them through the final practical test and the practical control test, rather than practical work as a means of enabling them to develop certain abilities, attitudes and a better understanding of biology.

5.3.3 Practical Control Tests

The duty of an examining board is to ensure that all certification issued in its name is based on reliable, valid and nationally comparable assessments. The Joint Matriculation Board recognises this duty in respect of teacher-awarded marks for practical work in biology. The Division of Education, Department of Indian Affairs, is entrusted with the responsibility by the Joint Matriculation Board to ensure that these marks awarded by the teachers are fair and comparable for all candidates. To ensure that these requirements are met, the Division of Education, Department of Indian Affairs, appoints a panel of examiners to moderate teacher-awarded marks for practical work by the use of practical control tests. The purpose, nature and mechanics of moderation have been described in an earlier chapter (pp. 59-65).

5.3.3.1 Advantages of Practical Control Tests

In order to establish the opinion of teachers with regard to the advantages of this test, a question in this regard was included in questionnaire C (Appendix A, section 3, p. 390). An analysis of the responses of the nineteen teachers is given in Table 5.11.

TABLE 5.11: ADVANTAGES OF PRACTICAL CONTROL TESTS

Responses	Teachers		Schools		Experience in teaching biology in standard ten				
	Number	Percentage	Number	Schools represented	1 year	2-3 years	4-5 years	6-10 years	Over 10 years
i. Maintain a uniform standard of awarding marks among schools	16	84,21	8	1;2;3;4; 5;7;8;9	-	4	2	6	4
ii. It makes it imperative for teachers and pupils to conduct practical work in schools	4	21,05	4	5;6;7;9	-	-	-	2	2
iii. Provides new ideas to teachers in assessing practical work in schools	1	5,26	1	3	-	-	-	1	-

According to Table 5.11 there were 84,21 per cent of the teachers, irrespective of their teaching experience, who expressed the view that one of the advantages of practical control tests is to maintain standards between schools. A similar response could be expected from over 56,70 per cent ($p < 0,01$) or above 63,10 per cent ($p < 0,05$) of the standard-ten biology teachers in the population (Table B.4, p. 410). This group of teachers seems to realise that a moderating procedure is essential because individually they are not able to compare the performance of their own pupils with those from other schools in terms of the national standards of attainment in practical work. This is in line with the thinking of other research workers.[29]

5.3.3.2 Effects of Practical Control Tests on the Course Practical Work

In order to establish what effect the practical control tests were having on the course practical work, a question in this regard was included in questionnaire C (Appendix A, section 3, No. 2, p. 390). An analysis of the responses of the teachers is indicated in Table 5.12.

TABLE 5.12: EFFECTS OF PRACTICAL CONTROL TESTS ON THE COURSE PRACTICAL WORK

Responses	Teachers		Schools	
	Number	Percentage	Number	Schools represented
i. A great deal of time was spent on revision work in order to prepare for the practical control test	6	31,58	4	3;5;8;9
ii. Had to rush through course practical work so that it could be completed before the practical control test	5	26,32	3	1;5;7
iii. To be fair to pupils the course practical work was used to prepare pupils for the practical control test.	14	73,68	9	1;2;3;4;5;6;7;8;9

According to Table 5.12 there were 73,68 per cent of the teachers that used the course practical work to prepare pupils for the practical control tests. A similar response could be expected from over 45,40 per cent ($p < 0{,}01$) or above 51,60 per cent ($p < 0{,}05$) of the standard-ten biology teachers in the population (Table B.4, p. 410). Implicit in the responses of teachers is the fact that the style of practical work was being patterned along the lines of the practical control tests (i.e., in terms of content and outcomes assessed in the practical control tests) and they are preparing the pupils for it in terms of revision. The practical control test has many limitations. There are limitations in terms of content and abilities. For example:

(i) Topics within such fields as ecology and physiology are excluded because they involve investigations requiring much longer time than that which is available under test conditions.

(ii) Abilities like setting up experiments, observing, recording and handling of results in the context of an entire investigation are excluded because of lack of time and apparatus.

There are also limitations imposed by organisational and administrative problems, etc. In spite of these limitations the teachers were still being influenced by the practical control tests. This indicates that the practical control test (which is a form of external examination because it is externally set, administered and marked) is having an undesirable backwash effect on the course practical work. This is consistent with the findings of research workers who investigated the effect of external practical examinations on the nature of practical work at schools.[30][31] This undesirable backwash effect could be affecting the use of inquiry approach in practical work which is being advocated in the new trends in biology teaching.

5.3.3.3 Effects of Practical Control Tests on Teacher Assessment of Practical Work

In order to establish the effects of practical control tests on internal assessment of practical work, a question in this regard was included in questionnaire C (Appendix A, section 3, No. 3, p. 390). An analysis of the responses of the teachers is indicated in Table 5.13.

TABLE 5.13: EFFECTS OF PRACTICAL CONTROL TESTS ON INTERNAL ASSESSMENT OF PRACTICAL WORK

Responses	Teachers		Schools	
	Number	Percentage	Number	Schools represented
i. Time taken for revision in practical work to prepare for practical control test limited the number of internal assessments	3	15,79	1	7
ii. To be fair to the pupils the internal assessments had to be aligned to the style followed in the practical control test	12	63,16	7	1;2;3;5; 6;8;9
iii. Could not assess what the teacher wanted to assess, because these are not assessed in the practical control test	3	15,79	2	1;4
iv. No effect	1	5,26	1	7

According to Table 5.13, 63,16 per cent of the teachers were matching their internal assessments of practical work to that of practical control tests. This indicates that in spite of the limitations of the practical control test (i.e., in terms of the limited range of content and abilities that could be assessed in this one-shot assessment (see pages 146 and 147), the teachers felt that it was fair to the pupils if they patterned their assessments along the lines of this test. This suggests that the practical control test is having an overbearing influence on the nature of practical work assessment at schools. The assessment of practical work is not based on sound educational principles. That is, instead of the assessment of practical work being directed by the objectives and the activities that the pupils were involved in while doing the course, assessment is being influenced by the practical control test which has many limitations.

5.3.3.4 Effects of Practical Control Tests on Pupils

A question about the effects of practical control tests on pupils was included in questionnaire C (Appendix A, section 3, No. 4, p. 390). The responses of teachers were analysed and are presented in Table 5.14.

TABLE 5.14: EFFECTS OF PRACTICAL CONTROL TESTS ON THE PUPILS

Responses	Teachers		Schools	
	Number	Percentage	Number	Schools represented
i. Spent a great deal of time preparing for the practical control test at the expense of other work.	11	57,89	7	1;3;4;5;7;8;9
ii. It made them tense, nervous or anxious.	18	94,74	9	1;2;3;4;5;6;7;8;9
iii. Fear of letting their school, teachers and colleagues down.	3	15,79	2	2;5

According to Table 5.14, 94,74 per cent of the teachers stated that practical control tests made the pupils tense, nervous or anxious. A similar response could be expected from over 69,90 per cent ($p < 0,01$) or above 76,30 per cent ($p < 0,05$) of the standard-ten biology teachers in the population (Table B.4, p. 410). This may be due to the procedure followed in assessment during the test, i.e., face-to-face contact between candidates and examiners who were strangers. The misinterpretation of the purpose of practical control tests, not only by teachers, but also by pupils (i.e., where the teachers could have conveyed to the pupils that individual performance is being assessed in these tests) could have contributed to this state of nervousness (anxiety) by pupils. If nervousness (anxiety) affects the performance of candidates, it will undermine the acceptability of such a procedure for moderation and also as a potential form of external examination. The majority of the teachers were also of the opinion that a great deal of time of the pupils was used up in preparing for the practical control test. This was not necessary in the context of this test and pupils could have used this time profitably in getting a better understanding of biology.

5.3.3.5 Recommendation by Teachers for Future Moderation of Teacher-Awarded Marks in Practical Work

According to Tables 5.12, 5.13 and 5.14 the teachers' responses suggest that the practical control tests are having an undesirable backwash effect on pupils and the nature of practical work at schools. The teachers were also aware that a moderation procedure was essential to maintain a uniform standard of awarding marks among schools (see Table 5.11). It is therefore useful to know the suggestions of teachers for future moderation of teacher-awarded marks. A question in this regard was included in questionnaire C (Appendix A, section 3, No. 5, p. 390). The responses of the teachers were analysed and this is indicated in Table 5.15.

TABLE 5.15: RECOMMENDATION BY TEACHERS FOR FUTURE MODERATION OF TEACHER-AWARDED MARKS IN PRACTICAL WORK

Recommendation	Teachers		Schools		Experience in teaching biology in standard ten				
	Number	Percentage	Number	Schools represented	1 year	2-3 years	4-5 years	6-10 years	Over 10 years
i. Should do away with practical control tests and substitute teacher assessment with some form of guidance from external moderators	17	89,47	9	1;2;3;4;5; 6;7;8;9	-	5	-	8	4
ii. Practical control tests should be continued in the present form at those schools that do not maintain standards between schools	1	5,26	1	3	-	-	-	-	1
iii. A standardised practical control test must be compiled and used	1	5,26	1		-	-	1	-	-

According to Table 5.15, there were 89,47 per cent of the teachers irrespective of their years of teaching experience, who stated that practical control tests should be done away with. A similar response could be expected from over 62,80 per cent ($p < 0,01$) or from above 69,30 per cent ($p < 0,05$) of standard-ten biology teachers in the population (Table B.4, p. 410). Some of the factors that might have contributed to the rejection of this test could have been the undesirable backwash effect that this test was having on the course practical work, on internal assessment and on pupils. While it is interesting to speculate on all the possibilities mentioned with regard to the factors that could have led to this rejection, one deduction seems clear: a form of moderation procedure, like the practical control test, which is rejected by the majority of the teachers, ought to be replaced by a procedure that has a desirable backwash effect and is acceptable to the teachers and the Department. These teachers who rejected the practical control test suggested a substitute form of moderation procedure which will involve guidance from external moderators instead of the practical control tests conducted by examiners. A similar view was expressed by Kerr[32] in his research work with regard to moderating practical work in biology.

While it is interesting to speculate on how the moderators and teachers should work in order to maintain reasonable comparability of standards between teachers and schools, it is also clear that: a form of moderation procedure that is supported by teachers (i.e., guidance from external moderators) and is based on sound educational lines, should have a desirable effect on the course practical work. This aspect will be discussed further later in this study.

In summary it could be stated that practical control tests seem to be having an undesirable backwash effect not only on the course practical work and on teacher assessment but also on candidates. Therefore in its present form both as a moderating instrument and in its potential as an external practical examination, it is of limited educational value within the context of assessment of practical work.

5.3.4 Responses of the Fifty-One Senior Biology Teachers to Assessment of Practical Work

In order to establish the views of the fifty-two senior biology teachers (who attended the National Convention, see page 19) on assessment of attainment in practical work, a series of questions were included in questionnaire A (see Appendix A, section C, pp. 378-379). Fifty-one questionnaires were analysed because one was a spoilt questionnaire. Questions 1, 2 and 3 required the teachers to indicate their views with regard to the exclusive use of cumulative assessment, final practical tests or pupils' practical books respectively in assessing attainment in practical work, while question 4 required their views on practical control tests. The teachers had to respond to each of these questions by placing a tick against one of the following statements or by writing their own statement if they did not agree with those that were indicated:

(i) whole-hearted support;
(ii) support with some reservation;
(iii) strong opposition;
(iv) others (specify) .....

The teachers also had to provide reasons as to why they made a particular response (see Appendix A, pp. 378-379).

The responses of the fifty-one teachers to questions 1, 2, 3 and 4 are indicated in Table 5.16.

TABLE 5.16: RESPONSES OF FIFTY-ONE SENIOR BIOLOGY TEACHERS WITH REGARD TO ASSESSMENT OF FINAL ATTAINMENT OF PUPILS IN PRACTICAL WORK

Statements	Teachers' Responses							
	Exclusive use of cumulative assessment		Exclusive use of final practical test		Exclusive use of practical books of pupils		Use of practical control tests in moderating teacher-awarded marks	
	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
i. Whole-hearted support	48	94,12	4	7,84	2	3,92	2	3,92
ii. Support but with some reservations	3	5,88	2	3,92	5	9,80	4	7,84
iii. Have strong opposition	-	-	45	88,24	44	86,27	45	88,24
iv. Others (specify)	-	-	-	-	-	-	-	-

According to Table 5.16 the following is evident with regard to assessing the final attainment of pupils in practical work:

(i) There were 94,12 per cent of the teachers who were in favour of using cumulative assessment.

(ii) There were 88,24 per cent of the teachers who had strong opposition to using the final practical test.

(iii) There were 86,27 per cent of the teachers who were not in favour of using practical books of pupils.

(iv) There were 88,24 per cent of the teachers who had strong opposition to the use of practical control tests in moderating teacher-awarded marks.

The following comments made by two teachers sum up the reasons given by 94,12 per cent of the teachers for whole-heartedly supporting the use of cumulative assessment for assessing the final attainment of pupils:

One teacher stated that cumulative assessment "was fair to the pupils because it did not involve the risk factor of a final test". Another stated that "small units of course work were assessed at a time and over a period - the work covered by pupils at the senior secondary level was comprehensively assessed".

The majority of the teachers (88,24 per cent of the teachers) had strong opposition to the use of a final practical test because:

(i) it did not assess comprehensively the work covered in the course;

(ii) there were problems in administering the test to a large number of pupils;

(iii) there were problems with regard to seasonal availability of fresh materials.

The teachers who were not in favour of using the practical books of pupils for assessing the final attainment of pupils gave the following reasons for their comments:

(i) This assessment procedure tends to place too much emphasis upon the results which pupils have recorded without observing the pupils at all stages of their work.

(ii) Much work is done in pairs or bigger groups in the laboratory and it remains to be seen whether assessment of individuals is reliable in such circumstances.

(iii) Much guidance is given by teachers in practical work and this can influence the nature of recording by the pupil. The question arises in such circumstances as to whether it is the teachers' work, the pupils or that of both that is being assessed by using the practical records.

(iv) The quality of practical records can be influenced by the quality and quantity of facilities which are available; e.g., the number of microscopes, slides and specimens that are available per class unit are insufficient for proper observation to be made by each pupil.

(v) Pupils may prepare records for assessment purposes from text-books or colleagues and not from direct observation.

The above comments made by 86,27 per cent of the teachers are consistent with the views that were expressed by the nineteen standard-ten biology teachers to the writer,[(33)] and those that are expressed by Whittaker[(34)] and Lister[(35)] with regard to the problems inherent in using pupils' practical books for assessment. The use of pupils' practical record for assessment can also have an undesirable effect on the nature of practical work at schools. This has been discussed on page 55 of this study. The point of view taken in this study is that these limitations expressed by the teachers and by various authors undermine the use of practical books in assessing the final attainment of pupils.

The majority of the teachers had strong opposition to the use of practical control tests in moderating teacher-awarded marks. They gave the following reasons for their responses:

(i) A great deal of time was spent in preparing the pupils for practical control tests and this interfered with the time that was left for completing the biology syllabus.

(ii) It made the pupils nervous.

(iii) It did not assess the course work comprehensively.

In summary, it can be stated that the majority of the senior biology teachers:

(i) preferred cumulative assessment in assessing the final attainment of pupils in practical work because it was fair to the pupils;

(ii) did not favour the final practical test in assessing the final attainment of pupils because of its many limitations;

(iii) had strong opposition to the practical control test because of its undesirable effects on pupils and the course work.

When these views expressed by the majority of the senior biology teachers are compared with the comments that were made by the standard-ten biology teachers with regard to assessment of attainment of practical work they appear to be remarkably similar. This indicates that there is a significant number of teachers who are aware of the values inherent in cumulative assessment and also the problems that are inherent in using other forms of assessment and a moderating procedure like the practical control test.

5.4 DEDUCTIONS ARISING FROM THE FOREGOING DISCUSSION

There is no uniform pattern followed by teachers in schools in assessing attainment in practical work for the Senior Certificate Biology examination. Some assess attainment through cumulative assessment while others through the use of final practical tests. This is not consistent with the requirement of the Division of Education, Department of Indian Affairs which stipulates that teacher-awarded marks for practical work must be based on cumulative assessment. The findings in this study indicate that teachers require guidance in terms of: the objectives and content to be assessed; procedure and techniques to be used in assessment. The teachers also favoured the use of cumulative assessment because it was fair to the pupils and it also provided a great deal of flexibility in using a variety of techniques to assess a greater part of the course work than "one-shot" assessments.

The time factor, seasonal availability of materials, insufficient equipment, large number of pupils, etc., imposed severe restrictions on the range of course work that could be assessed in final practical tests. The development and application of the final practical test was strongly influenced by the moderation procedure, i.e., the practical control test. The final practical test which was offset by special restrictions is of limited educational value in assessing the final attainment of pupils in practical work.

The standard-ten biology teachers are aware of the value of the practical control tests, i.e., to maintain standards between schools. There seems to be a misunderstanding among the teachers as to how these standards are maintained. It would appear that the majority of the teachers are under the misapprehension that individual performances of pupils are being assessed in the practical control tests. They equated the practical control test to an external practical examination. Unfortunately many teachers tried to solve the problem of getting pupils through practical control tests by accepting this moderation procedure to give them a directive in their teaching and assessment and furthermore adjusted the demands made on pupils to be consistent with those made in the practical control tests. The practical control tests are having an undesirable backwash effect on the course practical work, on internal assessment procedures and on the pupils.

The undesirable effect which practical control tests are having on practical work stems from seemingly two different sets of objectives of teachers, i.e., objectives which will enable pupils to perform well in the practical control tests and the objectives that they consider to be ideal for giving the pupils a better understanding of biology. If both these sets of objectives coincided then there would be no necessity to prepare pupils for the practical control tests. It seems that the practical control test is not reflecting the ideal objectives of practical work which the teachers had in mind. Therefore the majority of the teachers are of the opinion that practical control tests should be done away with. The standard-ten teachers are unanimous in their opinion that a moderation procedure with guidance from external moderators can free the teachers and pupils from the restrictive effects of the practical control tests and at the same time provide a means of maintaining standards between teachers and schools. This aspect will be dealt with in a subsequent chapter. The undesirable effects on the course work, assessment procedures and on pupils indicated by the teachers in terms of disadvantages of practical control tests are also applicable to external practical examinations because both are external "one-shot" assessments.

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10. Hoste, R., and Bloomfield, B.: *op. cit.*, pp. 46-48

11. *Ibid.*, p. 18

12. Mathews, J.C.: "Examinations", *Education in Chemistry*, Vol. 6, 1969. p. 207

13. Chalmers, R.A., and Stark, J.: *op. cit.*, p. 155

14. Young, J.A.: "Continuous Assessment - A Mixed Blessing", *Education in Chemistry*, Vol. 7, 1970. p. 13

15. Hoste, R., and Bloomfield, B.: *op. cit.*, p. 22

16. Kelly, P.J., and Lister, R.E.: *op. cit.*, p. 135

17. Duffey, J.: "The Assessment of Progress in Science", *School Science Review*, Vol. 54, No. 36, 1972. p. 23

18. Kelly, P.J., and Lister, R.E.: *op. cit.*, p. 133

19. *Ibid.*, pp. 133-134

20. Chalmers, R.A., and Stark, J.: *op. cit.*, p. 155

21. Kelly, P.J., and Lister, R.E.: *op. cit.*, p. 141

22. *Ibid.*, p. 134

23. *Ibid.*, p. 142

24. The Biological Education Committee: *op. cit.*, 10

25. Mathews, J.C.: *op. cit.*, pp. 206-207

26. Bloom, B.S. (ed): *op. cit.*, pp. 62-88

27. Mathews, J.C.: *op. cit.*, pp. 206-207

28. Kelly, P.J., and Lister, R.E.: *op. cit.*, p. 142

29. Eggleston, J.F., and Kelly, P.J.: *op. cit.*, p. 228

30. Kerr, J.F.: *op. cit.*, p. 67

31. Moodley, T.K.: *op. cit.*, p. 258

32. Kerr, J.F.: *op. cit.*, p. 97

33. The nineteen standard-ten biology teachers made oral comments with regard to the use of pupils' practical record as a source of assessment. These comments were made during the writer's visit to the nine schools and a written record was kept of these comments.

34. Whittaker, R.J.: *op. cit.*, p. 93

35. Lister, R.E.: "Trends in Techniques and Criteria Used in Assessing Student Achievement in Biology Education, in: UNESCO: *New Trends in Biology Education*, *op. cit.*, pp. 144-145

CHAPTER SIX

ANALYSIS OF RESPONSES AS RECORDED BY EXAMINERS TO PRACTICAL CONTROL TESTS

6.1 THE EXAMINERS' REPORT

As the examiners who conducted practical control tests were all experienced biology teachers, their views on practical control tests were clearly of crucial importance in this study. Consequently they were invited by the writer to comment on practical control tests. They recorded their comments on a form which is referred to as the "examiners' report" in this study (Appendix A, p. 360). A number of specific points on which they might like to comment were suggested in this report. (For the administration of the examiners' report, see Appendix A, p. 359). Of the eleven examiners (i.e., excluding the writer) that were appointed to conduct the practical control tests in 1977, 81,82 per cent (nine examiners) of the examiners returned the completed reports. The examiners' report was used to establish:

(i) the views of the examiners on using practical control tests to moderate teacher-awarded marks;

(ii) the feasibility of changing the present function of practical control tests, i.e., from a moderating procedure to an external examination.

6.2 ANALYSIS AND DISCUSSION

The free responses of examiners were not classified into discrete categories because of semantic problems. In this regard, Eggleston and Newbould state that classification of free response of any kind presents difficulties.[1] However, a tentative measure of the strength of the comment was obtained by measuring frequency of the comment. A summary of the examiners' comments under specific headings (related to the points listed in the examiners' reports) together with the frequency of each comment in the form of percentages is presented below in a style that was used by other research workers in a related field of study.[2] A discussion based on these comments will follow this summary.

6.2.1 The Most Important Shortcomings of the Practical Control Tests

(i) The four cognitive levels suggested for use in devising practical control test questions (see pages 61 and 62) were inappropriate for assessment of practical work (66,67 per cent of the examiners).

(ii) No explicit guidance was given in terms of objectives to be assessed (22,22 per cent of the examiners).

(iii) Practical control tests made the pupils nervous (i.e., caused anxiety) (77,78 per cent of the examiners).

(iv) Course work was not comprehensively assessed in the practical control test (66,67 per cent of the examiners).

6.2.2 Difficulties Experienced by Examiners in Devising and Administering Practical Control Tests

(i) It was not possible to limit the questions to the four cognitive levels suggested for use in devising questions (77,78 per cent of the examiners).

(ii) Insufficient time was available to devise suitable questions for the practical control tests (66,67 per cent of the examiners).

(iii) They were not sure of the materials that would be available at schools on which questions could be set (66,67 per cent of the examiners).

(iv) They were not sure of what work was completed at schools in terms of content and abilities that could be assessed (66,67 per cent of the examiners).

(v) Some topics indicated in the syllabus were not assessed because of limited availability of apparatus for individual investigations or because some of the investigations could not be carried out in the time that was available in the test situation (77,78 per cent of the examiners).

(vi) They had to change questions at the school on the morning of the test because certain materials required to answer a question were either not available, inadequate or that section of the work on which the question was based was not done by the pupils (66,67 per cent of the examiners).

(vii) Schools had poor facilities, e.g., insufficiently darkened rooms for projection work, broken screens, etc. (44,44 per cent of the examiners).

(viii) Specimens required for the test were not available at a school and teachers were sent out to collect them. This delayed the starting of the test (55,56 per cent of the examiners).

6.2.3 General Comments by Examiners on Practical Control Tests

(i) Doubts were expressed about the reliability of the practical control tests, i.e., whether the tests devised by different examiners for different schools could possibly get the same results if given to any one set of examinees (55,56 per cent of the examiners).

(ii) Practical control tests do not match the assessment procedures of teachers. Within this context, they felt that the marks allocated to the candidates by examiners may not be the same as those allocated to the same candidates by the teachers (66,67 per cent of the examiners).

6.3 DEDUCTIONS ARISING FROM THE FOREGOING COMMENTS MADE BY EXAMINERS

A common shortcoming of the practical control tests identified by the examiners, was the use of the four cognitive levels (i.e., knowledge, comprehension, application and a combination of analysis and synthesis) in devising these tests. This is consistent with the findings of the writer (p. 66) and is discussed from pages 202 to 207 of this study. From 1978, the practical control test papers are set by the biology inspectors and are administered and marked by the examiners (see page 62 of this study). This present procedure will still be affected by some of the problems that were faced by the examiners in terms of devising test questions, e.g., use of the four cognitive levels; uncertainty of work completed by pupils at schools; etc. This is the drawback of any practical test that is based on the four cognitive levels and is externally set, administered and marked.(3)

Doubts were expressed by the majority of the examiners about the reliability of the practical control tests. This may very well be the case because unequal and non-parallel tests (even those that are devised by biology inspectors at present - see page 62) are used, and marks for these tests are allocated by different examiners at different schools, and their standards of awarding marks may vary. Research evidence indicates that if "like minded" examiners are not selected through agreement trials, even with the use of equal and parallel tests and structured mark schemes, there can be variability in awarding marks to the same candidates by different examiners.(4)

The administration of the practical control tests was hampered by poor facilities and inadequate materials that were available at some schools. The presence of these difficulties, even if it occurred in a few schools, undermines the acceptability of practical control tests not only as a moderating procedure but also as a form of external examination.

Nervousness (anxiety) of pupils featured prominently in the examiners' reports. This is consistent with the views that were expressed by the majority of the standard-ten biology teachers (p. 149). This may have been due to the procedure followed in assessment during the practical control test, i.e., face to face contact between candidates and examiners who were total strangers. This "nervousness of pupils" (anxiety) could be a limiting factor in using practical control tests as a moderating instrument.

The majority of the examiners felt that the marks awarded by the teachers and examiners to the same candidates could differ because the practical control test did not mirror the assessment procedure followed by teachers. That is, the practical control test is a "one-shot" assessment while cumulative assessment is spread over a period of time. This may be true, because at present there is no clear specification of objectives of practical work, criteria in awarding marks, and no clear guidance on the techniques of assessment. The provision of this is not the responsibility of the examining board but that of the Division of Education, Department of Indian Affairs. If adequate guidance is given to the teachers and examiners, then there should be no discrepancy between the teachers and examiners in the standard of awarding marks no matter what procedure was followed by the teacher, i.e., the same criteria will be used in assessing the attainment of the same abilities by both the assessors. Cumulative assessment is regarded as a function of the teacher and the school guided by the Department while the sole function of the examiner during the practical control test is to judge the standard of awarding marks by teachers no matter how the teachers arrived at the marks. That is, the examiner during the practical control test is concerned with the overall standard of awarding marks to the group (i.e., the sample) and not with individuals, which is the concern of the teacher. Therefore the moderating procedure need not match the assessment procedure followed by the teachers because the functions of each differ.

The many problems that the examiners encountered in administering the practical control tests will become compounded if all the Senior Certificate biology candidates were assessed by these examiners in the context of an external practical examination. In summary, it may be stated that these problems and opinions expressed by the examiners undermine the acceptability of the present form of practical control test as a moderating procedure and also its potential as an external examination.

NOTES AND REFERENCES

1. Eggleston, J.F.; and Newbould, C.A.: *op. cit.*, p. 19.
2. Brown, P., Hitchman, P.J., and Yeoman, G.D.: *op. cit.*, pp. 38-43
3. Kelly, P.J., and Lister, R.E.: *op. cit.*, p. 142
4. Brown, P., Hitchman, P.J., and Yeoman, G.D.: *op. cit.*, pp. 24-26

CHAPTER SEVEN

PROCEDURES FOLLOWED IN MODERATING MARKS AWARDED BY TEACHERS FOR PRACTICAL WORK

7.1 GENERAL POSITION WITH REGARD TO MODERATING TEACHER-AWARDED MARKS

The moderation of teacher-awarded marks for practical work is divided into two stages. In the first stage the examiners conduct the practical control tests and allocate marks to candidates who are selected for this test. This first stage of moderation together with the purpose of moderation and the Departmental Regulations with regard to moderation has been discussed in Chapter 3 (pp. 59-65). The second stage involves the use of the practical control test marks in moderating teacher-awarded marks per school in respect of all Senior Certificate biology candidates from that school. This is carried out by the biology inspectors (see page 65 of this study). In this chapter a critical appraisal of the procedure followed by the biology inspectors in moderating teacher-awarded marks will be made. In order to make this appraisal the writer had to collate the following information from the Division of Education, Department of Indian Affairs (see page 346 of this study):

(i) the marks allocated by the teachers and examiners to the samples selected for the practical control tests at each of the fifty-four schools in the Republic (Appendix A, p. 348);

(ii) practical marks indicated on the merit list of each standard-ten biology teacher in the fifty-four schools in the Republic (Appendix A, p. 349);

(iii) the final marks awarded by the biology inspectors (i.e., after moderation) for practical work per Senior Certificate biology candidate at each school (Appendix A, p. 347).

All this information was collated by the writer in January 1978. The writer used this information to analyse the procedure that was followed by the biology inspectors in moderating teacher-awarded marks and these together with other related aspects will be discussed in relevant sections of this chapter.

7.2 ASSUMPTIONS ON WHICH MODERATION OF TEACHER-AWARDED MARKS IS BASED

In the course of moderation the biology inspectors do not change the merit order of pupils indicated by the class teacher even when teacher-awarded marks are adjusted by them. The moderation of teacher-awarded marks without changing the teachers' merit order of pupils is based on the following assumptions:

(i) the teachers are in a better position than any external examination or examiner to put pupils in an order of merit within their own class;

(ii) only an examiner is in a position to compare the standards between schools, i.e., in terms of the national standard.

Some overseas examining boards[1] also moderate teacher-awarded marks based on the above assumptions, which can be justified because:

(i) The teacher builds up a cumulative judgement about the performance of each individual in his class over a period of time and uses this as a basis in placing his pupils in merit order. This spread of observing pupils' performance over a period of time could even out the variation of performance due to extraneous sources. The ranking of the pupils by the teacher is likely to be nearer the "true" merit order (i.e., more reliable) than the ranking by external examiners at one point in time.

(ii) An external examiner who uses a uniform standard (i.e., a common national standard) in assessing pupils is in the best position to judge whether the standard of awarding marks by teachers is in line with the common national standard.

The present procedure of leaving the teacher's merit order unchanged while at the same time ensuring that the marks awarded by the teachers are comparable for all pupils is fair to the Senior Certificate biology candidates.

7.3 AN ANALYSIS OF THE MARKS AWARDED BY TEACHERS, EXAMINERS AND BIOLOGY INSPECTORS AND THE OUTCOMES THAT FLOW THEREFROM

The marks that were collated by the writer from the Division of Education, Department of Indian Affairs, were analysed in order to establish:

(i) if there was a necessity to moderate teacher-awarded marks;

(ii) the pattern followed in moderating teacher-awarded marks;

(iii) if there was a consistency between the teacher and the examiner in awarding marks to the same candidates.

These three aspects will be discussed under specific headings.

7.3.1 Possible Need for Moderation

In order to establish if there is a need for moderation, the marks awarded by examiners in practical control tests in the fifty-four Indian schools in the Republic were compared with the marks allocated by the teachers for the same candidates. This comparison was made to find out if there is a real difference between the examiners and teachers in the standard of awarding marks to the same candidates. If there is a difference, then this will indicate that teacher-awarded marks require moderation. This is based on the assumption that the examiner is awarding marks in terms of the national standard. In order to establish if there is a true difference between the marks awarded by the teachers and examiners, a statistical procedure referred to as a test of significance of differences between means for correlated data is used.[2] The starting point in this statistical test is to state a null hypothesis. The null hypothesis (H_o) in this case is:

There is no difference in the standard of awarding marks between the teachers and examiners.
The significance level (α level) is set at 0,01 level in order to prevent rejecting H_o when in fact it is true (i.e., to prevent type 1 error).[3] The test of significance of differences between means for correlated data involves c-mputing the z score. If the computed z score is greater

than 2,58 the null hypothesis is rejected at the 0,01 level of significance.[4] The reasons for choosing this statistical test are:[5][6]

(i) the samples are large (N = 467 for the Higher Grade and 301 for the Standard Grade);

(ii) the data are correlated because there are two sets of measurements for the same individuals (i.e., marks awarded by the teachers and examiners to the same individuals);

(iii) since the data are correlated the condition of independent sample no longer exists.

In order to compute the z score the means of each set of marks and the standard error of the difference between means must be calculated first. In order to calculate the standard error of the difference between means, the standard error of each mean and the Pearson r (product-moment correlation coefficient) by the use of raw scores must be computed. The computation of these statistics will be discussed in Appendix B, pp. 394-395; 397.

Some of the statistical values used in computing the z score are reflected in Table 7.1. The comparison of the marks awarded by the teachers and examiners together with the z scores are indicated in Table 7.1.

TABLE 7.1: A COMPARISON OF THE STANDARD OF AWARDING MARKS BETWEEN TEACHERS AND EXAMINERS FOR ALL INDIAN SCHOOLS IN THE REPUBLIC OF SOUTH AFRICA

Grades H = Higher S = Standard	Number of candidates	Means ($\bar{x}$), Standard Deviations (SD) and Standard Error of the Means ($S_{\bar{x}}$) (maximum marks - 70 for Higher Grade and 50 for Standard Grade)						Correlation coefficient (r) (Teacher-awarded marks and practical control test marks)		Significance of the difference between means of the teacher-awarded marks and practical control test marks for the same candidates. Null hypothesis: There is no true difference in the standard of awarding marks between the teachers and examiners		
		Marks awarded by examiners in the practical control tests			Teacher-awarded marks for candidates selected for the practical control test					Obtained z scores	Point of rejection: $\lvert z \rvert$ score greater than 2,58	Accept or reject null hypothesis (H_o) at α = 0,01
		$\bar{x}$	SD	$S_{\bar{x}}$	$\bar{x}$	SD	$S_{\bar{x}}$	r	p<			
H	467	31,53	10,65	0,49	35,18	10,36	0,48	0,61	0,01	-8,53	$\lvert z \rvert$ score is above 2,58	Reject H_o
S	301	20,25	6,27	0,36	23,94	6,04	0,35	0,73	0,01	-14,03	$\lvert z \rvert$ score is above 2,58	Reject H_o

According to Table 7.1 the z scores for the Higher Grade and the Standard Grade are -8,53 and-14,03 respectively. Since these $|z|$ scores are greater than 2,58 the null hypothesis for both the grades is rejected at the 1 per cent level of significance. This indicates that there is a significant difference in the standard of awarding marks between the teachers and examiners for both the grades. Therefore the moderation of teacher-awarded marks by the Division of Education, Department of Indian Affairs, is justified.

Further discrepancy in the standard of awarding marks between teachers and examiners is indicated in Table 7.2. This Table indicates the overall position of adjustment or non-adjustment of teacher-awarded marks by the biology inspectors in all Indian schools in the Republic of South Africa (54 Indian schools).

TABLE 7.2: OVERALL POSITION WITH REGARD TO THE ADJUSTMENT OR NON-ADJUSTMENT OF TEACHER-AWARDED MARKS IN INDIAN SCHOOLS IN THE REPUBLIC OF SOUTH AFRICA

SCHOOLS								Range of marks that teacher-awarded marks were adjusted with			
Teachers' marks accepted without adjustment		Teachers' marks adjusted									
		Marks increased		Marks decreased		Marks of some candidates were increased while those of others were decreased		Increased		Decreased	
Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	Higher Grade	Standard Grade	Higher Grade	Standard Grade
12	22,22	10	18,52	27	50,00	5	9,26	1 to 7	1 to 4	1 to 10	1 to 10

According to Table 7.2, teacher-awarded marks at 22,22 per cent of the schools were accepted without adjustment as a component of the Senior Certificate biology examination marks. Teachers at 77,78 per cent of the schools exercised either leniency or severity in awarding marks to pupils and therefore the marks were adjusted. The teachers in the majority of Indian schools are not awarding marks according to the national standard (represented by the examiner) and therefore the teacher-awarded marks among these schools are not comparable. The adjustment marks (i.e., the difference between the marks awarded by the teachers and those that were finally awarded by the biology inspectors) ranged from 1 to 10 for both the Higher Grade and Standard Grade at 77,78 per cent of the schools.

The findings in Table 7,1 and 7.2 suggest that there is a necessity for moderation of teacher-awarded marks for practical work in biology in the Senior Certificate biology examination.

7.3.2 The Pattern that is Followed in Moderating Teacher-Awarded Marks

Tables 7.3, 7.4 and 7.5 were constructed in order to establish:

(i) the criteria used by the biology inspectors in appraising the standard of awarding marks by the teachers;

(ii) the procedure followed in adjusting teacher-awarded marks to ensure uniformity of standards.

Table 7.3 contains information on ten schools that were chosen at random in which the marks awarded by the teachers for either the Standard Grade or Higher Grade were not adjusted by the biology inspectors. Table 7.4 also indicates ten schools that were chosen at random but in which the marks awarded by teachers for either the Standard Grade or Higher Grade were adjusted. Table 7.5 contains information on the adjustment or non-adjustment of individual teacher's marks at five schools. These five schools were selected because:

(i) it was possible to identify individual teachers at these five schools (from the merit list supplied by the teachers to the Division of Education, Department of Indian Affairs) who allocated marks to candidates that were chosen for the practical control tests;

(ii) each of these teachers had at least six candidates chosen for the practical control test and this was the minimum number required to make meaningful statistical comparisons.

Tables 7.3, 7.4 and 7.5 are presented on the pages that follow.

TABLE 7.3: EXAMPLES OF SAMPLE OF TEN SCHOOLS IN WHICH MARKS AWARDED BY TEACHERS WERE ACCEPTED WITHOUT CHANGE

SCHOOLS	GRADES (H = HIGHER, S = STANDARD)	Number of candidates who were selected for the practical control tests.	Means ($\bar{x}$), Standard Deviations (SD) and Standard Error of means ($S_{\bar{x}}$): Teacher-awarded marks for candidates selected for the practical control tests. (b) $\bar{x}$	(b) SD	(b) $S_{\bar{x}}$	Marks awarded by the examiners in the practical control tests. (a) $\bar{x}$	(a) SD	(a) $S_{\bar{x}}$	Teacher-awarded marks for all candidates in that particular grade at a school. $\bar{x}$	SD	$S_{\bar{x}}$	Difference between the means of practical control test marks (a) and teacher-awarded marks (b) for the same candidates, i.e., a-b	Correlation coefficient (rho) (Teacher-awarded marks and practical control test marks for the same candidates) NS = not significant at 0,01 or 0,05 level. rho	p<	The Wilcoxon matched-pairs signed-ranks test is used to establish if there is a significant difference in the overall standard of awarding marks by the teachers and the examiners to the same candidates. Null hypothesis (H_o): the overall standard of awarding marks by the teachers and examiners does not differ. Obtained T values	Table T values at 0,01 level	NS = not significant S = significant	Accept or reject null hypothesis (H_o) at α = 0.01
A	H	9	38,67	8,94	3,38	36,78	10,17	3,84	36,40 (N=52)	7,34	1,03	-1,89	0,55	NS	13,50 (N=8)	0	NS	Accept H_o
B	H	13	31,84	6,99	2,02	32,54	7,81	2,25	32,75 (N=75)	5,75	0,67	0,70	0,62	0,05	26,00 (N=10)	3	NS	Accept H_o
C	S	7	24,00	7,00	2,86	22,00	6,06	2,47	22,55 (N=29)	5,50	1,04	-2,00	0,53	NS	10,00 (N=7)	0	NS	Accept H_o
D	S	8	27,63	6,93	2,62	29,63	6,09	2,30	26,56 (N=41)	6,17	0,98	2,00	0,81	0,05	10,00 (N=8)	0	NS	Accept H_o
E	H	6	38,33	9,1[illegible]	4,09	39,83	7,57	3,39	37,90 (N=10)	7,08	2,36	1,50	0,93	0,05	7,50 (N=6)	0	NS	Accept H_o
F	H	10	44,00	8,50	2,98	41,30	7,70	2,57	43,42 (N=19)	7,06	1,66	-2,70	0,92	0,01	8,50 (N=9)	2	NS	Accept H_o
G	H	14	25,28	8,32	2,31	22,14	9,22	2,56	24,87 (N=87)	6,08	0,66	-3,14	0,58	0,05	24,00 (N=14)	13	NS	Accept H_o
H	S	11	24,73	5,76	1,82	21,36	4,96	1,57	22,40 (N=14)	5,50	1,53	-3,37	0,73	0,01	4,00 (N=11)	5	S	Reject H_o
I	H	18	32,38	12,00	2,91	33,67	12,04	2,92	29,47 (N=88	10,19	1,09	1,29	0,55	0,05	62,00 (N=17)	23	NS	Accept H_o
J	S	10	20,50	3,69	1,23	14,80	6,27	2,09	19,92 (N=29)	2,42	0,46	-5,70	0,47	NS	4,50 (N=10)	3	NS	Accept H_o

TABLE 7.4: EXAMPLES OF SAMPLE OF TEN SCHOOLS IN WHICH MARKS AWARDED BY TEACHERS WERE ADJUSTED

The Wilcoxon matched-pairs signed-ranks test is used to test the following null hypothesis (H_0):

(1) Before adjustment: The overall standard of awarding marks by the teachers and examiners does not differ.

(2) After adjustment: There is no true difference between the adjusted marks (moderated marks) and the practical control test marks.

SCHOOLS	GRADE H = HIGHER S = STANDARD	Number of candidates selected for the practical control tests	Means ($\bar{x}$), Standard Deviations (SD) and Standard Error of means ($S_{\bar{x}}$): Teacher awarded marks for candidates selected for the practical control tests (b)			Marks awarded by the examiners in the practical control tests. (a)			Teacher awarded marks for all candidates in that particular grade at school.			Difference between the means of practical control test marks (a) and teacher-awarded marks (b) for the same candidates i.e. a-b	Correlation coefficient (rho) (Teacher-awarded) marks and practical control test marks for the same candidates). NS = not significant at 0,01 or 0,05 levels.		Difference between means of practical control test marks and adjusted marks for the same candidates.	Marks that were added (+) to or subtracted (-) from the teacher awarded marks for all Higher Grade or Standard Grade candidates at the school.	Before Adjustment: Obtained T values	Before Adjustment: Table T values at 0,01 level	Before Adjustment: NS = not significant S = significant	Before Adjustment: Accept or reject null hypothesis (H_0) at α = 0,01	After Adjustment: Obtained T values at 0,01 level	After Adjustment: Table T values at 0,01 level	After Adjustment: NS = not significant S = significant	After Adjustment: Accept or reject null hypothesis (H_0) at α = 0,01
			$\bar{x}$	SD	$S_{\bar{x}}$	$\bar{x}$	SD	$S_{\bar{x}}$	$\bar{x}$	SD	$S_{\bar{x}}$		rho	p<										
A	H	12	42,67	7,50	2,26	30,33	9,86	2,97	42,77 (N=92)	5,47	1,65	-12,34	0,56	0,05	-4,30	-8	3,00 (N=12)	7	S	Reject H_0	15,50 (N=12)	7	NS	Accept H_0
B	H	13	37,46	10,21	2,95	29,38	12,12	3,50	35,94 (N=63)	6,42	1,85	-8,08	0,66	0,05	-0,08	-8	10,50 (N=13)	10	NS	Accept H_0	22,50 (N=11)	5	NS	Accept H_0
C	H	8	28,38	7,27	2,75	27,38	10,77	4,07	26,94 (N=46)	5,48	2,07	-1,00	0,71	0,05	-3,00	+2	17,00 (N=8)	0	NS	Accept H_0	7,50 (N=7)	0	NS	Accept H_0
D	H	16	44,06	7,67	1,98	28,19	9,37	2,42	44,70 (N=103)	6,50	1,68	-15,87	0,43	0,05	-5,87	-10	1,00 (N=16)	20	S	Reject H_0	14,50 (N=15)	16	S	Reject H_0
E	H	12	27,76	9,19	2,77	29,42	12,41	3,74	28,10 (N=105)	6,46	1,95	1,67	0,79	0,01	-1,33	+3	31,00 (N=12)	7	NS	Accept H_0	26,00 (N=11)	5	NS	Accept H_0
F	S	17	26,41	5,73	1,43	14,12	5,64	1,41	26,31 (N=51)	6,11	1,53	-12,29	0,76	0,01	-6,29	-6	0,00 (N=17)	23	S	Reject H_0	0,00 (N=17)	23	S	Reject H_0
G	H	6	41,17	5,81	2,60	37,33	3,61	1,62	39,50 (N=6)	7,42	3,32	-3,84	0,83	0,05	-1,83	-2	1,00 (N=6)	0	NS	Accept H_0	4,50 (N=6)	0	NS	Accept H_0
H	H	7	33,85	9,37	3,83	36,71	8,20	3,35	33,54 (N=24)	7,34	3,00	2,86	1,00	0,01	0,86	+2	2,00 (N=6)	0	NS	Accept H_0	7,00 (N=7)	0	NS	Accept H_0
I	H	17	35,53	9,33	2,33	30,12	11,97	2,99	35,72 (N=147)	7,01	1,75	-5,41	0,85	0,01	-3,41	-2	16,00 (N=17)	23	S	Reject H_0	27,50 (N=16)	20	S	Reject H_0
J	H	12	34,75	8,51	2,57	29,08	9,89	2,98	34,33 (N=126)	5,41	1,63	-5,67	0,80	0,01	-2,67	-3	0,00 (N=10)	3	S	Reject H_0	22,00 (N=12)	7	NS	Accept H_0

TABLE 7.5: ADJUSTMENT OR NON-ADJUSTMENT OF INDIVIDUAL TEACHERS' MARKS IN A SCHOOL (SAMPLE OF FIVE SCHOOLS)

	GRADES H = HIGHER S = STANDARD	TEACHERS	Number of candidates per teacher that were selected for the practical control test	Means ($\bar{x}$), Standard Deviations (SD) and Standard Error of means ($S_{\bar{x}}$)												Difference between the means of marks awarded by the examiners in the practical control tests (a) for candidates of each teacher and the teacher-awarded marks (b) for the same candidates, i.e., a-b.	Difference between the means of marks awarded by the examiners at each school (c) and the teacher-awarded marks for the same candidates (d), i.e., c-d.	Marks that were added (+) to or subtracted (-) from marks awarded by each teacher at a school.	The Wilcoxon matched-pairs signed-ranks test is used to test the following null hypothesis (H_0): The overall standard of awarding marks by each teacher at a school and the examiner does not differ.			
				Marks awarded by each teacher in a school to Senior Certificate candidates that were selected for the practical control test. (b)			Marks awarded by the examiners in the practical control tests for candidates of each teacher in a school. (a)			Teacher-awarded marks at each school for the candidates that were selected for the practical control test. (d)			Marks awarded by the examiners in the practical control test for candidates at each school. (c)						Obtained T values	Table T values at 0,01 level	NS = not significant S = significant	Accept or reject H_0 at a = 0,01
				$\bar{x}$	SD	$S_{\bar{x}}$	$\bar{x}$	SD	$S_{\bar{x}}$	$\bar{x}$	SD	$S_{\bar{x}}$	$\bar{x}$	SD	$S_{\bar{x}}$							
A	H	1	8	45,12	7,41	2,80	25,50	9,83	3,71	44,06 (N=16)	7,66	1,90	28,19 (N=16)	9,37	2,42	-19,63	-15,87	-10	0,00 (N=8)	0	S	Reject H_0
		2	8	43,00	8,26	3,12	30,87	8,65	3,27							-12,13		-10	0,00 (N=8)	0	S	Reject H_0
B	H	1	6	38,17	9,35	4.18	29,00	13,31	5,95	35,53 (N=17)	9,33	2,33	30,12 (N=17)	11,97	2,99	-9,17	-5,41	-2	0,00 (N=6)	0	S	Reject H_0
		2	8	34,25	9,94	3,76	31,15	12,94	4,89							-3,10		-2	9,50 (N=8)	0	NS	Accept H_0
C	H	1	9	29,11	9,92	3,51	29,44	7,91	2,80	32,38 (N=18)	12,00	2,91	33,67 (N=18)	12,04	2,92	0,33	1,29	Marks not adjusted	15,00 (N=8)	0	NS	Accept H_0
		2	9	35,67	13,69	4,84	37,89	14,33	5,07							2,22			17,50 (N=9)	2	NS	Accept H_0
D	H	1	8	38,37	12,94	4,89	30,75	11,78	5,27	35,07 (N=15)	12,96	3,46	30,60 (N=15)	11,78	3.15	-7,63	-4,47	-5	0,00 (N=8)	0	S	Reject H_0
		2	7	31,29	12,85	5,25	30,43	12,71	5,19							-0,86		-3	10,50 (N=7)	0	NS	Accept H_0
E	H	1	7	34,71	10,08	4,11	32,00	10,58	4,32	35,69 (N=16)	11,24	2,90	28,00 (N=16)	8,48	2,19	-2,71	-7,69	Marks not adjusted	1,50 (N=7)	0	NS	Accept H_0
		2	9	36,44	12,61	4,46	24,80	5,08	1,80							-11,55		-4	2,00 (N=9)	2	S	Reject H_0

The difference between the means of the practical control test marks and teacher-awarded marks for the same candidates (i.e., a-b) were analysed in Tables 7.3, 7.4 and 7.5 in order to establish if any consistent pattern is followed in using these differences between means in moderating teacher-awarded marks. The following results emerged from this analysis:

(i) Although the difference between the means of practical control test marks and teacher-awarded marks ranged from -5,70 to 2,00 in ten schools in Table 7.3, the teacher-awarded marks are accepted without change at these schools. However, the teacher-awarded marks in schools C, E, G, I and J (Table 7.4) are adjusted although the difference between the means of practical control test marks and teacher-awarded marks is within the same range as the schools in Table 7.3.

(ii) In Table 7.4, the differences between the means of practical control test marks and teacher-awarded marks are -1,00 and 2,86 for schools C and H respectively. The marks of all Higher Grade biology candidates are increased by 2 at these two schools. However, the marks of all Higher Grade candidates in school E (Table 7.4) are increased by 3 although the difference between the means of the practical control test marks and teacher-awarded marks is 1,67.

(iii) In Table 7.5 the differences between the means of practical control test marks and teacher-awarded marks for teachers 1 and 2 in school B are -9,17 and -3,10 respectively. The teacher-awarded marks for all candidates (Higher Grade) at this school are reduced by 2. However, the marks in school D (Table 7.5) are reduced by 5 for teacher 1 and by 3 for teacher 2 although the difference between the means is -7,62 and -0,86 for these two teachers respectively. Marks of all Higher Grade candidates in schools A and B (Table 7.5) are reduced by 10 and 2 respectively although the difference between the means of teacher-awarded marks and practical control test marks for the 2 teachers in school A ranged from -19,63 to -12,13 and for the two teachers in school B ranged from -9,17 to -3,10.

The use made of the difference between the mean marks in moderating teacher-awarded marks indicates no discernible consistent pattern. This inconsistent pattern of moderation has led to some unfair marks being awarded to candidates. For example, although the differences between the means of practical control test marks and the teacher-awarded marks are -5,70 and -6,29 for Standard Grade candidates in schools J (Table 7.3) and F (Table 7.4) respectively, the teacher-awarded marks of all Standard Grade candidates in school J remain unchanged; while those of school F are reduced by 6. Since the practical control test marks are used as a standard to judge the standard of awarding marks by teachers, and the mean differences are very similar at both these schools (i.e., -5,70 and -6,29) the marks at both these schools ought to have been left unchanged or adjusted by the same number of marks. The pupils in school F are being treated unfairly in the final marks that are awarded to them when compared with the final marks that are awarded to pupils in school J. Similar examples are indicated in points (i), (ii) and (iii) above. At some schools, there are discrepancies in the marks awarded to candidates in the same school (see Table 7.5). For example, in school A (Table 7.5) although teacher 1 is according to the practical test marks, more lenient than teacher 2 (the mean mark of teacher 1 is 45,13 compared with 25,50 for the practical control test; the mean mark of teacher 2 is 43,00 compared with 30,87 in the practical control test) in awarding marks to his pupils, the marks awarded by both these teachers (Higher Grade) in this school are reduced by 10. To be fair to candidates of teacher 2, their marks should have been reduced by a smaller amount than those of candidates of teacher 1 (whose standard of awarding marks was lenient).

This inconsistent pattern followed in appraising the standard of teacher-awarded marks by the use of the mean difference (of the practical control test marks and the teacher-awarded marks) and in adjusting teacher-awarded marks indicates that the final marks that are allocated for practical work (i.e., after moderation) are:

(a) not fair to all candidates;
(b) not of comparable standard for all candidates.

The moderation of teacher-awarded marks lacks validity (validity is used here to refer to whether the practical control test is doing what it is supposed to do, i.e., to ensure that the overall standard of awarding marks for practical work by teachers is fair and comparable for all candidates) and the final marks awarded lacks reliability (marks awarded are not consistent).

The purpose of moderation is to bring the standard of awarding marks of teachers into line with the standard of awarding marks by examiners (i.e., they are expected to represent the national standard). If there is no difference in the standard of awarding marks between the teachers and examiners at a school, then the marks of these teachers ought to have been accepted without change. The Wilcoxon's matched-pairs signed-ranks test is used to establish if there is a significant difference in the overall standard of awarding marks by the teachers and examiners to the same candidates. The results of this statistical test is indicated in Tables 7.3, 7.4 and 7.5. This nonparametric statistical test is chosen instead of the "t-test" because sample sizes as small as six are used in these tables. With such sample sizes violations of parametric assumptions are most devastating; hence in these cases nonparametric tests are most appropriate.[7][8][9]

The reasons for using the Wilcoxon's matched-pairs signed-ranks test of significance[10] for the data given in Tables 7.3, 7.4 and 7.5 are:

(i) The data are difference scores from two related samples (teacher-awarded marks and examiner-awarded marks given to the same individuals) and each subject is used as his own control.

(ii) The difference scores can be ranked in order of absolute magnitude.

In terms of power efficiency (i.e., amount in the increase in sample size which is necessary to make the Wilcoxon's matched-pairs signed-ranks test as powerful as the parametric t-test), when the assumptions of the parametric t-test are met, the asymptotic efficiency near H_0 of the Wilcoxon's matched-pairs signed-ranks test when compared with the t-test for small samples is near 95 per cent.(11) This means that to retain equivalent power to reject H_0 we need to draw 10 cases for the Wilcoxon's matched-pairs signed-ranks test for every 9,5 cases drawn for the t-test.(12) The Wilcoxon's matched-pairs signed-ranks test will be only neglibibly less efficient than the t-test in terms of the samples that are used in Tables 7.3, 7.4 and 7.5. The Wilcoxon's matched-pairs signed-ranks test is also an appropriate and powerful nonparametric test to use in terms of establishing if there is a significant difference in the standard of awarding marks between the examiners and the teachers because it takes into account the magnitude as well as the directions of the differences between the two sets of marks per individual.(13)

The rejection of the null hypothesis is set at 0,01 level of significance (α = 0,01). This level of significance was chosen in order to prevent rejecting H_0 when in fact it is true (i.e., to prevent type 1 error). The smaller the alpha (α) the less likely that H_0 will be rejected when in fact it is true.(14) If the T value (i.e., the smaller of the sums of the like-signed ranks) produced by the Wilcoxon test is equal to or less than the significance level, then the value is significant and the null hypothesis (H_0) is rejected and instead the research hypothesis (H_1) is accepted. T values are read off from a table which gives Critical values of T for different significance levels for $N \leq 25$.(15) N is the number of pairs minus any pairs whose d (difference between two sets of scores) is zero.[16] The computation and application of this statistic is fully explained in Appendix B,(pp. 395-397).

According to Table 7.3, the null hypothesis (i.e., the overall standard of awarding marks by the teachers and examiners does not differ) was accepted for nine out of the ten schools (the marks at these ten schools were not adjusted). In the remaining school (i.e., school H, Table 7.3) where the null hypothesis was rejected at the 0,01 level (i.e., acceptance of research hypothesis - there is a significant difference in the standard of awarding marks between the teachers and examiners) the teacher-awarded marks are also accepted without change.

According to Table 7.4, the marks of teachers in schools B, C, E, G and H are adjusted although the null hypothesis is accepted (i.e., the standard of awarding marks by the teachers and examiners does not differ). According to Table 7.5, there is a difference in the standard of awarding marks between teachers at the same school. For example, the null hypothesis is accepted for teacher 2 in school B but not for teacher 1 in the same school. In spite of this difference in the standard of awarding marks between teachers in school B, the marks awarded by teachers 1 and 2 are reduced by 2. In school D (Table 7.5) the null hypothesis is accepted for teacher 2 and rejected for teacher 1. In this case the marks of teacher 2 are reduced by 3 and the marks of teacher 1 are reduced by 5. Generally, these statistical findings indicate an inconsistent pattern in the adjustment of teacher-awarded marks between schools.

After the adjustment of marks, there should be no significant difference between the adjusted marks and the practical control test marks. This assertion is in line with the purpose of moderation, i.e., to bring the teacher-awarded marks into line with the examiner's marks. According to Table 7.4, even after adjustment the null hypothesis (i.e., there is no true difference between the adjusted marks and the practical control test) is rejected for schools D, F and I. This indicates that the procedure followed in adjusting marks in these three schools is not consistent with that followed in the remaining seven schools where the null hypothesis is accepted after adjusting the teacher-awarded marks. These findings further substantiate the statement that no discernibly consistent pattern is followed in judging the standard of awarding marks by teachers and in adjusting the teacher-awarded marks in ensuring uniformity of standards.

7.3.3 Consistency of Marks Awarded to the Same Pupils by the Teacher and Examiner

A major requirement of any assessment is that it should be reliable, i.e., produce results which are consistent.[17] Within the context of the present form of assessment of practical work, it is too much to hope that the marks awarded independently by the teacher and the examiner to the same pupils to be similar. If similar rank orders of pupils are produced by the marks awarded independently by the teachers and the examiners for the same set of candidates then this will indicate that both the assessors are consistent in awarding marks. If they are consistent then this will suggest that similar qualities were assessed by the teacher and the examiner. This assumption is made because if similar qualities were assessed by both the assessors then each candidate would have performed equally well or badly in the teacher assessment and in the practical control test. The pupils, therefore, would have been accorded similar ranks by the teacher and the examiner. This interpretation is along lines of other research workers in related fields of study.[18]

The correlation between the marks awarded to the same candidates by both the assessors will provide a measure of reliability of the marks[19] which is referred to as the inter-marker reliability (i.e., whether the marks awarded by the examiner and the teacher were consistent).[20] The statistical procedure that could be used to compute this inter-marker reliability for small samples ($N < 30$) and where the data could be easily ranked is the

Spearman rank correlation coefficient (rho) and the value (i.e., the rho value) is interpreted in the same way as the Pearson "r" value (produced by the product moment correlation).[21][22] The Spearman rank correlation coefficient indicates the degree of association between two sets of rankings. If the relation between the two sets of ranks is perfect, every difference between the two ranks would be zero and the rho value will equal to +1,00. The larger the differences between the two sets of ranks, the less perfect the association between the two ranks. The value of rho falls between +1,00 (a perfect positive relationship) and -1,00 (a perfect negative relationship). For N from 4 to 30 (i.e., N is equal to the number of pairs of marks or ranks), the critical value table gives the rho coefficients significant at the 0,05 and 0,01 levels.[23] The computation and interpretation of the Spearman rank correlation coefficient (rho) is discussed in Appendix B, (pp. 398-403). Guilford and Fruchter[24] state that the rho is almost as reliable as a Pearson r of the same size from a sample of the same size. Consequently, rho is almost as good an estimation of correlation as the Pearson r.[25]

Research workers in the United Kingdom[26][27][28] found inter-marker reliabilities for practical work to be between 0,32 to 0,70 ($p < 0{,}01$). The Secondary School Examinations Council (which is now the Schools Council) stipulates an inter-marker reliability (i.e., between teachers and moderators) exceeding 0,60 as acceptable for practical work.[29] The results obtained in Tables 7.3 and 7.4 for twenty individual schools chosen at random in the Republic of South Africa indicate that inter-marker reliabilities (i.e., between the teacher and examiner) exceeding 0,60 for practical work can be attained in practice in the majority of these schools. The results obtained in Table 7.1 for all fifty-four Indian schools in the Republic of South Africa (i.e., combined marks for these fifty-four schools) indicate inter-marker reliabilities (i.e., between the teacher and examiner) of 0,61 ($p < 0{,}01$) and 0,73 ($p < 0{,}01$) for the Higher Grade and Standard Grade respectively. According to Tables 7.3 and 7.4 the reliability coefficients (rho) which are significant at either 0,01 or 0,05 levels, ranged from 0,43 to 1,00. This range of rho values must be interpreted with caution especially when comparing it with findings by other research workers in related fields of study in the United Kingdom because the sample sizes in the present study for individual schools are small (N ranged from 6 to 18). Within this context, it could be stated that the rho values shown in Tables 7.3 and 7.4 (those that were significant at the 0,01 or 0,05 levels) compare favourably with reliability coefficients obtained for practical work by research workers in the United Kingdom.

The relationship between marks awarded by the teachers and examiners were obtained under difficult conditions, viz., absence of clearly stated objectives, absence of criteria for awarding marks, absence of guidance to teachers on techniques of assessment and without the use of equal and parallel tests by the teachers and examiners. These factors could have prevented the agreement between the teacher and examiner being better at some schools. The overall conclusion that can be drawn is that even within limitations, the correlation coefficient between teacher awarded-marks and practical control test marks in the majority of the schools in the sample is relatively high. This suggests that the teachers and examiners in the majority of these schools are looking at the same qualities. However, this does not mean that since the teachers and examiners are consistent in awarding marks (i.e., awarding similar ranks to pupils), that their standards of awarding marks (in terms of leniency and severity) are also the same. For example, in school I (Table 7.4) the rho value is 0,85 ($p < 0,01$), which is relatively a high correlation, and this indicates that the teacher and the examiner were generally consistent in awarding marks. However, the null hypothesis (i.e., the overall standard of awarding marks by the teachers and examiners does not differ) is rejected at the 0,01 level of significance and this indicates that the standard of awarding marks between the teacher and the examiner differs at this school.

The rho values in Tables 7.3 and 7.4 suggests that the consistency of awarding marks (which will influence the ranking of pupils) by the examiners and teachers varied between schools. For example, according to Table 7.4, schools A and J where the same number of pupils is involved, the rho values for marks awarded by the teachers and examiners are 0,56 ($p < 0{,}01$) and 0,80 ($p < 0{,}01$) respectively. This suggests that the examiners and the teachers in school A while testing some qualities in common are also substantially testing dissimilar qualities. The correlation coefficient of 0,80 ($p < 0{,}01$) in school J suggests that in different ways roughly the same sort of qualities are assessed by the examiners and teachers. In school H (Table 7.4) the correlation coefficient between teacher-awarded marks and practical control test marks is 1,00 ($p < 0{,}01$). This is a perfect positive relationship between the two sets of marks. This suggests that the teachers and examiners in school H are in complete agreement in ranking the same candidates (i.e., the teachers and examiners are highly consistent in awarding marks to the same candidates). This implies that the qualities assessed by the teachers and examiners are very similar in school H.

There may be many reasons for the variation of consistency of awarding marks by the examiners and teachers between schools. For example, the qualities assessed by the examiners could have varied from school to school or the qualities assessed by the teachers could have varied between schools. The available evidence does not make it possible to decide on a particular reason for this variation.

7.4 DEDUCTIONS ARISING FROM THE FOREGOING DISCUSSION

The statistical analysis of marks collated by the writer from the Division of Education, Department of Indian Affairs, indicates the following:

(i) there is a significant difference in the standard of awarding marks between the teachers and examiners and therefore there is need for moderation of teacher-awarded marks;

(ii) there is discrepancy among teachers in the same school in the overall standard of awarding marks for practical work;

(iii) the qualities (outcomes of practical work) assessed by the examiners and teachers varies between schools;

(iv) there are no specific criteria or statistical measures used in appraising the standard of awarding marks by teachers and this has led to many inconsistencies;

(v) there is no consistent pattern that is followed in adjusting teacher-awarded marks to ensure uniformity of standards.

There may be many reasons for the above inconsistencies. For example, the lack of objectives for practical work; use of unequal and non-parallel tests by examiners; not using "like-minded" examiners; not using specific criteria or statistical measures in appraising the standard of awarding marks by teachers; not using statistical measures in adjusting teacher-awarded marks to bring about uniformity of standards. These aspects will be discussed in relevant sections of this study in the form of suggestions. While it is interesting to speculate on all the possibilities mentioned one deduction seems clear: the practical marks that are awarded to Senior Certificate biology candidates by the Division of Education, Department of Indian Affairs, after moderation, are not fair and comparable for all candidates.

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CHAPTER EIGHT

SUGGESTED SCHEME OF OBJECTIVES AND A TWO-DIMENSIONAL GRID FOR PRACTICAL WORK IN BIOLOGY AT THE SENIOR SECONDARY LEVEL

8.1 OPERATIONAL DIVISIONS AND OBJECTIVES

A list of outcomes of practical work that could be attained by pupils through current practical work is given in Chapter 4 (pp. 113-114). This list was developed as a result of analysing the literature, syllabuses and responses and comments made by the members of the Biology Subject Committee, senior biology teachers (at the Convention), biology inspectors, examiners (who conducted practical control tests) and the standard-ten biology teachers. This list of outcomes will be used as a basis for formulating a suggested scheme of objectives for practical work in biology at the senior secondary level. The objectives will reflect the abilities and attitudes that pupils will exhibit while doing practical work at schools. A two-dimensional-grid, with appropriate weightings, will also be proposed in this chapter.

Since the test items pin-point the task the pupil is expected to perform and the specific behaviour he is expected to exhibit, wherever possible, each objective will be clarified by an appropriate test item.

In order to develop a well-organised scheme, the objectives are contained within the operational divisions from which they were originally derived (see Chapter 4 - pp. 105-111). Operational division D which was stated as the "ability to interpret observations and to make appropriate deductions and inferences in Chapter 4 (p. 114) was replaced by the "ability to handle results" in this scheme of objectives. "Handling of results" was considered to be more appropriate because the activities listed under this division are related to using information provided by observation or results of practical investigations. Operational division A was also changed from "knowledge of techniques, processes and materials" (see Chapter 4 - p. 113) to "knowledge of techniques, materials, specifics and classification". This change was made so that all the activities that pupils display in practical work under this operational division could be incorporated.

Against this background, all the objectives listed under each operational division are important behaviours to be developed by pupils through practical work. All the objectives listed under operational divisions 8.1.1 to 8.1.4 could be assessed by the teacher and moderated by the examiner in the context of the Senior Certificate Examination. However, only those objectives under operational division 8.1.5 (i.e., attitudes) that could be moderated externally (i.e., following safety regulations; careful and economic use of materials; leaving the work place neat and tidy) should be assessed by teachers in the context of the Senior Certificate Examination. This has been discussed from pages 111 to 113 of this study.

The proposed scheme of objectives, each clarified by an appropriate test item, is indicated below under specific operational divisions.

8.1.1 Knowledge of Techniques, Materials, Specifics and Classification that are Basic to Practical Work

Under this operational division the objectives are indicated by Roman numerals.

Specification:

The pupil should be able to:

(i) Identify apparatus and chemicals at reasonable speed by pointing out or naming and/or describing their purpose in terms of use. This objective is represented by the following examples of test items:

(a) What is this substance? (mercury)

(b) Which of these substances is iodine?

(c) What apparatus is this? (Potometer)

(d) Which piece of apparatus would you use to measure out quickly a 70 cm^3 of a solution ? (measuring cylinder)

(ii) identify specimens and models or parts of them at reasonable speed (by pointing out or naming) and/or stating the function(s) of the parts. This objective is represented by the following examples of test items:

(a) Name this organ in this specimen. (bladder in a rat)

(b) Point out the organ where urea is produced in this organism. (liver)

(c) Name the function of this part of the eye. (iris in the model of the eye)

(d) What is this structure and state its function? (sebacious gland in the V/S of skin of a mammal)

(iii) describe various laboratory techniques (including procedures), that are basic to practical work. The following test items illustrate this objective:

(a) I have materials here to prepare a slide of a blood smear. I want you to describe step by step how you would prepare this slide.

(b) I have materials here to set up an experiment to demonstrate transpiration pull. I want you to describe step by step how you will set up this experiment.

(iv) recall terms, facts, concepts, principles, processes, shapes, symmetries, developmental stages, properties and relationships, that are specific to biology. The following test items illustrate this objective:

(a) Which generation of the life cycle of a plant does this specimen on the slide represent? (gametophyte of the moss)

(b) What term will you use to indicate this process in the beaker? (diffusion: drop of ink in water)

(c) What is the symmetry of this organism? (bilateral symmetry of Planaria)

(d) What type of symbiotic relationship is formed between these two organisms? (parasitic)

(v) classify organisms that are basic to the course. Knowledge of classification of organisms are illustrated in the following test items:

(a) To which class of animal does this organism belong? (earthworm)

(b) To what plant division does this plant belong? (fern)

8.1.2 Ability in the Skill of Using Techniques and Materials which are Basic to Practical Work

This operational division deals mostly with the pupils' efficiency or inefficiency in the mastery of specific manipulative skills. The skills in the form of objectives are indicated by Roman numerals.

Specification:

The pupils should be able to:

(i) select apparatus and materials to carry out a specified task. The following test items illustrate this objective:

(a) I want to investigate whether this leaf contains starch. From the materials that have been provided on the side bench, select those that you will use to carry out this task. Remove the materials that you have selected to your working area.

(b) I want to set up an experiment to demonstrate osmosis. Which of these materials should I use?

(ii) set up apparatus and other materials, systematically with reasonable speed and accuracy.
The following test items illustrate this skill:

(a) Set up an experiment to demonstrate osmosis, with the materials that you have selected for this purpose.

(b) Use the material that you have selected, to investigate whether this leaf contains starch.

(iii) use correctly various laboratory techniques which are basic to the course.

The following test items illustrate this objective:

(a) Cut a transverse section of the stem that is provided. Stain this section with iodine and then prepare a wet mount of this section.

(b) From the materials that are provided, prepare a slide of a human blood smear. Use the microscope and by means of the pointer indicate a leucocyte in your blood smear preparation.

The activities that one will look for under this ability (specific objective) will differ from task to task. For example, preparing a wet mount of the transverse section of a stem may include:

1. Positioning of stem in hand while sectioning.
2. Section cut (whether thin and useful).
3. Using the correct amount of iodine.
4. Placing the mountant first and then the section.
5. Lowering the coverslip without trapping air bubbles.

For the preparation of a slide of human blood smear and locating a leucocyte, the following activities may be taken into account:

<u>Preparation of a slide of blood smear</u>

1. Cleaning of the slides.
2. Cleaning and sterilizing the finger.
3. Quality of the smear (a thin spread).
4. Staining (correct stain used).
5. Drying and removing excess stain.

<u>Preparation and use of microscope</u>

1. Correct placing of the microscope on the work table (lamp or mirror on the opposite side to the person viewing it).
2. Selection of the correct lens to start with.
3. Correct light setting (using mirror and/or lamp correctly).

4. Correct diaphragm setting.
5. Correct condenser setting.
6. Orientation of slide on the stage and selection of the clearest spot on the slide.
7. Correct focussing: fine and coarse.
8. Correct use of the pointer.

(iv) detect and/or rectify error(s) in an experimental set up. This objective is represented by the following examples of test items:

(a) The mercury level in this experiment did not rise since it was set up four hours ago. Locate the error and rectify the mistake. (transpiration pull experiment)

(b) The air bubble in the capillary tube has not moved since this experiment was set up four hours ago. Identify the error and rectify the mistake. (rate of transpiration)

(v) explain the implications of the techniques, procedure, materials, etc., used in a specific investigation. This objective is illustrated by the following examples of test items:

(a) Why were the radicles made to face different directions in this experiment? (experiment on geotropism)

(b) Why were the two clinostats placed in the dark cupboard in this experiment? (experiment on geotropism)

8.1.3 Ability to Make Appropriate Observations and Accurate Recording of Observations

Observations are normally communicated either orally or in a written form. Therefore, observation and recording could not be separated. Under this operational division the objectives are indicated by Roman numerals.

Specifications:

The pupil should be able to:

(i) record microscopic and macroscopic observations appropriately (neatly, accurately and with a sense of proportion) in the form of a diagram(s) at a reasonable speed and to label it neatly, methodically and correctly.

This objective is represented by the following examples of test items:

(a) Draw a labelled diagram of the material in this slide as seen under the high power of the microscope. (antheridium of fern)

(b) Make a floral diagram of the flower provided.

(c) Make a labelled diagram to indicate the placentation in the ovary which is under the dissecting microscope.

(ii) record microscopic and macroscopic observations appropriately (with accuracy, comprehensiveness and discrimination) in the form of words or describe orally these observations.

This objective is represented by the following examples of test items:

(a) Observe the wet mount of epidermal cells under the microscope. Add a drop of solution A on one side of a cover glass and draw it under the cover glass with the help of filter paper. While doing so, observe what happens under the coverslip. Write down in words what occurs. (Plasmolysis)

(b) I am going to drop this substance into this beaker of water. Tell me all those things that you see happening after this substance is dropped into the beaker. (Diffusion of potassium permanganate)

(c) Describe orally the androecium of this flower in technical terms.

(iii) record observation correctly in the form of tables, illustrations, sketches and floral formulae.

The following test items illustrate this objective:

(a) In the potometer experiment observe the movement of the air bubble from point A to B. Obtain 3 readings at each temperature (i.e., at 25°C, 35°C and 45°C). Record your observation in the form of a table.

(b) From your observation of this terrarium illustrate a food web involving any four organisms in this ecosystem.

(c) From your observation of the T.S. of the stem, sketch an outline plan of the various tissue types found in this stem.

(d) From your observation of specimen A (flower) write down its floral formula.

8.1.4 Ability to Handle Results

This operational division involves activities that follow an observation or result. These activities include explanations, interpretations, inferring, predicting, deducing and responding to problem questions which follow practical work. The objectives are indicated by Roman numerals.

Specification:

The pupil should be able to:

(i) Explain from observation (in clear, precise and unambiguous biological terms) concepts, processes, changes, properties, classifications (reasons for classifying an organism into a particular group), relationships (between parts of an organism and between organisms), similarities and differences, in their own words.

The following test items illustrate this objective:

(a) From your observation of this terrarium and using suitable examples from it explain the concept of an ecosystem. (concept)

(b) Explain what you have just observed in terms of diffusion. (process - potassium permanganate in water)

(c) Explain the changes that occurred to the epidermal cell after solution "A" was drawn under the cover glass. (changes - plasmolysis)

(d) Explain the property that this membrane must possess in terms of the result obtained in this experiment. (property - osmosis)

(e) From your observation of this flower, explain why you classified it into a monocotyledonous or a dicotyledonous group. (classification with reasons)

(f) Explain the symbiotic relationship that exists between plants A and B. (relationship - parasitic)

(g) Explain how plant C is different from D. (structural differences)

(ii) interpret accurately observation or result.
The following test items illustrate this objective:

(a) Interpret data in the table that you constructed with regard to the relationship between the movement of air bubble and temperature.

(b) Interpret the result you obtained in this experiment. (translocation of food in leaves)

(iii) make appropriate inferences from observation or result. The following test items illustrate this objective:

(a) How is this plant adapted to grow in a very dry environment? (inferring adaptation to habitat from observation of structure)

(b) Examine specimens "F" and "G" and infer which organism shows the greatest specialisation to live in water. (inferring adaptation to habitat from observation of structure)

(c) Examine the V/S of the mammalian heart. Infer how the thickness of the walls of the atria and ventricles are related to the functioning of these chambers. (inferring function from structure)

(iv) predict appropriately on the probable effect of a change in a factor on the present observation which is at equilibrium.

This objective is represented by the following test items:

(a) From your observation of this closed balanced aquarium predict what would happen if the number of these snails was to be trebled.

(b) Predict what would happen if you used erythrocytes instead of plant cells in this investigation on plasmolysis.

(v) make appropriate deductions (arrive at conclusions) from the observed data.

This objective is represented by the following test items:

(a) What deduction could you make from the results that you obtained in the experiment on trans= location of food in leaves?

(b) What deduction could you make from the results that you obtained in this investigation with regard to the relationship between temperature and the rate of transpiration?

(vi) answer accurately problem questions based on the present observation of an investigation.

The following test items illustrate this objective:

(a) Suggest a way of increasing the humidity around the leaves of this twig. What effect will this (increasing the humidity) have on the result of this experiment? (transpiration pull)

(b) In what way would a smaller number of leaves on this twig affect the result of this experiment? (red ink experiment to show path of water up the stem)

(vii) answer accurately problem questions based on broader theory or principle (covered in the course) which is related to the present observation, explanation and deduction.

This objective is represented by the following test items:

(a) Explain three ways in which this process of osmosis is biologically important in plants.

(b) If saliva was extracted from a locust and placed in a test tube with starch solution to establish its effect on starch, will you follow the same procedure as you did in this experiment (when you tested the reaction of salivary amylase on starch)? Why?

8.1.5 Showing Desirable Attitudes to Practical Work

This operational division indicates the appropriate attitudes that pupils should develop to practical work. The different objectives listed under attitudes are clarified with activities that could be observed over a period of time. The objectives are indicated by Roman numerals under specific sub-operational divisions.

Specification:

The pupil should be able to:

8.1.5.1 Sub-operational Division - Persistence

(i) show determination to pursue his work through to a successful conclusion. (attitude displayed is persistence)

The following activities illustrate this objective:

(a) Unwilling to give up if initial attempts are unsuccessful in investigations or setting up experiments.

(b) Willing to try again with a suitably modified technique or changed procedure where initial attempts had failed.

(c) Accepting that practical work should not be rushed through for the sake of completion and therefore making sure that it is successfully completed.

8.1.5.2 Sub-operational Division - Resourcefulness

(i) improvise apparatus, search out relevant information and seek advice when necessary. (attitude displayed is resourcefulness)

The following activities illustrate this objective:

(a) Substitutes and uses apparatus such as tumblers and jam jars as beakers or bell jars, and straws for pipettes, instead of relying only on a standard apparatus (i.e., improvises).

(b) Seeks advice and information from various sources with regard to unfamiliar investigations. For example, some of the sources of advice and information can be their teachers, health inspectors, tertiary institutions, museums and libraries.

8.1.5.3 Sub-operational Division - Co-operation

(i) follow safety regulations in the laboratory. (attitude displayed is co-operation)

The following activities illustrate this objective:

(a) Willingly complies with safety regulations and would observe them even if he were not under supervision. For example, facing the opening of a heated test tube with its contents away from himself and his colleagues; heating alcohol in a container placed in a water bath and not directly on an open flame; avoids tasting or inhaling any material that is given or is in the laboratory unless asked to do so by the teacher.

(ii) use economically and with care materials in the laboratory. (attitude displayed is co-operation).

The following activities illustrate this objective:

(a) The specimens that are provided for investigation are handled with care and are not damaged.

(b) Chemical(s) are not spilt or used in large quantities when small quantities would have been appropriate and effective.

(c) Glassware and microscopes are handled with care so that they are not damaged.

(iii) keep his work place neat and tidy. (attitude displayed is co-operation)

The following activities illustrate this objective:

(a) While setting up experiments or working on set exercises in the laboratory, the working area is not cluttered with unnecessary materials and all wastes are put into appropriate disposals.

(b) Any spillage is cleaned and the working area is kept neat and tidy during and at the end of practicals.

(iv) work willingly with peers in a group. (attitude displayed is co-operation)

The following activities illustrate this objective:

(a) Is willing to do his share of work as a member of a team in group practical work without hindering the work of others in the group.

(b) Shows respect and is tolerant of other people's ideas.

(v) collect and bring in material for investigatory work when asked to do so. (attitude displayed is co-operation)

The following activity illustrates this objective:

(a) Willingly (without the fear of being punished), collects and brings in specimens provided that it is within reach and sufficient time is given.

8.1.5.4 Sub-operational Division - Enthusiasm

(i) show initiative, provide new ideas and make suggestions for new and further investigations (attitude displayed is enthusiasm)

The following activities illustrate this objective:

(a) Needs only a hint to get started with investigations.

(b) Willingly carries out investigations without much supervision from the teacher.

(c) Makes suggestions for new or further investigations without any prompting.

(d) Proposes new ideas and shows originality during discussion and in investigatory work.

8.1.5.5 Sub-operational Division - Sensitivity

(i) show willingness to handle living things with care and to take proper care of living things. (attitude displayed is sensitivity)

The following activities illustrate this objective:

(a) Uses a net to scoop out fish or a tadpole from the aquarium and handles it in such a way that no discomfort is caused to the organisms. These organisms are not also kept out of water for too long.

(b) Willingly and regularly feeds the animals that are caged, and cleans the cage regularly.

(c) Waters the potted plants regularly.

8.1.5.6 Sub-operational Division - Tolerance of Varying Views

(i) accept or reject views and conclusions only with valid reasons.

The following activities illustrate this objective:

(a) As a member of a group, the pupil does not accept unsubstantiated interpretations of or deductions from investigations, as expressed by members of the group.

(b) As a member of a group, the pupil does not reject substantiated interpretations of or deductions from investigations, as expressed by members of a group.

8.1.5.7 Sub-operational Division - Fairmindedness

(i) suspend judgement in the absence of proper evidence.

The following activity illustrates this objective:

(a) In an experiment or investigation, the pupil will not make a deduction or an inference until sufficient data on it is collected or is presented.

(ii) make honest and objective observations and recording of biological data.

The following activity illustrates this objective:

(a) If results of an experiment do not give the expected result, then the pupil will record what was observed. In this respect, pupils will willingly record or report accurately what one observes in a practical investigation and not what one is supposed to observe.

(iii) show willingness to consider new interpretations of biological data.

The following activity illustrates this objective:

(a) Shows flexibility by being willing to consider or to change one's view about a particular problem in practical work in the light of new interpretation or evidence.

It is clear from the above suggested scheme of objectives for practical work in biology and the examples of test items or activities, that there is a close connection between the statement of an objective and the plan for measuring attainment of that objective.

The suggested scheme of objectives includes all the more important activities which are relevant to practical work in biology in the senior secondary level. Each objective in this scheme is not an entity on its own but through interdependence they ought to achieve the overall purpose of practical work in biology. Each objective should not be isolated for development and for assessment but must be seen as being valid only in the context of an investigation by pupils. For example, the ability to prepare a slide of the transverse section of a stem must not be seen in isolation but in relation to an investigation on the distribution of chloroplasts and starch grains in the section of a stem.

It is appreciated that this suggested scheme of objectives has an initial appearance of complexity which could daunt teachers and examiners who might be concerned with its operation. It is suggested that with use, this detailed specification would be found to be both practicable and more worthwhile in terms of guidance than schemes which have an outwardly less complex appearance.

8.2 DISCUSSION ON THE OPERATIONAL DIVISIONS AND OBJECTIVES SUGGESTED FOR PRACTICAL WORK

In view of the interest shown by various authors[(1)(2)(3)(4)(5)(6)] in using the taxonomy of educational objectives (or a modified scheme of it) devised by Bloom and his colleagues[(7)] for the cognitive domain, Krathwohl[(8)] for the affective domain, and Harrow[(9)] for the psychomotor domain, to develop objectives in the various subjects, it is worthwhile at this stage to outline the relation of the suggested scheme of objectives of practical work in biology in this study to the above= mentioned schemes of classification.

The objective to be achieved through practical work shows some relation to categories of objectives developed for the three domains. For example, all the objectives listed under operational division 8.1.1 (i.e., knowledge of techniques, materials, specifics and classification) in this study cover several aspects of the category "Knowledge" in Bloom's Taxonomy.[(10)] All the objectives listed under operational division 8.1.2 (i.e., ability in the skill of using techniques and materials) and 8.1.3 (i.e., observation and recording) fit into the psychomotor domain because it involves practical skills of manipulation, observation and recording. Harrow[(11)] quite independently of Bloom and Krathwohl published a handbook on the psychomotor domain. Harrow's scheme though useful as a framework for vocational training and physical education could not be applied to practical work in biology. It incorporates a developmental approach and is specifically designed for vocational training and physical education. In the absence of clear categories of the psychomotor domain into which practical work in biology could be fitted it will suffice to place objectives that deal with practical skills under the psychomotor domain without categorising them any further.

A simple "recall" of knowledge, operational division 8.1.1, may involve a variety of modes of thought, such as "pure" recall, selection from alternatives, selecting the best technique from a number of possibilities or understanding relationships, e.g., matching a function to a particular structure.[12] The operational division 8.1.2 involves the "doing part" (i.e., selecting materials and carrying out manipulative skills). Firstly it may involve selecting appropriate materials from those that are provided to carry out a specified task. If the materials and task are "familiar" then this objective will fit into the "Knowledge" category of Bloom because it involves a simple recall of knowledge. If the material or task is "unfamiliar" then this objective will fit into the "Application" category of Bloom.[13] Secondly this operational division (i.e. 8.1.2) involves using the materials chosen in carrying out a familiar task (psychomotor domain). Thirdly it involves the ability to explain the implications of the procedure and materials used in investigations ("Comprehension" in Bloom's Taxonomy).[14] Therefore operational division 8.1.2 involves a number of processes in carrying out a task. In the cognitive domain it involves the categories of "Knowledge" and "Comprehension". It is also difficult to separate the affective and cognitive from the psychomotor domain. Although the focal ability for this operational division 8.1.2 is the "ability to use techniques and materials", it also involves recall of knowledge and of techniques ("Knowledge" in the cognitive domain), and understanding ("Comprehension" in the cognitive domain) of these techniques before using them. When the techniques and materials are being used (psychomotor domain) the necessary care and safety precautions must also be taken (affective domain). Therefore the difficulty arises in not only placing an operational division under any specific category of a domain but also in classifying it into a particular domain.

Operational division 8.1.2 was deliberately formulated as such because in practice, selecting and using appropriate materials and explaining the implications of the techniques and materials used, represent an important overlapping continuity in biological science investigations. Since the emphasis in this study is on objectives for practical work and not on the development of a taxonomy of objectives, this operational division is retained as it is.

Operational division 8.1.3 which deals with the "ability to make appropriate observations and accurate recording of observations" involves many levels of complexity. At its simplest level observation involves; "identification and classification into known categories of the objects or processes which are being investigated, i.e., a descriptive skill based on observation. At a more complex level the ability involves the pupil in the exercise of a degree of discernment in establishing patterns from his observations and systematizing the information derived from them".[15]

Observations are normally communicated orally or through notes, diagrams, tables, illustrations, and graphs. They involve analysing and classifying information derived from observation and then selecting the appropriate form in which this could be recorded adequately, correctly and relevantly. They involve honesty in recording and the awareness by the student of the possible distortions of the data by the use of different methods of recording. Although this ability of making appropriate observations and accurate recording of observations is an integral part of practical work, it could not be fitted into Bloom's, Krathwohl's or Harrow's taxonomy.

Operational division 8.1.4 which deals with "the ability to handle results" involves the explanation of observations, interpretation of results, making of deductions, making of inferences, predicting and responding to problem questions. This general ability includes "Application", "Analysis" and "Synthesis" of Bloom's categories.[16] "Analysis" and "Synthesis" represent an overlapping continuity in biological investigations. In making an inference or a deduction from observation the process of synthesis is involved, but synthesis could not be arrived at without analysis of observational data. Analysis is important in order to ensure that the inference or deduction made is valid. Therefore "inference" and "deduction", (objectives iii and v under operational division 8.1.4) each an amalgam of two of Bloom's categories of "Analysis" and "Synthesis", were accepted as more valid than Bloom's categories in the context of practical work in biology. It must also be emphasised that affective behaviour may be an essential element in this cognitive attainment (i.e., Application, Analysis and Synthesis). For example, making honest deductions and inference may not be possible without being open-minded and willing to be convinced by evidence only. Bloom's categories refer to the cognitive domain in terms of pencil and paper tests, and practical work differs in nature from theoretical work. For example, such skills as interpretation of data when measured by pencil and paper tests have very low correlation with the same skill in laboratory situations.[17] The "ability to handle results", in this study was accepted as more valid in practical work rather than related Bloom's categories.

Operational division 8.1.5 which deals with "desirable attitudes to practical work" corresponds to the affective domain of Kranthwohl, Bloom and Masia.[18] There is difficulty in classifying the various attitudinal attributes displayed by pupils when in action in the laboratory into the different levels of acceptance in the affective domain. For example, "following safety regulations in a laboratory" can be classified into level 5 (which is characterization) of the affective domain. If classified into this level, it will indicate that the pupil has accepted safety regulations as a permanent characteristic of his way of living. It may also be classified into level 2 (which is responding). If classified into this level it will indicate that the pupil observes safety regulations, because if he does not he may be reprimanded or lose marks, and not because it is a part of his characteristic. In view of this difficulty, it was felt that any desirable behaviour pattern that the pupil displays in terms of attitudes will be accepted as pupil attainment in the affective domain without any classification into levels of acceptance. It is worthwhile also to point out that both cognitive and psychomotor behaviour may be an essential part of the affective attainment. For example, "following safety regulations in the laboratory" is not possible unless some knowledge and understanding of safety regulations has been acquired and the response shown by the pupil indicates a physical manifestation of the inward decision to respond in a certain way. Therefore an overlap between the two domains cannot be ignored. It was felt necessary therefore to retain all the attributes listed under operational division 8.1.5 just as they were, instead of categorising them into a taxonomy.

The common problem in using all the taxonomies of educational objectives is in deciding to which category of a classification scheme a certain ability expressed by the pupil, fits into. For example, a task involving application for one pupil may be a repetitive task involving recall of knowledge for another. The classification level of the task depends on what has gone before in practical work in the past experience of the learner.

Further complications arise in using these schemes because some of the abilities which represent overlapping continuity in scientific investigations involve the cognitive, affective and psychomotor domains and it is difficult to separate them.

Explicit in these taxonomies is the suggestion that each level in the hierarchy, although built on the lower ones, has no immediate relationship with the other higher levels. For example, in Bloom's taxonomy, "Synthesis" is not immediately related to "Evaluation", but is built on "Analysis", "Application", "Comprehension" and "Knowledge". Implicit in this is that "Evaluation", "Synthesis", "Application" and "Comprehension" are not involved in the "Knowledge" category. If, for example, the ability to "recall knowledge" is taken into account, it "may involve 'pure' recall, selection from alternatives, e.g., selecting the best hypothesis or interpretation of a phenomenon from a number of possibilities, or understanding relationships, e.g., matching a function to a particular structure".(19) Therefore, an expression of a pupil's ability is not confined to particular cognitive levels (Bloom's categories) but involves a variety of cognitive levels. Kelly states, "the expression of students' abilities may involve a variety of modes of thought not necessarily considered in the formulation of ability objectives and yet of possible influence on their expression".(20) The same view is shared by Davies.(21)

For the reasons outlined above the taxonomies developed for the cognitive, affective and psychomotor domains, were used only as a guide in this study for formulating objectives for practical work in biology in the senior secondary level. In terms of priority it was considered more important to accentuate practical work objectives in biology rather than a taxonomy.

In the final analysis it could be stated that this scheme of objectives suggested for practical work in biology at the senior secondary level emphasises a range of attitudes and abilities categorised into operational divisions. The suggested scheme of objectives does not imply that there is a priority of relationships between the operational divisions, nor does it suggest a hierarchical sequence because these were of limited value in the specific context of practical work in biology.

8.3 DIFFERENTIATION OF OBJECTIVES FOR HIGHER GRADE AND STANDARD GRADE

Differentiation in this study refers to the process of distinguishing, by the use of criteria, between Standard Grade and Higher Grade biology. The criteria may be different objectives and content. If there is any differentiation between Standard Grade and Higher Grade biology, then this ought to be indicated in the aims, objectives and the content of the course.

8.3.1 Differentiation Indicated in Biology Syllabuses

An analysis of the biology syllabuses (Theory - Higher Grade and Standard Grade) of the Joint Matriculation Board,[22] which is in no way different from the biology syllabuses of the Division of Education, Department of Indian Affairs, reveals the following:

(i) There is no differentiation between the Standard Grade and Higher Grade in terms of what is listed as "objectives", "study approach and general aims", and "general remarks".

(ii) In terms of content, besides minor insignificant differences (e.g., a floral and a half-flower diagram for the Higher Grade and a longitudinal section of a flower for the Standard Grade, etc.) there were no significant differences between the grades.

An analysis of the syllabus for practical work in biology in Indian schools[23] indicates no significant differences between the Standard Grade and Higher Grade.

The biology syllabuses (theory and practical) which are the main sources of information for the teachers and examiners with regard to the content and learning experiences that pupils will be exposed to, give very little information about differentiating between the grades. The syllabuses advocate the same approach for the Standard Grade and Higher Grade and the content areas for these grades are more or less similar. Some differentiation is brought about in the examination between the grades as is indicated in the Standard Grade Biology Syllabus as follows:

> *"the question will be more direct and less demanding in factual content than the Higher Grade, but will also test insight and understanding as well as factual knowledge".* (24)

The above statement is of very little help to the teachers.

In terms of the Senior Certificate Examination in biology the Higher Grade is allocated a total of 400 marks (i.e., 330 for theory and 70 for practical work) while the Standard Grade is allocated a total of 300 marks (i.e., 250 for theory and 50 for practical work). The following differentiation between the grades is suggested for practical control tests by the Division of Education, Department of Indian Affairs:[25]

	Higher Grade	Standard Grade
Knowledge	25 per cent	35 per cent
Comprehension	35 per cent	40 per cent
Application	30 per cent	25 per cent
Analysis and Synthesis	10 per cent	0 per cent
Total	100 per cent	100 per cent

Greater emphasis in terms of weighting (i.e., proportion of marks out of 100) was placed on the higher cognitive levels (i.e., Comprehension, Application and a combination of Analysis and Synthesis) for the Higher Grade than for the Standard Grade in the practical control tests. The emphasis in the Standard Grade was on "Knowledge" and "Comprehension". This differentiation in terms of cognitive levels is of little help in the context of practical work assessment. This aspect has been discussed from pages 202 to 207 of this study.

In planning a biology curriculum (including practical work) the aims and objectives give direction to the learning experience that can be provided to attain these aims and objectives. These aims and objectives, together with the activities that the pupils were engaged in should give direction to "what to assess" and "how to assess" that which is to be assessed (see pages 41 to 43 of this study). From the curriculum-planning point of view it may be logical to argue that if the approach and the content are basically the same for both the grades, then why the necessity for differentiation in assessing attainment. The present differentiation between the grades as revealed by the biology syllabuses is not based on sound educational principles. If any worthwhile differentiation between the Higher Grade and Standard Grade is to be made in terms of practical work, it must be reflected in the objectives and content of the course. This will give direction to the approach and assessment of practical work.

8.3.2 Differentiation Between the Standard Grade and Higher Grade in Practical Work as Indicated by Biology Educators

Biology educators in this study refer to biology inspectors, examiners and biology teachers who took part in this investigation. The responses and comments made by this group of teachers, examiners and biology inspectors (see Chapter 4) indicate that all the objectives listed in this chapter (i.e., Chapter 8) under operational divisions 8.1.1 (knowledge), 8.1.2 (skill in the use of techniques and materials) and 8.1.3 (observation and recording) are attained by pupils offering biology at the Higher Grade and Standard Grade. They also indicated that besides the following abilities and attitudes, all the other objectives listed under operational divisions 8.1.4 (handling of results) and 8.1.5 (attitudes) are attained by pupils. They expressed doubt as to whether the abilities and attitudes listed below are attained by pupils offering biology in the Higher Grade or Standard Grade. These are:

(i) the ability to make deductions;
(ii) the ability to make predictions;
(iii) the ability to answer problem questions based on present observation;

(iv) the ability to respond to problem questions based on broader theory or principle but which are related to present observation or result;

(v) resourcefulness;

(vi) enthusiasm.

These aspects will be discussed below.

The majority of the teachers (p. 85; p. 92), and the examiners (p. 92) indicated that "deduction-making" (under operational division - "Handling of Results") was not attained by pupils through current practical work. The biology inspectors were unanimous (p. 92) in stating that "deduction-making" was attainable by all pupils. When this ability is analysed in terms of Bloom's categories, it involves the process of "Analysis" and "Synthesis". Only pupils offering biology at the Higher Grade were to be assessed for the attainment of this cognitive level (combination of Analysis and Synthesis) in the practical control test (p. 62). Within this context, and also in terms of the importance of "deduction-making" in investigatory work (see page 108), this ability should be developed in pupils offering biology at the Higher Grade.

The standard-ten biology teachers were unanimous in stating that "prediction-making" (listed under operational division - "Handling of Results") was attained by pupils through current practical work (p. 107). No comment was made on this aspect by the fifty-two senior biology teachers and the eleven examiners (p. 85; p. 92). Two out of the three inspectors stated that this ability is attained by pupils offering biology at the Higher Grade (p. 92). "Prediction-making" is an important ability for developing in practical work since it is an integral part of scientific inquiry (see page 108). From this point of view and due to emphasis on the higher cognitive levels for Higher Grade biology (see page 208) "prediction-making" (which refers to application of ideas and principles to a new situation) should be developed in pupils offering biology at the Higher Grade.

Abilities like "answering problem questions based on present observation" and "responding to problem questions based on broader theory or principle but which are related to present observation or result" (under operational division - "Handling of Results") are suitable for pupils offering biology at the Higher Grade. This suggestion is made because:

(i) two biology inspectors commented that these two abilities could not be developed by pupils offering biology at the Standard Grade (p. 92);

(ii) the standard-ten biology teachers were unanimous in stating that these two abilities are attained and assessed at the Higher Grade (p. 109).

"Resourcefulness" (under operational division - "Attitudes") seems to be beyond the level of pupils offering biology at the Standard Grade. This is supported by evidence provided by two biology inspectors (p. 93) and also the majority of the standard-ten biology teachers (p. 111). One of the biology inspectors also stated that "enthusiasm" (under operational division - "Attitudes") could not be developed by pupils offering biology at the Standard Grade (p. 93). The standard-ten biology teachers felt that this attitude, in terms of development, was beyond the scope of pupils offering biology at the Higher Grade and Standard Grade. Research evidence indicates that this attitude could be developed by pupils at the senior secondary level.[26] From the response of the standard-ten biology teachers, biology inspectors and from research evidence it is evident that "resourcefulness" and "enthusiasm" could be developed by pupils offering biology at the Higher Grade.

From the foregoing discussion, the following suggestions are made about differentiation between the Higher Grade and Standard Grade in terms of objectives for practical work:

(i) All the operational divisions included in the scheme of objectives for practical work are suggested for the Higher Grade and Standard Grade.

(ii) All the objectives listed under operational divisions 8.1.1 (knowledge), 8.1.2 (skill in the use of techniques and materials) and 8.1.3 (observation and recording) are suggested for the Higher Grade and Standard Grade.

(iii) Under operational division 8.1.4 (handling of results), except for the following objectives, all objectives are suggested for pupils offering biology at the Higher Grade and Standard Grade. The following objectives are suggested for pupils offering biology at the Higher Grade.

(a) The pupil should be able to make appropriate deductions (arrive at conclusion) from the observed data (p. 196).

(b) The pupil should be able to predict appropriately the probable effect of a change in a factor on the present observation which is at equilibrium (p. 196).

(c) The pupil should be able to answer accurately problem questions based on the present observation of an investigation (p. 196).

(d) The pupil should be able to answer problem questions based on broader theory or principle (covered in the course) which is related to the present observation, explanation and deduction (p. 197).

(iv) Under operational division 8.1.5 (attitudes), with the exception of the following objectives, the remaining objectives are suggested for the Higher Grade and Standard Grade.

The following objectives are suggested for the Higher Grade:

(a) The pupil should be able to improvise apparatus, search out relevant information and seek advice when necessary i.e., resourcefulness (p. 198).

(b) The pupil should be able to show initiative, provide new ideas and make suggestions for new and further investigations, i.e., enthusiasm (pp. 199-200).

Besides the difference between Standard Grade and Higher Grade biology, in terms of objectives, there should also be a difference between the two grades in terms of weighting of the operational divisions. This aspect is discussed in the sections that follow.

8.4 SPECIFICATION OF OPERATIONAL DIVISIONS AND CONTENT IN THE FORM OF A TWO-DIMENSIONAL GRID

The past ten years have seen the beginning of quantitative specifications of abilities and content in the form of a two-dimensional grid for science examinations in the United Kingdom.[27] The "grids" from overseas examining boards[28][29] clearly indicate the two dimensions (i.e., the abilities and the content) and the weighting in terms of these dimensions. Weighting refers to the percentage that is awarded to each ability and content area. These abilities are not expressed in the form of objectives as defined in this study (p. 37). They are expressed more in the form of behaviour systems (e.g., ability to comprehend familiar situations) which are referred to as operational divisions in this study (p. 78). An analysis of these grids indicate that specification based on operational divisions is likely to be more useful and of universal applicability than one based on objectives. Certainly when it comes to weightings it will be far more manageable and meaningful to use operational divisions. Therefore the two-dimensional grid suggested for practical work in this study will be in terms of operational divisions and content. Such a grid will aid the assessor (i.e., the teacher, examiner, moderator, etc.) in assessment of practical work, i.e., in terms of ensuring that all the operational divisions and content area are adequately assessed. It is also useful in the teaching situation because the teacher and the pupil will be in the know as to what predominant behaviours the pupils ought to develop and express in a particular section of the work.

Predetermined weighting is a matter of judgement because there is no correct weighting that ought to be given.[30] There remains the problem of how to decide what the best weighting of each operational division and each content area would be. "At present, decisions and such weighting rest heavily on opinion and lightly on fact."[31]

Schools Council Examinations Bulletin 27[32] states that specifications which gave predetermined weighting can only be meaningful if the areas (in terms of operational divisions and content) can be shown to be different and can be identified consistently by teachers and assessors alike. In this regard the operational divisions indicated in this chapter are distinct categories and were identified by the teachers, examiners and biology inspectors as distinct units that can be attained by pupils through current practical work. The practical syllabus[33] identifies clearly the various subject areas and each area is distinct from the other in terms of specific information. Therefore it will be meaningful to give predetermined weightings to the operational divisions and content area in this study.

In order to be as objective as possible in weighting the operational divisions and content areas the writer had to:

(i) take into account the weightings that were given to the cognitive levels in the practical control tests (see page 62);
(ii) analyse the circulars and syllabuses of Education Departments and the Division of Education, Department of Indian Affairs;
(iii) analyse the responses of the four examiners (these were the examiners who had two or more years experience in conducting practical control tests) who indicated weightings for the operational divisions (see page 22 and Appendix A, p. 373);
(iv) seek information from research work in related fields of study.

All the above aspects will be discussed in the relevant sections of this chapter.

8.4.1 Weighting of Operational Divisions

There were four examiners (out of a total of eleven examiners that were appointed to conduct practical control tests in 1977) who had two or more years experience in conducting practical control tests (see pages 27 and 28). These four examiners had to indicate the weightings for the operational divisions that were listed on a form that was developed for this purpose (Appendix A, p. 373). The administration of these forms is discussed on page 373 of this study. Their responses are indicated in Table 8.1. The letters a, b, c, d, and e in this Table refer to the five operational divisions that are listed in the suggested scheme of objectives in this chapter, i.e., knowledge, techniques, observation and recording, handling of results, and attitudes respectively.

TABLE 8.1: RESPONSES OF THE FOUR EXAMINERS WITH REGARD TO SPECIFICATION OF WEIGHTS TO THE FIVE OPERATIONAL DIVISIONS OF PRACTICAL WORK

Examiners	Grades (H = Higher (S = Standard	Operational divisions of practical work				
		a	b	c	d	e
A	H	33,00	20,00	10,00	35,00	2,00
	S	48,00	20,00	10,00	20,00	2,00
B	H	25,00	20,00	10,00	40,00	5,00
	S	40,00	20,00	15,00	20,00	5,00
C	H	25,00	20,00	10,00	40,00	5,00
	S	40,00	20,00	10,00	25,00	5,00
D	H	33,00	20,00	10,00	35,00	2,00
	S	40,00	20,00	15,00	20,00	5,00
Mean	H	29,00	20,00	10,00	37,50	3,50
	S	42,00	20,00	12,50	21,25	4,25

The weightings are indicated in a percentage form. The responses of these four examiners as indicated in Table 8.1, together with information gathered from sources, i, ii, iii and v (p. 214) will be discussed below under each operational division.

8.4.1.1 Knowledge of Techniques, Materials, Specifics and Classification

According to Table 8.1, the mean weighting is 29 per cent and 42 per cent for the Standard Grade and Higher Grade respectively. The weightings suggested for "recall of knowledge" in the practical control test, by the Division of Education, Department of Indian Affairs are 25 per cent and 35 per cent for the Higher Grade and Standard Grade respectively. The Natal Education Department places an unduly heavy emphasis on "recall of knowledge" (i.e., 50 per cent and 70 per cent for the Higher Grade and Standard Grade respectively).[34] Although basic knowledge is important, there is far more to practical work than imparting and assessing a large body of facts. This emphasis on "knowledge" also results in an educationally undesirable imbalance in other operational divisions in favour of knowledge. Research studies indicate a weighting of about 13 to 15 per cent for recall of knowledge.[35][36] The writer suggests a weighting of 25 per cent and 35 per cent for the Higher Grade and Standard Grade respectively. These weightings are suggested because:

(i) the percentages are the same as those suggested for the practical control tests;

(ii) the percentage difference between the Higher Grade and Standard Grade is close to that suggested by the examiners;

(iii) it does not create an imbalance in the other operational divisions in favour of "knowledge".

8.4.1.2 Ability in the Skill of Using Techniques and Materials

The Division of Education, Department of Indian Affairs and the Natal Education Department do not indicate the weighting for this and the remaining operational divisions. Instead, they indicate the weightings that should be given to the cognitive levels (i.e., comprehension, application, etc.)[37][38] The examiners in Table 8.1 were unanimous in suggesting a weighting of 20 per cent for both the grades. The emphasis in this operational division is on techniques which are basic to biological investigations. These are equally important to both grades. Therefore there is no necessity to differentiate between the grades in terms of weighting for this operational division. Research workers[39][40][41] allocate a weighting between 10 and 20 per cent for this operational division. In order to prevent an imbalance in the other operational divisions the writer suggests a weighting of 15 per cent.

8.4.1.3 Ability to Make Appropriate Observations and Accurate Recording of Observations

According to Table 8.1, the examiners were unanimous in suggesting a weighting of 10 per cent for the Higher Grade. The mean weighting based on the responses of these examiners for the Standard Grade is 12,50 per cent. This ability of the pupil to report his observations orally or in a written form is a basic skill in practical work and is equally important to both the grades. Therefore there is no necessity to differentiate between the grades in terms of weighting for this operational division. Research workers[42][43][44] allocate a weighting of between 20 and 30 per cent. The writer suggests a weighting of 10 per cent because any weighting higher than this will create an undesirable imbalance in the weighting of the other operational divisions in this study.

8.4.1.4 Ability to Handle Results

According to Table 8.1, the mean weighting of examiners is 37,50 per cent and 21,25 per cent for the Higher Grade and Standard Grade respectively. This operational division involves the intellectual skills of Comprehension, Application, Analysis and Synthesis as indicated by Bloom,[45] but in a practical situation or mode. The Division of Education, Department of Indian Affairs gives a weighting of 75 per cent and 65 per cent for the Standard Grade and Higher Grade respectively in the practical control tests for these cognitive levels (see Appendix A, p. 352). The Natal Education Department gives a weighting of 30 per cent and 50 per cent for the Standard Grade and Higher Grade respectively for these cognitive levels in practical work.[46] No provision is made in the weightings suggested by the Division of Education and the Natal Education Department for use of techniques, observation and recording. Therefore, when weightings already suggested for these skills in this study (i.e., 25 per cent for techniques, observation and recording) are subtracted from the total suggested for the above cognitive levels by the Division of Education, Department of Indian Affairs (i.e., 75 per cent for the Higher Grade and 65 per cent for the Standard Grade), 50 per cent and 40 per cent remain for the Higher Grade and Standard Grade respectively. A weighting is still to be made for the last operational division (i.e. attitude). The writer suggests a weighting of 45 per cent for the Higher Grade and 35 per cent for the Standard Grade for this operational division (i.e., ability to handle results). This is what the weightings would have been for this operational division in the practical control tests, after setting aside weightings for recall of knowledge, practical skills (i.e., techniques, observation and recording) and attitudes. Research workers[(47)(48)(49)] allocate a weighting of between 13 and 30 per cent. However, the weightings suggested by the writer are appropriate because of the variety of cognitive skills that pupils will have to exercise in the context of practical work under this operational division.

8.4.1.5 Showing Desirable Attitudes to Practical Work

It is evident, from information sent out from moderators to senior biology teachers at schools under the control of the Natal Education Department, that attitudes are assessed in practical work, e.g., keeping the work-place neat and tidy.[(50)] This indicates that there are certain attitudes like, "keeping the work-place neat and tidy", "following safety regulations in the laboratory" and "using economically and with care materials in the laboratory" that can be assessed by the teachers and moderated externally. This aspect has been discussed on page 112 of this study. According to Table 8.1, the examiners gave a weighting which ranged between 2 per cent and 5 per cent (i.e., a mean of 3,50 per cent and 4,25 per cent for the Higher Grade and Standard Grade respectively). When this weighting is compared with the other weightings given by examiners for operational divisions a to d, it appears to be relatively small. Implicit in this is the indication that these examiners are rather cautious when it comes to assessment of attitudes. This is in line with the views expressed in the Schools Council Examination Bulletin No. 27[51] and by Macintosh.[52] Research workers[53][54][55] allocate a weighting of between 10 and 25 per cent. The writer suggests a weighting of 5 per cent for both the grades for this operational division. Such a weighting is realistic in an area where one has to be cautious and at the same time it does not deny the fact that teachers are trying to foster favourable attitudes to practical work in biology.

In Table 8.2 the weightings suggested for each operational division of practical work are given.

TABLE 8.2: SUGGESTED SCHEME OF WEIGHTING OF OPERATIONAL DIVISIONS IN PRACTICAL WORK

Operational divisions	Weighting in percentage	
	Higher Grade	Standard Grade
(a) Knowledge of techniques, materials, specifics and classification	25	35
(b) Ability in the skill of using techniques and materials	15	15
(c) Ability to make appropriate observation and accurate recording of observation	10	10
(d) Ability to handle results	45	35
(e) Showing desirable attitudes to practical work	5	5
Total	100	100

Explicit in the weightings given in Table 8.2 is the fact that more emphasis is placed on "knowledge" for the Standard Grade than for the Higher Grade. More emphasis is placed on the higher cognitive levels (i.e., ability to handle results which include categories of Comprehension, Application, Analysis and

Synthesis as exemplified by Bloom's Taxonomy) for the Higher Grade than the Standard Grade. These "emphases" are in line with the requirement[56] of the Division of Education, Department of Indian Affairs within the context of differentiated education.

8.4.2 Content Weighting

In order to construct a two-dimensional grid the operational divisions and content must be weighted.

As far as the demarcation of the content is concerned, there is a clear indication of this in the practical syllabus[57] in the form of different sections, e.g., microscope work, experiments, plant anatomy, etc. The weightings that could be given to each of these content areas is a matter of judgement.[58]

From analysing the practical syllabuses[59][60] and from discussion with senior biology teachers, the writer suggests the weightings that are given in Table 8.3

TABLE 8.3: SUGGESTED SCHEME OF WEIGHTING THE CONTENT FROM THE PRACTICAL SYLLABUS

Content areas from syllabus	Weighting in percentage for Higher Grade and Standard Grade
1. Knowledge of and use of microscope	5
2. Slide preparation	5
3. Experiments	15
4. Cells, tissues and plant anatomy	10
5. Mammal - structure and physiology	10
6. Diversity and unity of organisms	40
7. Flower studies	5
8. Ecology	10
Total	100

According to Table 8.3, there are no separate weightings indicated for the Standard Grade and Higher Grade because there is no significant distinction between these two groups in terms of content reflected in the practical syllabus. This aspect had been discussed on pages 207 and 208 of this study. The highest weighting is given to "diversity of organisms" (i.e., 40 per cent). This is weighted heavily because it makes up about two-fifths of the practical syllabus and in a similar way "slide preparation" and "knowledge of and use of the microscope" is each given a weighting of 5 per cent because each of these sections makes up one-twentieth of the practical syllabus. In this way the different sections of the syllabus were weighted. The aim of this weighting is to ensure that the assessment of attainment in practical work covers comprehensively the content areas that are done in the course and this coverage is a balanced one. The weighting of content can do no more than guide the assessor in his sampling of the content and therefore this weighting must be viewed in the same context. No such weightings have been suggested by the Division of Education, Department of Indian Affairs.

These suggested weightings given to various content areas of the practical syllabus compare favourably to those given to the same syllabus by the Natal Education Department.[61]

8.4.3 A Two-Dimensional Grid

The weightings given to the operational divisions (Table 8.2) and to content (Table 8.3) were used to construct a two-dimensional grid. Table 8.4 indicates a two-dimensional grid suggested for practical work at the senior secondary level for Indian schools.

TABLE 8.4: TWO-DIMENSIONAL GRID FOR PRACTICAL WORK IN BIOLOGY AT THE SENIOR SECONDARY LEVEL

CONTENT	Behavioural aspects of the objectives										Total percentage (content)
	Knowledge of techniques, materials, specifics and classification		Ability in the skill of using techniques and materials		Ability to make appropriate observations and accurate recording		Ability to handle results		Showing desirable attitudes to practical work		
	H	S	H	S	H	S	H	S	H	S	H & S
1. Knowledge of and use of microscope	1	1	4	4	-	-	-	-	-	-	5
2. Slide preparation	-		4	4	-	-	-	-	1	1	5
3. Experiments	1	3	5	5	1	1	6	4	2	2	15
4. Cells, tissues and plant anatomy	2	2	-	-	3	3	5	5	-	-	10
5. Mammal-structure and physiology	4	6	-	-	1	1	5	3	-	-	10
6. Diversity and unity in organisms	14	19	-	-	2	2	23	18	1	1	40
7. Flower studies	1	2	1	1	2	2	1	-	-	-	5
8. Ecology	2	2	1	1	1	1	5	5	1	1	10
9. Total percentage (operational divisions)	25	35	15	15	10	10	45	35	5	5	100

The most important feature of this grid is the total row and the total column, which represent the balance of the course in terms of the content and operational divisions respectively. The following points should also be noted about this grid:

(i) Percentages are not allocated to each cell of the grid. This is because it is more appropriate to assess certain abilities or attitudes only in certain areas of content. For example, "the ability to handle results" is more appropriately assessed in experimental work than on content that deals with the use of microscope. Although all the behaviours are expected in some sections of the work (e.g., experiments), their relative importance in other content area varies.

(ii) Although this grid is an examination or assessment grid, it will undoubtedly influence the way in which practical work is done at schools. At the same time it does not deny that in practical work in biology other abilities not indicated by a percentage in relation to a content area may be important. For example, preparation of slides (content) may not only require the skill of using special techniques in preparing the slide but also the ability to use a microscope, observe and record and interpret the observation (i.e., ability to handle results). However, it does make clear that the behaviours (e.g., using special techniques in preparing a slide) indicated for each content area (e.g., slide preparation) are predominant or focal behaviours for that content area and will be considered as such by the assessor.

(iii) As already stated, weighting given to each cell of a two-dimensional grid is a matter of judgement and there is no "correct" weighting that ought to be given. Therefore it is undesirable to interpret a grid too rigidly as a teaching blue print but it could be used as a guide for assessing attainment in practical work.

Two-dimensional grids, similar to the one suggested by the writer, are provided by overseas examining boards[(62)(63)] as background information to teachers and examiners in different subjects in the United Kingdom. This is done to guide the teachers and examiners as to "what to assess" and in "what quantities to assess that which is to be assessed". Nuttall[(64)] states that a two-dimensional grid is a prerequisite to ensure that an assessment procedure has content-validity. Content-validity refers to adequate assessment of activities which pupils are expected to carry out in each subject area and this is important in the context of practical work assessment for the Senior Certificate biology examination. It is against this background, that the writer has constructed a two-dimensional grid for practical work in biology at the senior secondary level.

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CHAPTER NINE

CHOICE OF AN APPROPRIATE ASSESSMENT PROCEDURE IN ASSESSING ATTAINMENT IN PRACTICAL WORK AND SUGGESTIONS FOR THE IMPLEMENTATION THEREOF

9.1 GENERAL POSITION WITH REGARD TO ASSESSMENT PROCEDURES

One of the aims of this study is to identify an assessment procedure which will provide the most efficient and appropriate measure of attainment in practical work in biology, at the senior secondary level. Procedures followed by overseas examining boards in assessing attainment in practical work were analysed and discussed from pages 48 to 56 of this study. It was found that the idea of evaluating project work as part of the assessment of practical work (as was used by some overseas examining boards) could not be implemented in Indian schools because of the intolerable burden it would place on the teacher in terms of the large numbers of pupils he would have to supervise per biology class unit (pp. 110-111). Assessment of current practical exercises as used by some overseas examining boards (pp. 51-53), could be used in Indian schools within the context of cumulative assessment of practical work provided that:

(i) suitable criteria are developed in awarding marks for each operational division of practical work;

(ii) teachers are adequately trained for this purpose.

The exclusive use of practical books of pupils for assessing attainment in practical work was considered to be of limited educational value because doubts were expressed by the teachers about the originality of work that was reflected in these books (p. 156). In spite of this problem expressed by the senior biology teachers, they used it as a source of assessment within the context of cumulative assessment. If some of the problems encountered by teachers in using practical books as a source of assessment (e.g., insufficient equipment and materials for individual work; pupils not entering work from direct observation etc., - p. 156) could be overcome, then this assessment could form an important component of cumulative assessment.

Against this background, it was felt appropriate to examine in detail cumulative assessment and "one-shot" assessments (i.e., practical control tests and final practical tests) which are currently being used at Indian schools. These assessment procedures were analysed and discussed in Chapter 5. Cumulative assessment, final practical tests and practical control tests will be analysed in this chapter in a comparative way against a set of criteria in order to identify a suitable assessment procedure.

9.2 THE PROCEDURE THAT WAS FOLLOWED IN CHOOSING AN APPROPRIATE FORM OF ASSESSMENT

A list of criteria by which a suitable form of assessment might be judged was drawn up as a result of a literature survey[1][2][3][4] and discussions[5] with standard-ten biology teachers, biology inspectors and examiners of practical control tests. An informal consensus of opinion was adopted to draw up a list of criteria. This procedure in drawing up a list of criteria by the writer is similar to those used by other research workers in a related field of study.[6] The criteria for choosing a suitable assessment procedure are as follows:

(i) It should be a valid form of assessment.

(ii) The assessment must be reliable.

(iii) The nature of assessment should not have an undesirable backwash effect on practical work.

(iv) Logistical problems must not undermine the application of the assessment procedure.

(v) It should produce results which are nationally comparable.

(vi) It should discriminate between pupils of different abilities.

The current cumulative assessment and "one-shot" assessments will be examined in terms of each of these criteria. This is in line with the procedure used by Kelly and Lister in choosing an appropriate form of assessment for assessing practical work in Nuffield A-Level Biology.[7]

9.2.1 It Should be a Valid Form of Assessment

It may be logical to argue that an assessment of attainment in practical work cannot be complete unless all the subject areas and objectives (or operational divisions) indicated in a two-dimensional grid are assessed in correct proportions. Provided this is done, the assessment procedure is said to have a high content validity.[8] The Schools Council Examination Bulletin 31[9] lists this type of validity as one of the desirable characteristics of an assessment procedure. Analysis of the responses of standard-ten biology teachers (pp. 133-142) and examiners (pp. 161-164) indicates that severe restrictions were imposed on the range of course work that could be assessed in "one-shot" assessments (i.e., the final practical tests and practical control tests). These restrictions were the time factor, seasonal availability of materials, insufficient equipment, etc. These views expressed by the teachers and examiners are consistent with the findings of other research workers in a related field of study.[10] There are no comparable limitations with regard to cumulative assessment. The standard-ten biology teachers have indicated that this form of assessment provides much more flexibility in adequately sampling the objectives and content of the course, than a conventional "one-shot" assessment. A similar view is expressed in the Schools Council Examination Bulletin 31.[11] The authors of this Bulletin state that, provided all aspects of the course are assessed in correct proportions, cumulative assessment has a high content validity and is potentially superior to any other procedure in this respect.[12] This view is consistent with the findings of other research workers[13][14][15] and is in line with the findings in this study.

Validity may also be examined in relation to an independent criterion (i.e., the criterion-related validity). For example, the candidates' performance in cumulative assessment or in a final practical test, can be compared with their performance in the Senior Certificate written examination in biology. This Senior Certificate written examination acts as an independent criterion. A close relationship between their performance in this written examination and final practical test or cumulative assessment would indicate a high criterion - related validity. This is usually measured by using the Pearson Product-Moment Correlation. The computation of this statistical technique is given in Appendix B (p. 397). It was not possible to establish from the mark lists that were submitted by teachers to the Division of Education, Department of Indian Affairs, whether these practical marks were awarded through final practical tests or cumulative assessment. There is evidence that not all the teachers awarded marks through cumulative assessment (p. 119). Against this background, it was not possible to compare the candidate's performance in cumulative assessment or final practical tests with their performance in the Senior Certificate written examinations in biology. It was therefore decided to take into consideration teacher-awarded marks (whether they be obtained through cumulative assessment or final practical tests), practical control test marks and the Senior Certificate written marks in biology.

To make a meaningful comparison of the "r" values between teacher-awarded marks and Senior Certificate written examination marks on one hand and the practical control test marks and the Senior Certificate written examination marks on the other, the marks of those candidates that did the practical control test were used (i.e., Higher Grade N = 467; Standard Grade N = 301). The correlations (r) are indicated below:

(i) The correlations (r) of the teacher-awarded marks and the Senior Certificate written examination marks are 0,54 ($p < 0,01$) and 0,54 ($p < 0,01$) for the Higher Grade and Standard Grade respectively.

(ii) The correlations (r) of the practical control test marks and the Senior Certificate written examination marks are 0,57 ($p < 0,01$) and 0,54 ($p < 0,01$) for the Higher Grade and Standard Grade respectively.

The practical control test is traditionally accepted by the Division of Education, Department of Indian Affairs to maintain a uniform standard in awarding marks for practical work. The fact that the correlations resulting from the above sets of marks are roughly the same, seems to suggest that teacher-awarded marks (whether they be obtained through cumulative assessment or final practical tests) might be used with as much confidence as the marks awarded in practical control tests. This interpretation is in line with other research workers in terms of criterion-related validity.(16)

9.2.2 The Assessment Must be Reliable

Reliability refers to consistency of results produced by an assessment procedure. "Assuming the validity is the same, ranking of the candidates should be the same irrespective of when and by whom the assessment is made".(17)

Reliability cannot be looked at in isolation from validity because they are interdependent.(18) Cumulative assessment is claimed to be a more valid form of assessment than final practical tests and practical control tests (pp. 117-159). Nuttall(19) from the National Foundation for Educational Research in England and Wales states that assessment marks should be highly reliable if they are to be of any value in a national examination but care must be taken not to pursue reliability at the expense of validity. Similar views are expressed by Backhouse(20) and in Schools Council Examination Bulletins No. 1(21) and No. 31.(22) Examination Bulletin No. 1 states, "all methods of assessment are unreliable to some degree. There is no yardstick of reliability, and information is needed from many sources, from conventional examiations as well as other types of examinations - so that the respective degree of reliability can be compared".(23) It goes on to say that even if a new method of examining is known to be unreliable it is not necessarily more unreliable than some established method. In this regard, Backhouse(24) states that even if a practical assessment procedure shows low reliability, it should not be abolished because by including it as a component in assessing the subject it is possible that the validity is being increased. It must also be noted that statistical analysis can give a measure of efficiency of an assessment procedure, but it cannot indicate whether such procedure is desirable or not. Therefore one of the criteria when choosing a particular procedure to assess practical work, should always be based on fitness for purpose.

Cumulative assessment which provides information about a pupil's attainment in a range of objectives and subject matter over a period of time evens out variation due to extraneous sources and increases the reliability of the assessment. In this way cumulative assessment could produce results which are likely to be nearer the true performance (i.e., more reliable) of pupils than those produced by "one-shot" assessments like the final practical test or practical control test (which is a form of external examination). This view expressed by the writer is shared by Eggleston,[25][26][27] Christopher,[28] Yeoman,[29] and Hoste and Bloomfield.[30] Suggestions for increasing the reliability of cumulative assessment will be outlined at the end of this chapter and in Chapter 11.

9.2.3 The Nature of Assessment Should Not Have An Undesirable Backwash Effect on Practical Work

"Undesirable backwash effect" is used to refer to the harmful effect of the assessment procedure on the curriculum and the teaching process.

The final practical tests and practical control tests are "one-shot" assessments. These assessments are bound by special restrictions (e.g., time-factor, seasonal availability of materials, insufficient equipment, etc., pp. 137-150) which are inevitable in "one-shot" assessments. These restrictions limit the choice of content and abilities that might be assessed in the final practical test and practical control test (pp. 137-150).

In spite of the limitations, teachers have still conducted final practical tests (p.121). The driving force behind this was that the final test was a means of preparing pupils for the practical control test (p. 134). The course practical work was also geared to prepare pupils for the practical control test (p. 146). Implicit in this, is that teachers have accepted the practical control test, in spite of its limitations, to give them a directive in their teaching and assessment. They also adjusted to the demands made on pupils to be consistent with those required of pupils in the practical control tests. Therefore, the pupils will concentrate on those aspects of practical work which will be assessed in the final practical test and the practical control test. Implicit in this is that pupils will not be involved in "finding out" or "getting-to-know-by-investigations" which forms the basis of new trends in biology teaching and is still not a part of the final practical tests and practical control tests.(31) This is inevitable if the final practical test and practical control test, with their limitations, are allowed to give a directive to practical work at schools. A heavy reliance upon these tests as the chief source of motivation for the pupils to do practical work is undesirable because they would accept the course practical work as preparing them for the tests and not as a means for giving them a better understanding of biology. It is evident that the final practical tests and practical control tests are having an undesirable backwash effect on the course practical work. This is consistent with the findings of Kerr.(32) He found that "one-shot" assessment, with its limitations adversely affects the nature of practical work at schools, e.g., pattern of work becomes inflexible, repetitive, outmoded and often inadequately integrated with the theory.

Cumulative assessment does not impose any special restrictions on the nature of practical work at school. "In this case the course is the assessment and the assessment is the course".(33) If there are any limitations, then these limitations are imposed by the teacher, e.g., assessing only limited aspects of the syllabus. As it gives constant feedback on pupil progress, cumulative assessment shifts the focus of the teacher from the class as a single entity towards individual pupils, and is a source of information for diagnosing individual difficulties (p. 131). The standard-ten biology teachers also recognised the educational value of this form of assessment in terms of it providing a feedback to them on their teaching effectiveness (p. 131). The views expressed by these teachers are consistent with the views expressed by research workers on cumulative assessment.[34][35] It is evident from this discussion, that cumulative assessment has a desirable backwash effect on the nature of practical work at schools. In this regard Chalmers and Stark[36] found that since introducing cumulative assessment in chemistry in the Schttish H N C Course:

(i) there has been a marked improvement in the quality of pupils' work, the industry with which they have tackled it, the interest they have shown in it and the enjoyment they have got out of it;

(ii) the teachers have appreciated the much greater freedom to devise interesting and varied laboratory programmes and have noted with satisfaction the beneficial effects of it on pupils. This is consistent with the views expressed in the Schools Council Examination Bulletin 31.[37]

9.2.4 Logistical Problems Must Not Undermine the Application of the Assessment Procedure

The view that is taken in this study is that the presence of logistical problems (i.e., unreasonable demands made on teachers, examiners, facilities, materials and finance) in devising and administering an assessment procedure would undermine the acceptability of that procedure.

The standard-ten biology teachers indicated that they had difficulties in devising and administering the final practical tests (pp. 137-139). Some of the factors that contributed to these difficulties were:

(i) large number of pupils per class unit to be assessed in one-point-in-time;

(ii) requiring extra personnel to invigilate;

(iii) seasonal availability of materials;

(iv) insufficient apparatus and materials.

The examiners also faced problems in conducting the practical control tests (pp. 161-162). Some of these were:

(i) poor facilities (i.e., broken screens, insufficient darkening of room for slide projection work, etc.) and insufficient apparatus and specimens in schools;

(ii) they had to change the questions at school on the morning of the test because the materials on which the questions were based were either not available, inadequate or that section of the work on which the question was based had not been done by the pupils.

The problems encountered by the teachers and examiners in conducting the final practical tests and practical control tests (as a potential external examination) undermines the acceptability of these procedures to assess attainment in practical work. The problems encountered in conducting a practical control test will be compounded if it is used as an external examination, because of the large number of candidates to be assessed. The Biological Education Committee of the Royal Society and the Institute of Biology in the United Kingdom found that with a large number of candidates formal practical examinations are expensive to conduct in terms of specimens, apparatus, transport and examiners.[38] In the Division of Education, Department of Indian Affairs, 3 795 candidates entered for the Senior Certificate Biology Examination in 1977.

The standard-ten biology teachers have stated that cumulative assessment also involves them in an enormous amount of work in terms of time and labour (p. 129). The pressure of assessment is transferred from a single assessment to a series of periodic assessment (p. 129). However, cumulative assessment provides for a great deal of flexibility in terms of the materials and techniques that can be used. The teachers are not faced with the problems encountered in devising and administering the final practical tests and practical control tests. Small units of work are assessed at a time and materials that are used are those required for daily practical work. There are no organisational and administrative problems because the class teacher conducts the assessment.

Against this background, the cumulative assessment procedure has an advantage over the final practical tests and practical control tests (as a potential external examination).

9.2.5 It Should Produce Results which are Nationally Comparable

If an assessment is to be fair to all candidates in the context of the Senior Certificate biology examination, it must provide results which are nationally comparable. That is, similar levels of attainment in practical work irrespective of which school the pupils are in, ought to receive similar marks. Although it is generally accepted that a teacher can put his own pupils in an order of merit more accurately than an external assessor, it is also acknowledged that the teacher is not able to compare the performance of his own pupils with those of other schools in terms of the national standards of attainment.[39][40] The problem of equating standards across schools proves to be the main stumbling block to cumulative assessment and final practical tests which are both teacher assessments. Tables 7.3, 7.4 and 7.5 (pp. 174-176) indicate that the overall standard of awarding marks by teachers was not consistent in the same school and among schools. Table 7.2 (p. 171) indicates that the marks awarded by teachers at 77,70 per cent of Indian schools in the Republic of South Africa (i.e., in 1977) had to be adjusted through moderation. From the information that was available to the writer it was not possible to establish the total number of schools in the Republic that awarded marks either through cumulative assessment or final practical tests. Therefore it was not possible to establish whether the marks awarded by one of these assessment procedures is better than the other in terms of adhering to the national standard. However, the writer was able to identify two schools in which marks were awarded exclusively through final practical tests and seven schools where marks were awarded through cumulative assessment (p. 119). These were the nine schools where the writer conducted practical control tests. When the marks awarded at these nine schools are analysed, the following is evident:

(i) at the two schools in which marks were awarded exclusively through final practical tests, the marks were adjusted by the biology inspectors;

(ii) at the seven schools where marks were awarded through cumulative assessment, the marks awarded at five schools were adjusted.

These findings indicate that marks awarded through cumulative assessment are not less likely to adhere to a common standard, than the final practical tests.

The practical control test (which is externally set, administered and marked) can not be used to maintain uniformity of standards between schools in its present form because of the use of non-parallel tests and examiner variability. With the use of parallel tests and "like-minded" examiners (selected in an agreement trial) the practical control test has virtues, such as impartiality and comparability of standards between schools. However, these virtues are offset by special problems indicated in the preceding sections of this chapter. Within this context, and from the point of view of fitness for purpose (assessing the final attainment of pupils adequately), cumulative assessment could be a useful means of maintaining standards between schools, provided that:

(i) the objectives of practical work are clearly specified;

(ii) there is a quantitative specification (two-dimensional grid) of objectives or operational divisions and content;

(iii) criteria of awarding marks are clearly stated;

(iv) guidance on assessment techniques is provided.

A similar view is expressed by Hoste and Bloomfield(41) from the National Foundation for Educational Research in England and Wales. They felt that cumulative assessment adheres to national standards. Research workers(42) also found no evidence of standards being significantly different for candidates awarded marks by cumulative assessment and by examinations.

9.2.6 It Should Discriminate Between Pupils of Different Abilities

A measure of spreading out the pupils over the whole range is what is meant by discrimination. In this way the better candidates (i.e., those with higher attainment and ability) are separated from the weaker ones. To be discriminating an assessment measure needs to be at an appropriate level of difficulty for the group of candidates for whom it is designed. Ideally, one would design an assessment procedure so that the mean mark based on pupils' attainment in it will be about 50 per cent of the maximum possible mark. This mean mark would indicate that the assessment measure is at the right level of difficulty; it allows for the best possible spread of marks although it does not ensure it.

The mean, standard deviation and range taken together are useful statistical indices that can be used to give an indication of the ability of an assessment procedure to discriminate.(43) Since the maximum marks for teacher assessment and practical control tests are 70 and 50 for the Higher Grade and Standard Grade respectively, the best discrimination will be given if the mean marks are 35 (Higher Grade) and 25 (Standard Grade), and the range of marks are 0-70 (Higher Grade) and 0-50 (Standard Grade). In addition a standard deviation of about one-fifth of the range (i.e., 14 and 10 for the Higher Grade and Standard Grade respectively) means that the candidates are spread out over the range and not bunched at any one point.(44)(45)

The relevant data, to make an analysis along similar lines to that outlined above, is indicated in Table 9.1. The data is based on marks awarded to all candidates that were selected for the practical control test (i.e., Higher Grade N = 467; Standard Grade N = 301) in all Indian schools in the Republic (i.e., 54 schools) in 1977.

TABLE 9.1: MEANS, STANDARD DEVIATIONS AND RANGES FOR PRACTICAL CONTROL TESTS AND TEACHER-AWARDED MARKS

Statistical Indices	Teacher Assessment		Practical Control Test	
	Higher Grade (N = 467)	Standard Grade (N = 301)	Higher Grade (N = 467	Standard Grade (N = 301)
Maximum Possible Mark	70,00	50,00	70,00	50,00
Expected Range	70,00	50,00	70,00	50,00
Expected Standard Deviation	14,00	10,00	14,00	10,00
Expected Mean	35,00	25,00	35,00	25,00
Actual Range	52,00	34,00	49,00	32,00
Actual Standard Deviation	10,36	6,04	10,65	6,28
Actual Mean	35,18	23,94	31,53	20,25
Standard Error of the Mean	0,48	0,35	0,49	0,36

These statistics suggest that:

(i) The teachers were just about right (not severe or lenient) in awarding marks to both the grades. Teacher awarded-marks indicate that teacher-assessment was rather less than ideally discriminating (i.e., the standard deviations of teacher-awarded marks were less than the expected standard deviations) for both the grades.

(ii) The practical control tests for both the grades were somewhat on the difficult side (the actual means were lower than the expected means) and rather less than ideally discriminating (i.e., the standard deviations of practical control test marks were less than the expected standard deviations) for both the grades.

However, since the actual ranges for the practical control test were 49 and 32 for the Higher Grade and Standard Grade respectively rather than 70 and 50, the actual as opposed to the expected discrimination was quite good (the standard deviations were above one-fifth of the actual ranges). However, the teachers did not spread the marks over a range but bunched them at certain points. This resulted in lower standard deviations and higher means when compared with practical control tests.

Generally, the teacher assessment (no matter whether the marks were awarded through cumulative assessment or final practical test) gives adequate discrimination when compared with the practical control test. The practical control test is accepted by the Division of Education, Department of Indian Affairs, as maintaining uniform standards in awarding marks for practical work.

The standard-ten biology teachers who took part in this investigation expressed the view that, through cumulative assessment, as in the final practical test, it was possible to distinguish the bright, average and the weak pupils (p. 132) This view is consistent with the findings of research workers in a related field of study.[46] Therefore cumulative assessment is not less accurate when compared with the final practical tests in discriminating between pupils of different abilities.

If the premise that only a teacher is in the best position to provide information about a pupil's progress in practical work (based on observation of the pupil over a period of time) and to rank his pupils in order of merit (p. 166), based on this information, is accepted, then it follows that cumulative assessment is the most valid form of assessment in terms of discriminating between pupils.

9.3 CHOICE OF AN APPROPRIATE ASSESSMENT PROCEDURE

From the foregoing discussion, it is evident that cumulative assessment as a procedure for assessing attainment in practical work is superior to other forms of assessment. Therefore it is suggested that this procedure is used by teachers to assess pupils' performances in practical work in biology for the Senior Certificate Examination in biology. This suggestion is made because:

(i) Cumulative assessment has a high content validity when compared with other assessment procedures.

(ii) Criterion-related validity suggests that teacher assessment (no matter whether the marks were awarded through cumulative assessment or final practical test) might be used with as much confidence as an external assessment, such as the practical control test.

(iii) This assessment procedure evens out the variations due to extraneous sources and increases the reliability of assessment because it provides information about a pupil's attainment of a range of objectives and content matter over a period of time.

(iv) It has a desirable backwash effect on the course practical mark.

(v) It provides a great deal of flexibility in terms of the materials and techniques that could be used without presenting many logistical problems.

(vi) Teachers using cumulative assessment are not at any great disadvantage when compared with others using different forms of assessment in terms of producing results which are nationally comparable, and in discriminating between pupils of different abilities.

(vii) It is a fair form of assessment without involving as much risk of failure as in "one-shot" assessments.

Considering the points enumerated above and fitness of purpose (i.e., assessing the final attainment of pupils adequately), this study suggests that cumulative assessment could provide the most efficient and appropriate measure of attainment in practical work.

9.4 SUGGESTIONS FOR IMPLEMENTING THE CUMULATIVE ASSESSMENT PROCEDURE

Cumulative assessment does not automatically ensure valid and reliable results. The following are prerequisites if cumulative assessment is to provide a meaningful measure of attainment in practical work:

(i) Objectives of practical work and a two-dimensional grid with weightings must be clearly specified and used in assessment.

(ii) Criteria for awarding marks must be specified and used for assessment.

(iii) Guidance must be provided to teachers on assessment techniques.

(iv) Standards (i.e., 8, 9 and/or 10) in which marks must be collated must be specified.

Each of these aspects will be discussed under specific headings in the following sections of this chapter.

9.4.1 Objectives and the Two-Dimensional Grid

It has already been pointed out in the preceding sections of this study that objectives of practical work and a two-dimensional grid with appropriate weightings are essential. These will give the teachers direction in organising learning situations and in devising assessment techniques. Therefore a scheme of objectives and the use of a two-dimensional grid with appropriate weightings have been suggested in Chapter 8 of this study. The present study has revealed that there is a great need for the teachers to become aware of "what to assess" (objectives) and in "what proportions to assess" (weightings). A nodding acquaintance or partial understanding of the suggested scheme of objectives and weighting is worse than useless in the context of cumulative assessment. With a good understanding of these, it would be reasonable to expect that teachers in all schools will demand from their pupils the same behavioural outcomes in the same proportions. This is essential to ensure the validity and reliability of this method.

9.4.2 Criteria for Awarding Marks

The objectives and a two-dimensional grid do not automatically ensure validity and reliability. Teacher standards for awarding marks must be roughly the same. A mark scheme was constructed by the biology inspectors and used by examiners who conducted the practical control tests in 1978. This suggests the type of criteria that could be developed for teachers' use in awarding marks in various subject areas. For example, the examiners used the following criteria in awarding marks for the preparation of a slide.

	Criteria	Marks
(i)	Quality of section or quantity of material used	2
(ii)	Amount of mountant	2
(iii)	Removal of air bubbles	2
(iv)	Drying of slide	2
	Total	8

The above scheme does not specify clearly the criteria to use in awarding the sub-total marks. For example, a teacher may be in doubt whether to award one mark or two marks when the quality of a section is assessed. Even though this may be implicit, the criteria must be clearly stated in order to bring about uniformity in the standard of awarding marks among teachers. For example, the following criteria are suggested for use when awarding marks on the preparation of a slide on the transverse section of a stem:

Criteria		Marks
(i) <u>Quality of section</u>		2
(a) thin and transverse	(2 marks)	
(b) thick (but useful) and transverse	(1 mark)	
(ii) <u>Amount of Mountant</u>		2
(a) completely covers the space between the slide and the coverslip only	(2 marks)	
(b) completely covers the section only	(1 mark)	
(iii) <u>Air bubbles</u>		2
(a) no air bubbles between the slide and coverslip	(2 marks)	
(b) few air bubbles present but this does not interfere with observing the section	(1 mark)	
(iv) <u>Staining</u>		2
(a) correct stain was selected; it was used sparingly (i.e., economically)	(2 marks)	
(b) correct stain was selected; it was used wastefully	(1 mark)	
	Total	8

Criteria for awarding marks for each operational division or for entire investigations, as used by overseas examining boards (see pages 50 to 52 of this study), could also be developed by the Division of Education, Department of Indian Affairs, for use by the teachers. The aim in specifying criteria is to incorporate reliability into cumulative assessment and ensure comparability of standards between teachers and schools.

Research evidence[47][48] indicates that even with the use of highly structured criteria for awarding marks, there can be variation between assessors in the standard of awarding marks. It is for this reason, that the writer suggests that the teachers and biology inspectors should come together periodically to discuss the implementation of the criteria for awarding marks.

9.4.3 Assessment Techniques

The present study has revealed that there is a great need for biology teachers to become aware of the variety of assessment techniques that can be used within the context of cumulative assessment. Guidance should be provided by biology inspectors and moderators who will visit schools regularly (this aspect will be discussed in Chapter 11). In addition, a range of material giving information on techniques of assessment should be published by the Division of Education, Department of Indian Affairs, for the use of teachers. Such guidance is provided to teachers by overseas examining boards[49][50] and other related bodies.[51] Assessing pupils while they are carrying out current practical exercises (i.e., day-to-day practical work) can play an important role in measuring attainment. Suitable criteria for awarding marks for the various operational divisions might be developed and used along the lines suggested by the developers of the Nuffield A-Level Biological Science (see pages 50 to 52 of this study). The most useful information is likely to come from a range of contrasting exercises selected for this purpose at appropriate times during the period of cumulative assessment. Care should be taken not to allow assessment of current practical exercises to interrupt the pupils' work unduly, and when marks are allocated the assistance given to pupils should be taken into account.

Practical tests should also be used periodically. These tests should be based on units of work completed by pupils. Although tests offer a more limited means of sampling, if structured mark schemes are used, they provide a means of providing more objective criteria in awarding marks. When constructing these tests consideration should be given to as many aspects of practical work as possible in terms of objectives. By using some variation (e.g., familiar materials in a new situation or unfamiliar materials in a routine situation, etc.) it is possible to test pupils' ability in tackling new work.

The present study has indicated that the work recorded by pupils in their practical books is not their original work (p. 156). An attempt should be made to get pupils to record their own observations and interpretations. If this attempt is successful, practical books will provide a useful source for assessing "recording" and "handling of results".

9.4.4 Standards (i.e., 8, 9 and/or 10) in Which Marks Must be Collated for Cumulative Assessment

The findings in this study (p. 123) indicate that there is a need for biology teachers to become aware of which period in the senior secondary level they should collate marks in order to make a cumulative judgement on attainment in practical work. In fairness to pupils and on educational grounds it is recommended that pupils' attainment in practical work for the Senior Certificate biology examination, should be assessed in the final matriculation year. In standards 8 and 9 the pupils are still acquiring (within the context of subject matter) the abilities and attitudes that are basic to practical work. From the point of view of definition of attainment in this study (i.e., the degree of mastery of the objectives of practical work within the context of subject matter), and from having given the pupils an opportunity to attain these objectives, it is appropriate to assess pupils in the standard-ten year. This is consistent with the practices of some examining boards in the United Kingdom.[52] This also overcomes the problem of standard-ten biology teachers relying on marks awarded by other teachers in standards 8 and 9. In terms of validity, the practical work covered in the standard-ten year covers a good cross section of the operational divisions and content indicated in the two dimensional grid in this study. The assessment should be spread over the first three terms of the final matriculation year.

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2. Nuttall, D.L.: "Planning and Examination", in: Hudson, B. (ed.): *op. cit.*, pp. 6-17

3. Hoste, R., and Bloomfield, B.: *op. cit.*, pp. 21-26

4. Kelly, P.J., and Lister, R.E.: *op. cit.*, pp. 140-141

5. These discussions took place soon after they filled in questionnaire B2 (see page 391) and it centred on criteria for judging a suitable assessment procedure. Oral and written comments made by them on this aspect were collated by the writer.

6. Kelly, P.J., and Lister, R.E.: *op. cit.*, pp. 140-141

7. *Ibid.*, pp. 122-151

8. Nuttall, D.L., and Willmott, A.S.: *op. cit.*, p. 160

9. *Ibid.*, p. 21

10. Kelly, P.J., and Lister, R.E.: *op. cit.*, p. 142

11. Hoste, R., and Bloomfield, B.: *op. cit.*, p. 22

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31. The writer scrutinised the final practical test papers and the practical control test papers at the nine schools where he conducted practical control tests. He also scrutinised the practical control test papers that were used by examiners in 1978.

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33. Hoste, R., and Bloomfield, B.: *op. cit.*, p. 22

34. *Ibid.*, p. 18

35. Chalmers, R.A., and Stark, J.: *op. cit.*, pp. 155-160

36. *Ibid.*

37. Hoste, R. and Bloomfield, B.: *op. cit.*, p. 13

38. The Biological Education Committee: *op. cit.*, p. 10

39. Eggleston, J.F., and Kelly, P.J.: *op. cit.*, p. 228

40. Secondary School Examination Council: *CSE - Some Suggestions for Teachers and Examiners*, *op. cit.*, p. 25

41. Hoste, R. and Bloomfield, B.: *op. cit.*, pp. 41-48

42. *Ibid.*, p. 113

43. Brown, P., Hitchman, P.J., and Yeoman, G.D.: *op. cit.*, p. 35

44. *Ibid.*

45. The Schools Council: *CSE: Experimental Examinations: Science, op. cit.*, p. 12

46. Kelly, P.J., and Lister, R.E.: *op. cit.*, p. 135

47. Brown, P., Hitchman, P.J., and Yeoman, G.D.: *op. cit.*, p. 25

48. Kelly, P.J., and Lister, R.E.: *op. cit.*, 145

49. The West Yorkshire and Lindsey Regional Examining Board: *CSE Examinations - Assessment in a Nutshell, op. cit.*, pp. 29-36

50. Joint Matriculation Board (Nuffield): Instructions for the Internal Assessment of Class Practical Work, *op. cit.*, pp. 1-2

51. Nuffield Foundation: *Nuffield Advanced Biological Science -* Teachers' Guide to the Laboratory Guide, Volume II , *op. cit.*, pp. 207-213

52. Joint Matriculation Board (Nuffield): Instructions for the Internal Assessment of Class Practical Work, *op. cit.*, pp. 1-2

CHAPTER TEN

SUGGESTED PROCEDURE IN SELECTION OF MODERATORS

10.1 GENERAL POSITION WITH REGARD TO SELECTION OF MODERATORS

A distinction is made between examiners and moderators in this study. An examiner is a person who is appointed by the examining body or its representative to conduct practical control tests at schools. He makes a single visit to a school to administer this test to a selected sample and to allocate marks to this sample of pupils on their performance in it. A moderator is viewed as a person who is also appointed by the above body but in addition to moderating teacher-awarded marks, he will give guidance to teachers on objectives and assessment techniques. The suggested procedure of moderation and the duties of a moderator will be discussed in Chapter 11.

Some overseas examining boards[1] appoint moderators (sometimes referred to as inter-school assessors) to advise teachers on assessment of practical work and also to moderate marks awarded by teachers. This idea of a dual role is in line with recommendations made by research workers in this field of study,[2][3] and coincides with the opinions expressed by all the standard-ten biology teachers who took part in this investigation (pp. 150-152). It is against this background that appointment of moderators and not examiners, will be discussed in this chapter.

The Division of Education, Department of Indian Affairs, appoints a panel of examiners to conduct practical control tests (pp. 60-61). The criterion used in this appointment is their experience in teaching biology at the senior secondary level. These examiners use tests and mark schemes developed by the biology inspectors in awarding marks to a sample of Senior Certificate biology candidates at each school (p. 62). It is hardly likely that these examiners, independently of each other, could have awarded similar marks to any one set of examinees. It was not possible to establish if this was the case, because no two examiners assessed the same pupils for the same work. However, research studies indicate that there is variation between examiners in awarding marks to the same candidates even if experienced teachers, equal and parallel tests and structured mark schemes are used.(4)(5) This indicates that appointing examiners for practical control tests purely on the basis of teaching experience does not ensure that the marks that are awarded by them are fair and comparable. To obviate this problem some of the overseas examining boards(6) appoint moderators who are "like-minded" in terms of discrimination, standards and conformity. These terms are discussed on page 70 of this study. Only those moderators who pass the tests for discrimination, standards and conformity at an agreement trial are appointed. These tests, together with the purpose, nature and mechanics of agreement trials, used by overseas examining boards have been discussed from pages 69 to 75 of this study. These agreement trials are useful because:

(i) the qualities essential for moderation are identified in advance of moderation;

(ii) this identification is done objectively through the use of statistical procedures;

(iii) from the information gathered in the agreement trial, "like-minded" moderators are appointed.

Choosing "like-minded" moderators is essential to ensure that the marks that they award are uniform within reasonable limits. This uniformity of standard is the "corner stone" on which moderation is based. Therefore the point of view taken in this study is that moderators who are appointed to ensure uniformity of standards must pass the tests of discrimination, standards and conformity in an agreement trial conducted by the Division of Education, Department of Indian Affairs.

It must be acknowledged that conducting an agreement trial for selecting moderators for practical work presents many problems. Agreement trials described by the overseas examining boards(7) and in the Schools Council Examination Bulletin No. 5(8) refer to the use of completed work of pupils for assessment in these trials. However, assessment of practical work involves both completed work (e.g., written responses, dissected specimens, etc.) and observing pupils in the work situation (e.g., manipulative skills).

In an agreement trial, each prospective moderator will have to assess identical work of pupils. For example, all must assess at the same time oral responses or manipulative skills of a candidate. This creates several problems:

(i) accommodating a large number of examiners around a candidate to assess certain skills through direct observation, e.g., manipulation of a microscope;

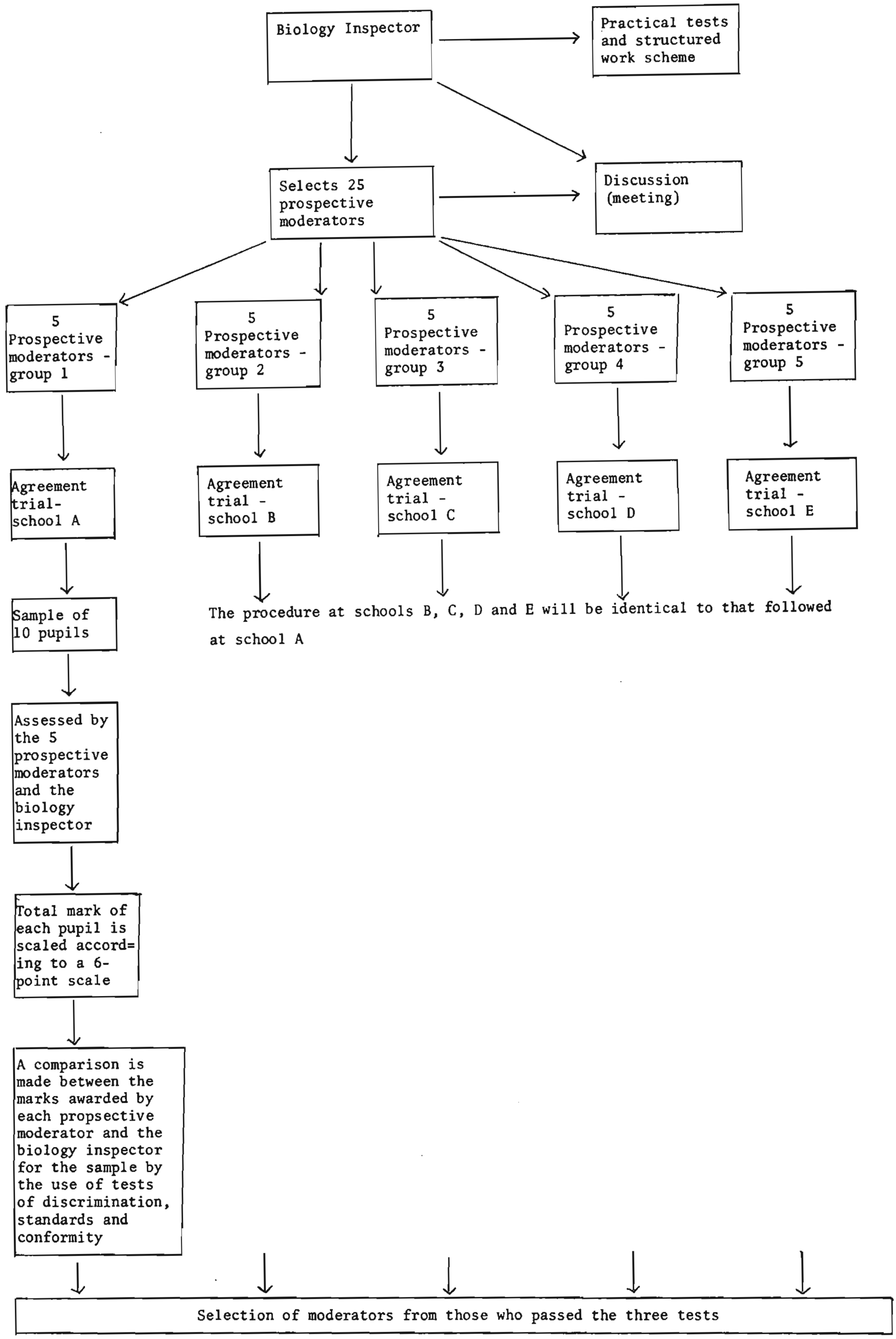
(ii) the pupil may be under stress due to being surrounded by a large number of examiners at the same time.

For the reasons above, the procedure for conducting agreement trials of the Schools Council and overseas examining boards will be modified to meet the needs of the local situation.

10.2 THE PATTERN OF THE AGREEMENT TRIAL

The writer suggests the use of an agreement trial for the selection of moderators. This is summarized in the following diagram:

A SUMMARY OF SUGGESTED PROCEDURE IN AGREEMENT TRIALS



The various aspects indicated in the diagram will be discussed under specific headings.

10.2.1 The Role of the Biology Inspector in An Agreement Trial

Although the overall responsibility of maintaining standards in an examination lies with the examining board, the senior biology inspector (who will be referred to as the biology inspector or inspector in this section of the study) should be entrusted with maintaining the overall standard of awarding marks in practical work as at present. Within this context, the biology inspector will be entrusted with the organisation and administration of agreement trials, and in selecting the moderators. An assumption is also made that the standard of awarding marks by the biology inspector is equivalent to the national standard and he maintains uniformity of standard irrespective of when and to which sample of Senior Certificate biology candidates he awards marks. This is important in an agreement trial because the inspector's mark is used as a criterion against which each prospective moderator's mark is checked.

10.2.2 Practical Tests and Structured Mark Scheme

The subject areas of practical work that will be covered by the standard-ten biology pupils in the first two terms must be ascertained by the biology inspector from the teachers at the five schools where the agreement trial is going to be held. On the basis of this information, the biology inspector must devise two practical test papers (i.e., one for each grade). The same practical test papers will be used at five schools. These must be modelled along lines similar to the test papers that will ultimately be used by the moderators when they moderate the final marks of teachers (i.e., during the third visit to schools). The writer suggests that the duration of the test should be about two hours. It is possible to assess a good cross section of the operational divisions of practical work suggested in Chapter 8, within this time limit.

The distribution of time for each operational division might be as follows:

(i) knowledge of techniques, etc. - 15 minutes;
(ii) ability in using techniques and materials - 30 minutes;
(iii) ability to make appropriate observations and accurate recording of observations - 15 minutes;
(iv) ability to handle results - 30 minutes;
(v) showing desirable attitudes to practical work - will overlap with (ii) as far as time is concerned.

Therefore the total time that the pupils require in completing the test will be 90 minutes. The remaining 30 minutes will be required for issuing instructions to pupils, exchanging test materials between pupils, etc. If the work selected is confined to these operational divisions, a test of two hours duration will provide sufficient information for the inspector to make an informed judgement in selection of moderators. In setting these test papers the purpose of the agreement trial must be kept in mind. The main concern in the trial is to assess the judgement used by prospective moderators in awarding marks to the group as a whole (i.e., the sample that is selected) and not in assessing the final attainment of pupils in practical work.

A structured mark scheme for each test paper must be constructed by the biology inspector. This scheme should be along lines specified from pages 227 to 281 of this study and it should indicate the criteria for awarding specific marks. The total marks should be 50 and 70 for the Standard Grade and Higher Grade respectively, because these are the marks that are awarded for practical work in the Senior Certificate biology examinations.

10.2.3 Suitable Time for the Agreement Trial

In the suggested procedure of moderation in this study (Chapter 11) the moderator will make several visits to a school during the year to guide teachers with regard to assessment and to moderate teacher-awarded marks. Therefore a moderator for a school should be appointed in the preceding year, and the time to conduct the agreement trial will be in the second week of the third term. By this time, the pupils would have completed the major part of the practical syllabus. The trial examinations will not be conducted at schools until later in this term, so it will not coincide with the agreement trial. The point of view taken in this study is that an agreement trial as extensive as the initial one (which involves twenty-five prospective moderators and five schools) need not be conducted every year. In subsequent years, an agreement trial might be conducted at two schools with ten prospective moderators. The moderators appointed in the initial trial could be allowed to continue serving in this capacity for the maximum period of three years. The moderators selected in subsequent trials would be used to:

(i) replace those moderators who have dropped out as a result of transfers, promotions, retirement, etc.;

(ii) replace those moderators who have served for two or three years.

In this way, in addition to making provision for replacement of moderators, continuity and introduction of "new-blood" is ensured. This is consistent with the procedure followed by some overseas examining boards.

10.2.4 Selection of Prospective Moderators

The biology inspectors together should select twenty-five prospective moderators to take part in the agreement trial. They will select these on the basis of having seen them previously in action during regular inspection, at Science Conventions or at

Biology Subject Committee meetings. The selection of prospective moderators will be left in the final analysis to the senior biology inspector. Since the moderator, once appointed will function at schools which are geographically close to their place of employment, it is advisable to select prospective moderators also on this basis. For example, fourteen ought to be selected from the Coastal Belt of Natal, three from the Midlands and Uplands of Natal, five from the Transvaal and three from the Cape. Moderators from these areas will be able to cover all the schools under the control of the Division of Education, Department of Indian Affairs. These numbers suggested for the respective areas are proportionally related to the number of schools in each area (p. 25). The number of twenty-five prospective moderators has been suggested because this is a large enough number for a group of eighteen moderators to be selected from it. At present twelve examiners are used to conduct practical control tests at schools. The new suggested scheme of moderation will require about fifteen moderators (i.e., each moderator will be in charge of three or four schools) and in addition three for replacements during the course of the year.

The agreement trial should be held in Durban because it is geographically close to the majority of the prospective moderators. This is in line with the present procedure followed by the Division of Education, Department of Indian Affairs, in inviting the examiners who are appointed to conduct practical control tests to a meeting in Durban, prior to the commencement of the test.

10.2.5 Organisation of the Agreement Trial

After the twenty-five prospective moderators are selected, they are organised at random into five equal groups (i.e., five groups of five moderators each). Each group is assigned to a particular school to take part in an agreement trial. For this purpose five schools will have to be selected in the Durban area. The pre= requisite is that each of these schools must have at least five Higher Grade and five Standard Grade biology candidates. This is the minimum number of candidates from each grade that will be selected for the agreement trial (i.e., a sample of ten). The procedure followed in selecting a representative sample is discussed on page 255.

The following is implicit in the foregoing discussion:

(i) the agreement trial will be conducted in five schools (i.e., schools A to E);

(ii) five prospective moderators will participate in an agreement trial at a school;

(iii) each prospective moderator will participate only once in an agreement trial;

(iv) the trial at the five schools will have to be conducted on different days because the biology inspector will have to be present at each of the trials (i.e., his marks will be used as a criterion against which each prospective moderator's marks in each school are checked);

(v) a sample of ten pupils (five from each grade) will be assessed at each school.

Five prospective moderators are suggested for the agreement at each school because this is about the maximum number that could be accommodated in a laboratory to assess effectively at the same time, identical work of pupils. It must also be pointed out that a number larger than ten pupils to be assessed in the context of an agreement trial will place a heavy burden on the organisers and prospective moderators in terms of time, apparatus, types of activities that can be assessed, etc.

The biology inspector must finalise the dates of the agreement trial at the five schools and must meet with the prospective moderators prior to the agreement trial. The writer suggests that the meeting between the prospective moderators and the biology inspector should be held on the Friday of the first week of the third term and the agreement trial should be conducted from Monday to Friday of the following week. The principals and teachers at the five schools and the prospective moderators must be notified of these arrangements. Each standard-ten biology teacher at the five schools must prepare separate merit lists for his Higher Grade and Standard Grade pupils (based on the internal assessment of practical work). These merit lists will be used in choosing a representative sample for the agreement trial at each school.

10.2.6 Meeting Between the Prospective Moderators and the Biology Inspector

At this meeting the biology inspector outlines the purpose, nature and mechanics of an agreement trial (pp. 69-75). The test papers and the criteria for awarding marks (i.e., the mark scheme) which will be used in this trial must also be discussed. From this discussion, there ought to emerge from the collective thinking of practitioners in the subject, a consensus on the overall standard of awarding marks for practical work which is in line with the national standard. On the basis of this discussion the criteria for awarding marks (i.e., the mark scheme) could be modified if necessary. The prospective moderators must be notified about:

(i) their groupings;
(ii) the school in which the agreement trial for each group will be conducted;
(iii) their time of arrival and departure from the school;
(iv) the time of the test.

After the discussion on the agreement trial, the next phase of the discussion should centre on the pattern of the moderation procedure that they will be following, once they are appointed as moderators. The format of this discussion will be identical to that outlined in the next chapter. The purpose of this meeting is to discuss, the interpretation and the application of standards to assessment of practical work, and also the guidance that could be given to teachers to achieve this end.

10.2.7 Administration of the Agreement Trial

The procedure followed in conducting the agreement trial in the five schools will be identical. Therefore the following description of this trial at one school is applicable to all the others.

10.2.7.1 The Procedure Followed in Selecting a Representative Sample of Pupils

The biology inspector and the prospective moderators have to select from the merit list of any one teacher in the school, a representative sample of five Higher Grade pupils and from the merit list of the same teacher or another teacher a representative sample of five Standard Grade pupils (i.e., a sample of ten pupils). It is meaningless to apply any statistical techniques to choose a sample of five for each grade (p. 307).

The writer suggests the use of purposive sampling[9] where pupils of different abilities (i.e., the bright, average and weak according to the teacher's merit list) are included in the sample. The following procedure should be followed in using purposive sampling in selecting pupils. Select the pupil:

(i) with the highest mark (i.e., pupil A);
(ii) with the lowest mark (i.e., pupil C);
(iii) who has a mark in between the highest and lowest mark (i.e., pupil B);
(iv) whose mark lies in between the marks of pupils A and B;
(v) whose mark lies in between the marks of pupils B and C.

In this way, a representative sample (of different abilities) of pupils from the merit list could be included in the sample for each grade. This procedure is at present being followed by the Division of Education, Department of Indian Affairs in selecting pupils for the practical control tests (p. 63). If there are fewer than six pupils in a grade, then all the pupils are included in the agreement trial.

10.2.7.2 Assessment of Pupils' Performance

Each pupil selected for assessment in the agreement trial must be provided with clear instructions as to what is expected from him during the test. These instructions should be included in the question paper and the roster. The roster will indicate the sequence that each pupil must follow in answering questions. This will obviate the problem of all the pupils answering a question at the same time, and especially those that will have to be assessed during the test itself (i.e., manipulative skills and oral responses). For example, the manipulation of a micro=scope by a pupil will have to be assessed by all the assessors at the same time. In this way all the assessors will be assessing identical aspects of the pupil's work and this is important in an agreement trial situation.

Oral questions requiring oral or written responses should be asked by the biology inspector. The biology inspector and the five prospective moderators must award marks to pupils independently of each other. Written responses of pupils could be marked after the test is completed. Marks allocated for sections of a written script for each candidate by an assessor must be recorded not on the script, but on a separate sheet that will be provided for this purpose, to ensure that assessors are not influenced by each other's marks. Manipulative skills and oral responses must be assessed during the test itself and a record of these marks must be kept.

10.2.7.3 Entry of Marks onto Validation Sheets

After the completion of the test, and marking, each prospective moderator must enter the total marks (i.e., out of a total of 70 and 50 for the Higher Grade and Standard Grade respectively) that he allocated to each candidate in the appropriate column on a validation sheet (see pages 264 to 267). The names of pupils must be entered in alphabetical order (using the surnames of candidates). This is essential to ensure that the two sub= samples of five, into which the sample of ten is divided are random subsamples.[10] It is only subject to these conditions that the range estimates (statistical procedure) advocated for selecting "like-minded" moderators will give reliable results.[11] The Higher Grade and Standard Grade pupils are not entered separately on the validation sheet because it is the overall standard of awarding marks to pupils (no matter to which grade they belong) that is under scrutiny in an agreement trial.

The validation sheets must then be handed to the biology inspector who will then enter his marks for the same sample on each validation sheet.

10.3 ANALYSIS OF AGREEMENT TRIAL RESULTS FOR SELECTING MODERATORS

The biology inspector and the prospective moderators must compare statistically the marks awarded by each prospective moderator with the inspector's marks for the same sample. Reasonable limits of agreements are sought rather than absolute standards.[12] Agreement here means:[13]

(i) that the prospective moderators are not severe or lenient in awarding marks, compared with the inspector's;

(ii) that they discriminate between pupils of various abilities in the same way as the inspector;

(iii) that they conform with the inspector in assessing the same qualities in pupils, i.e., they are showing a similar consistency in awarding marks or ranking pupils as the biology inspector.

These three qualities are described as standards, discrimination and conformity, respectively in the Schools Council Examination Bulletin No. 5,[14] by Kennedy[15] and Hale.[16] These three qualities are essential in the context of moderation and therefore a suitable statistical technique must be used to measure these qualities in the prospective moderators (i.e., by using the marks that they allocated in the agreement trial).

In choosing a suitable statistical measure for the agreement trial the following factors have to be taken into account:

(i) The sample sizes chosen for the agreement trial are small (i.e., 10 pupils).

(ii) This sample that is chosen is a representative one and is a cross section of the pupils that appeared on the merit list.

(iii) The statistical measure should take into account the three qualities that are essential for moderation.

(iv) Reasonable limits of agreement (i.e., critical values) are to be built into the statistical measure and these limits should be attained in practice and be applicable on a national scale.

(v) The statistical work should be kept to the minimum, i.e., it should not involve considerable mathematical computation and a knowledge of statistics. The computations need be simple enough to be used by those not interested in statistics but yet provide efficient results.

The Schools Council Examination Bulletin No. 5[17] suggests the use of range estimates which takes into account all the factors listed above. The range estimates is a statistical measure that is hardly known in the educational world but is extensively used in quality control in industry.[18] This statistical measure is used in industry in assuring that desired quality standards are being met as economically as possible.[19] Quality is used to refer to some property of the product such as the outside diameter of a ball bearing, the breaking strength of yarn, the concentration of fruit juices. Any manufacturing process, however good, is characterized by a certain amount of variability which is of the same chance or random nature as the variation we might find between repeated casting of a pair of dice.[20] It is customary in quality control to select a representative sample of products to check for any variation from the desired standard. To measure this variation the range is used.[21] Freund and Williams[22] state, "Since we have only to subtract the smallest sample value from the largest, the range is often used in problems of quality control where it is important to obtain results quickly and with a minimum of arithmetic". Control limits are set and if the variation from the desired standard lies within the control limits the batch of product that the sample represents is accepted. This is interpreted as the process being in a state of statistical control (i.e., the only kind of variation present is chance variation).[23] If the variations from the desired standard lie outside the control limits, then the batch of product that the sample represents can be rejected or new control limits can be established for it. Quality controls are explained in detail in books of business statistics[24][25] and a discussion on this falls outside the scope of this study. The application of this statistical measure is described from pages 261 to 268 of this study and is discussed fully in Appendix B, (pp. 412-418). The rationale behind the use of range estimates in quality control in industry is equally applicable in agreement trials and in moderation of teacher-awarded marks. In quality control and in controlling the standard of awarding marks, a reasonable level of variation from the desired standard is sought (variation within fixed or controlled limits). Variations from the desired standards that fall outside the fixed limits are considered undesirable in both cases.

The writer therefore suggests the use of range estimates as a statistical measurement in agreement trials and in moderating teacher-awarded marks. The Schools Council Examination Bulletin No. 5[26] states that there is no justification for the use of complicated statistical procedures in appraising standard of awarding marks when a valid and simple alternative in the shape of range estimate exists. This pronouncement is made as a result of extensive trials held by the Schools Council. Examining Boards in the United Kingdom are also using this statistical measure in agreement trials[27] and in moderation of teacher-awarded marks.[28] The only requirements for using this statistical measure are:

(i) The marks are converted to grades on a 6-point scale (grades 1 to 6). This is discussed on pages 261 and 262 of this study.

(ii) A representative sample of pupils are selected. This is discussed on page 255 of this study.

(iii) Rearranging in a random order (in alphabetical order) the surnames of the sample of pupils on the validation sheet to ensure that the 2 subsamples of 5 (in the case of this study) into which the subsample of 10 are divided are random subsamples.

10.3.1 Scaling of the Marks According to a Six-Point Scale

The marks that are entered on the validation sheet by each prospective moderator and the biology inspector will have to be converted to grades on a six-point scale in order to use the range estimates.[29] Schools Council Examinations Bulletin No. 15[30] indicates the value of each grade for the CSE in the form of percentages as follows:

grade 1 = 65 per cent or over
grade 2 = 55 per cent to 64 per cent
grade 3 = 45 per cent to 54 per cent
grade 4 = 35 per cent to 44 per cent
grade 5 = 34 per cent or less

No value is given for grade 6 but it is referred to as an ungraded category (i.e., work is below standard and is not suited for grading).[31] Since grades will be used in the context of agreement trial for appraising the overall standard of awarding marks by prospective moderators and not for indicating the final attainment of pupils, the above percentages can be used to transform marks to grades on a 6-point scale. The simplest technique to do this is to use linear transformations which require the selection and use of two "fixed-points" on the mark scale.[32] Since the intermediate grades (i.e., 2 to 4) indicated above have equal scale values (i.e., 9 per cent), then if grade 6 is added to it, grade 5, which will become an intermediate grade, will also have an equal scale value (i.e., 9 per cent). Grade 5 will then have a value of 25 per cent to 34 per cent and grade 6, a value of 24 per cent or less. Similar values were obtained when linear transformations were used for grades 5 and 6.[33] These percentage values for grades 1 to 6 were used to transform the Higher Grade and Standard Grade marks (i.e., 0 to 70 and 0 to 50 respectively) to grades on 6-point scales.

Grades	Mark Range (Higher Grade)	Mark Range (Standard Grade)
1	46 - 70	33 - 50
2	39 - 45	28 - 32
3	32 - 38	23 - 27
4	25 - 31	18 - 22
5	18 - 24	13 - 17
6	0 - 17	0 - 12

When marks are converted into grades (i.e., 1 to 6) it is not possible to discern the small differences between pupils which the assessors usually make in terms of marks. Duffey[34] states that a 5-point scale (in this study it is a 6-point scale) gives sufficient discrimination without discerning small differences that might be meaningless. A similar view is expressed by Kelly and Lister.[35] This 6-point scale could be used whenever marks are to be converted to grades in the context of agreement trials.

10.3.2 Statistical Procedure Used in Identifying Like-Minded Moderators

After the marks on the validation sheets have been converted to grades, the next stage involves comparing statistically each prospective moderator's grades with the inspector's grades for the same sample. For this, the range estimates (which include the tests for standards, discrimination and conformity - discussed from pages 257 to 260) are used. The criteria for identifying "like-minded" moderators when a sample of twenty pupils are assessed in an agreement trial has been described from pages 69 to 75 of this study. When that description is compared with the suggestions that will be made in this section of the study, slight variations will be seen. In the previous description, the moderator's grade was compared with the average of the grade awarded by all the moderators. In this section of the study each prospective moderator's grade is compared with the inspector's grade. Another difference is that a sample of ten pupils made up of two subsamples of five each (as opposed to a sample of 20 pupils made up of five subsamples of four each) are used in the agreement trial suggested in this study. These variations in no way alter the stringency of the tests of discrimination, conformity and standards.[36] The West Yorkshire and Lindsey Regional Examining Board suggests the following criteria as acceptable limits for their agreement trial.[37] These are appropriate in this study.

(i) Standards: the difference between the grand totals of the inspector and the prospective moderator should not exceed 5.

(ii) Discrimination: the sum of ranges of the biology inspector should not be less than half but not more than twice that of the prospective moderator.

(iii) Conformity: the sum of ranges in the difference column (difference between the biology inspector's grades and the prospective moderator's grade) should not exceed 6.

The writer suggests the use of the above criteria in selecting moderators. These criteria have been arrived at after extensive trials conducted by the Schools Council and Examining Boards in the United Kingdom and they are not too stringent to be applied locally.

To make the tests for standards, discrimination and conformity, the following will have to be computed on each prospective moderator's validation sheet by the biology inspector:

(i) the grade total and the grade range for each subsample;

(ii) the grand total of the grades and the sum of ranges;

(iii) the difference between the grades awarded to each candidate by the prospective moderator (referred to on the validation sheets as A - pp. 264-267) and the biology inspector (referred to on the validation sheets as B - pp. 264-267), i.e., A - B;

(iv) the range of differences (i.e., A - B) are then totalled for each subsample and then the sum of ranges is recorded (the calculation of the range of differences is discussed on page 73).

The mathematics involved in the calculations are minimal and they probably take longer to describe than to do. Examples of completed validation sheets with information on results with regard to whether the prospective moderator has passed the tests are given in Figures 10.1, 10.2, 10.3 and 10.4.

SCHOOL .... PROSPECTIVE MODERATOR ....a.................

Candidate's Surname (entered alphabetically)	Grade H = Higher Grade S = Standard Grade	Marks (maximum - Higher Grade = 70 Standard " = 50)		Grades (1 - 6)		
		Prospective Moderator	Biology Inspector	Prospective Moderator (A)	Biology Inspector (B)	Differences (A-B)
Aligran	H	48	50	1	1	0
Baloo	S	29	28	2	2	0
Coovadia	S	26	24	3	3	0
Dharam	H	33	30	3	4	-1
Elton	S	28	29	2	2	0
Total	-	-	-	11	12	-
Range	-	-	-	2	3	1
Evandren	H	35	33	3	3	0
Indren	S	28	30	2	2	0
Jaikoo	S	35	31	1	2	-1
Naidoo	H	50	53	1	1	0
Ponnen	H	49	45	1	2	-1
Total	-	-	-	8	10	-
Range	-	-	-	2	2	1
GRAND TOTAL	-	-	-	*19*	*22*	-
SUM OF RANGES	-	-	-	*4*	*5*	*2*

Test	Result	Reason
(i) Standards	Pass	the difference between 22 and 19 does not exceed 5 (criterion limit)
(ii) Discrimination	Pass	5 is not less than half of or more than twice 4
(iii) Conformity	Pass	2 does not exceed 6 (criterion limit)

BIOLOGY INSPECTOR .... DATE ....

FIG. 10.1 EXAMPLE OF A WORKED VALIDATION SHEET. THE RESULTS OF ALL THREE TESTS ARE ACCEPTABLE

SCHOOL .... PROSPECTIVE MODERATOR ....b.................

Candidate's Surname (entered alphabetically)	Grade H = Higher Grade S = Standard Grade	Marks (maximum - Higher Grade = 70 Standard " = 50)		Grades (1 - 6)		
		Prospective Moderator	Biology Inspector	Prospective Moderator (A)	Biology Inspector (B)	Differences (A-B)
A	S	19	16	4	5	-1
B	S	20	17	4	5	-1
C	H	48	43	1	2	-1
D	H	42	34	2	3	-1
E	H	23	11	5	6	-1
Total	-	-	-	16	21	-
Range	-	-	-	4	4	0
F	S	30	27	2	3	-1
G	S	29	19	2	4	-2
H	S	16	20	5	4	+1
I	H	47	37	1	3	-2
J	H	50	54	1	1	0
Total	-	-	-	11	15	-
Range	-	-	-	4	3	3
GRAND TOTAL	-	-	-	27	36	-
SUM OF RANGES	-	-	-	8	7	3

	Test	Result	Reason
(i)	Standards	Failed	The difference between 36 and 27 exceeds 5 (criterion limit)
(ii)	Discrimination	Pass	7 is not less than half or more than twice 8
(iii)	Conformity	Pass	3 does not exceed 6 (criterion limit)

BIOLOGY INSPECTOR .... DATE ....

FIG. 10.2 EXAMPLE OF A VALIDATION SHEET WHERE THE RESULT ON THE STANDARDS TEST WAS UNACCEPTABLE

SCHOOL .... PROSPECTIVE MODERATOR ....

Candidate's Surname (entered alphabetically)	Grade H = Higher Grade S = Standard Grade	Marks (maximum - Higher Grade = 70 Standard " = 50)		Grades (1 - 6)		
		Prospective Moderator	Biology Inspector	Prospective Moderator (A)	Biology Inspector (B)	Differences (A-B)
A	S	7	20	6	4	+2
B	S	20	25	4	3	+1
C	H	50	42	1	2	-1
D	S	27	24	2	3	-1
E	H	49	44	1	2	-1
Total	-	-	-	14	14	-
Range	-	-	-	5	2	3
F	H	47	42	1	2	-1
G	H	50	40	1	2	-1
H	H	30	35	4	3	+1
I	S	25	26	3	3	0
J	S	10	21	6	4	+2
Total	-	-	-	15	14	-
Range	-	-	-	5	2	3
GRAND TOTAL	-	-	-	29	28	-
SUM OF RANGES	-	-	-	10	4	6

	Test	Result	Reason
(i)	Standards	Pass	The difference between 28 and 29 does not exceed 5 (criterion limit)
(ii)	Discrimination	Fail	4 is less than half of or more than twice 10
(iii)	Conformity	Pass	6 does not exceed 6 (criterion limit)

BIOLOGY INSPECTOR .... DATE ....

FIG. 10.3 EXAMPLE OF A VALIDATION SHEET WHERE THE RESULT ON THE DISCRIMINATION TEST WAS UNACCEPTABLE

SCHOOL ....   PROSPECTIVE MODERATOR ....

Candidate's Surname (entered alphabetically)	Grade H = Higher Grade S = Standard Grade	Marks (maximum - Higher Grade = 70 Standard " = 50)		Grades (1 - 6)		
		Prospective Moderator	Biology Inspector	Prospective Moderator (A)	Biology Inspector (A)	Differences (A-B)
A	H	55	35	1	3	-2
B	H	50	53	1	1	0
C	S	30	45	2	1	+1
D	S	25	15	3	5	-2
E	H	23	20	5	5	0
Total	-	-	-	12	15	-
Range	-	-	-	4	4	3
F	H	34	44	3	2	+1
G	S	10	21	6	4	+2
H	S	24	20	3	4	-1
I	H	42	35	2	3	-1
J	S	26	19	2	4	-2
Total	-	-	-	16	17	-
Range	-	-	-	4	2	4
GRAND TOTAL	-	-	-	28	32	-
SUM OF RANGES	-	-	-	8	6	7

	Test	Result	Reason
(i)	Standards	Pass	The difference between 32 and 28 does not exceed 5 (criterion limit)
(ii)	Discrimination	Pass	6 is not less than half or more than twice 8
(iii)	Conformity	Fail	7 exceeds 6 (criterion limit)

BIOLOGY INSPECTOR ....   DATE ....

FIG. 10.4 EXAMPLE OF A VALIDATION SHEET WHERE THE RESULT ON THE CONFORMITY TEST WAS UNACCEPTABLE

According to Figures 10.1 to 10.4 only prospective moderator "a" passed the tests for standards, discrimination and conformity. The others are either too lenient or severe (prospective moderator "b"), reckless in spreading out the pupils (prospective moderator "c"), or inconsistent (prospective moderator "d") when compared with the marks that were allocated by the biology inspector to the same set of candidates. These test results indicate that prospective moderator "a" who agrees within reasonable limits with the biology inspector in awarding marks (the biology inspector represents the national standard) is eligible for appointment as a moderator. These tests should be used in appointing "like-minded" moderators.

If the required number of moderators (i.e., total of 18) could not be selected in the initial agreement trial (because some were not "like-minded" in terms of the tests), then further groups of five each should be invited to take part in a subsequent agreement trial which must be conducted along similar lines to the initial one. Those prospective moderators who were not accepted in the original trial must not be included in the subsequent trial.

This suggested pattern of selecting moderators is designed to ensure a fair moderation of teacher awarded-marks. It is also based on the following assumptions:

(i) that the overall standard (i.e., in terms of standards, consistency and discrimination) of awarding marks by the biology inspector is uniform in the assessment trial held in the 5 schools and his overall standard is equivalent to the national standard;

(ii) the moderators once appointed will adopt the same overall standard of awarding marks during moderation as they applied in the agreement trial.

Evidence gathered from extensive trials of appointing moderators in this way, by the West Yorkshire and Lindsey Regional Examining Board, seems to confirm the above two assumptions.[38] The Schools Council Examination Bulletin No. 5 states that choosing moderators in agreement trials, "are more practicable, expeditious, and effective than any that have hitherto been suggested, and they can provide the beginning for what will no doubt prove a long process of development"[39] It is in this context that the suggested agreement trial is viewed in this study.

The moment of appointment of moderators must be delayed till the agreement trials in all the schools have been completed. This information on appointment and the schools that they are appointed to must be conveyed to the moderators by the end of the third term.

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2. Kerr, J.F.: *op. cit.*, p. 97
3. Moodley, T.K.: *op. cit.*, p. 259
4. Brown, P., Hitchman, P.J., and Yeoman, G.D.,: *op. cit.*, p. 25
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6. The West Yorkshire and Lindsey Regional Examining Board: cited by: Hoste, R., and Bloomfield, B.: *op. cit.*, pp. 91-98
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10. Schools Council: *CSE: School Based Examinations: Examining, Assessing and Moderating by Teachers, op. cit.*, p. 6
11. *Ibid.*
12. *Ibid.*, p. 5
13. *Ibid.*
14. *Ibid.*, p. 7
15. Kennedy, J.B.: *op. cit.*, pp. 199-201
16. Hale, D.E.: "Moderation", in Macintosh, H.G. (ed.): *op. cit.*, pp. 189-192
17. Schools Council: *CSE: School-Based Examinations: Examining, Assessing and Moderating by Teachers, op. cit.*, pp. 6-29
18. *Ibid.*, p. 6
19. Freund, J.E., and Williams, F.J.: *Modern Business Statistics*, Isaac Pitman, London, 1965. p. 475
20. *Ibid.*
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22. *Ibid.*
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24. *Ibid.*, pp. 474-491

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26. Schools Council: *CSE: School-Based Examinations: Examining, Assessing and Moderating by Teachers, op. cit.*, p. 6

27. The West Yorkshire and Lindsey Regional Examining Board: cited by: Kennedy, J.B.: *op. cit.*, pp. 197-201

28. The West Yorkshire and Lindsey Regional Examining Board: *CSE Examinations, Assessment in a Nutshell, op. cit.*, pp. 1-36

29. Schools Council: *CSE: School-Based Examinations: Examining, Assessing and Moderating by Teachers, op. cit.*, pp. 4-10

30. Schools Council: *Teachers' Experience of School Based Examining (English and Physics)*, Examinations Bulletin No. 15, HMSO, London, 1967. p. 51

31. Hale, D.E.: *op. cit.*, p. 190

32. Newbould, C.A.: "Statistical Considerations", in: Hudson, B. (ed.): *op. cit.*, pp. 57-59

33. Two fixed points that were chosen were boundaries between grades 2 and 3 and between grades 3 and 4 which lie at the mark divisions between 55 and 54 and between 45 and 44 per cent respectively. These were then plotted on a graph paper (with the grade boundaries on the vertical axis and the mark scale on the horizontal axis) and a straight line was drawn through these points. Then it was possible to translate all the marks to grades.

34. Duffey, J.: "The Assessment of Progress in Science", *School Science Review*, Vol. 54, No. 36, 1972. p. 23

35. Kelly, P.J., and Lister, R.E.: *op. cit.*, p. 135

36. The West Yorkshire and Lindsey Regional Examining Board: *CSE Examinations, Assessment in a Nutshell, op. cit.*, pp. 9-10

37. *Ibid.*, pp. 11-12

38. Schools Council: *CSE: School-Based Examinations: Examining, Assessing and Moderating by Teachers: op. cit.*, p. 5

39. *Ibid.*

CHAPTER ELEVEN

SUGGESTED MODERATION PROCEDURES TO BE FOLLOWED

11.1 THE REASONS FOR SUGGESTING A NEW APPROACH TO MODERATION

The involvement of the teacher in assessment of practical work for the Senior Certificate Examination places a heavy responsibility upon both the teacher and the Division of Education, Department of Indian Affairs. It requires teachers to recognise that competence in assessment is an integral part of their professional duties. It requires the Division of Education, Department of Indian Affairs to make appropriate arrangements for moderating the judgement of teachers and bringing this into line with the national standards. Moderation must, therefore, of necessity follow assessment whenever common standards are to be applied to teacher assessment of practical work. The procedure followed by local and overseas examining boards in moderating teacher-awarded marks has been discussed in Chapter 3.

An analysis of the procedure followed in moderating teacher-awarded marks by the Division of Education, Department of Indian Affairs, indicated that the marks that are awarded for practical work to Senior Certificate biology candidates are not fair and comparable for all candidates (p. 186). Two main reasons for this were:

(i) there are no specific criteria or statistical measures used in appraising the standard of awarding marks by teachers;

(ii) there is no consistent pattern for adjusting teacher-awarded marks to ensure uniformity of standard.

The findings in this study also indicate that the present moderating procedure is having an undesirable backwash effect on the course practical work and on pupils (pp. 145-150). Therefore, the teachers expressed the view that the present form of moderation must be replaced by a system that:

(i) will include guidance;

(ii) will ensure that the marks that are awarded by them are fair and comparable.

Some of the overseas examining boards[(1)(2)] have the above two facets built into their moderation procedure.

The findings in this study together with the moderation procedures followed by overseas examining boards will be taken into account in suggesting a pattern for moderating teacher-awarded marks. The point of view taken in this study is that a good moderating procedure will promote correct teaching and learning methods and also the attainment of desirable objectives of practical work (p. 4).

11.2 APPOINTMENT OF MODERATORS

The procedure to select "like-minded" moderators in an agreement trial had been discussed in Chapter 10. Those prospective moderators who have passed the tests for discrimination, standards and conformity are now available for appointment as moderators. In making his decision in appointing moderators the biology inspector will be guided by factors such as, the total number of moderators that are required and the number that is required in each area (i.e., in terms of schools). In terms of the moderation procedure that will be suggested in this chapter, each moderator should be able to manage about four schools. Therefore the total number that will be required for all the schools in the Republic will be about fifteen plus three for replacements. A moderator must be allocated schools which are geographically close to his place of employment. For example, a moderator will be able to manage four schools in the North Coast of Natal if he is employed in a school in that area. If he is a biology teacher at a particular school, he must not be appointed a moderator at that school. The moderation at this school could be done by a moderator from a neighbouring area and in some cases by the biology inspector. The moderators that are appointed must be well acquainted with the syllabus, objectives of practical work, assessment techniques and criteria for awarding marks. Only then, will they be able to guide the teachers in the awarding of marks, and in appraising the teacher-awarded marks for fairness and comparability for all candidates. These aspects are discussed in this chapter.

11.3 THE PATTERN OF THE MODERATION PROCEDURE

The suggested procedure of moderation is summarised in the diagram on page 273. A single moderator is used to illustrate this procedure in one of the schools. The procedure followed by all the moderators in all the schools that they visit will be identical to that indicated in the diagram.

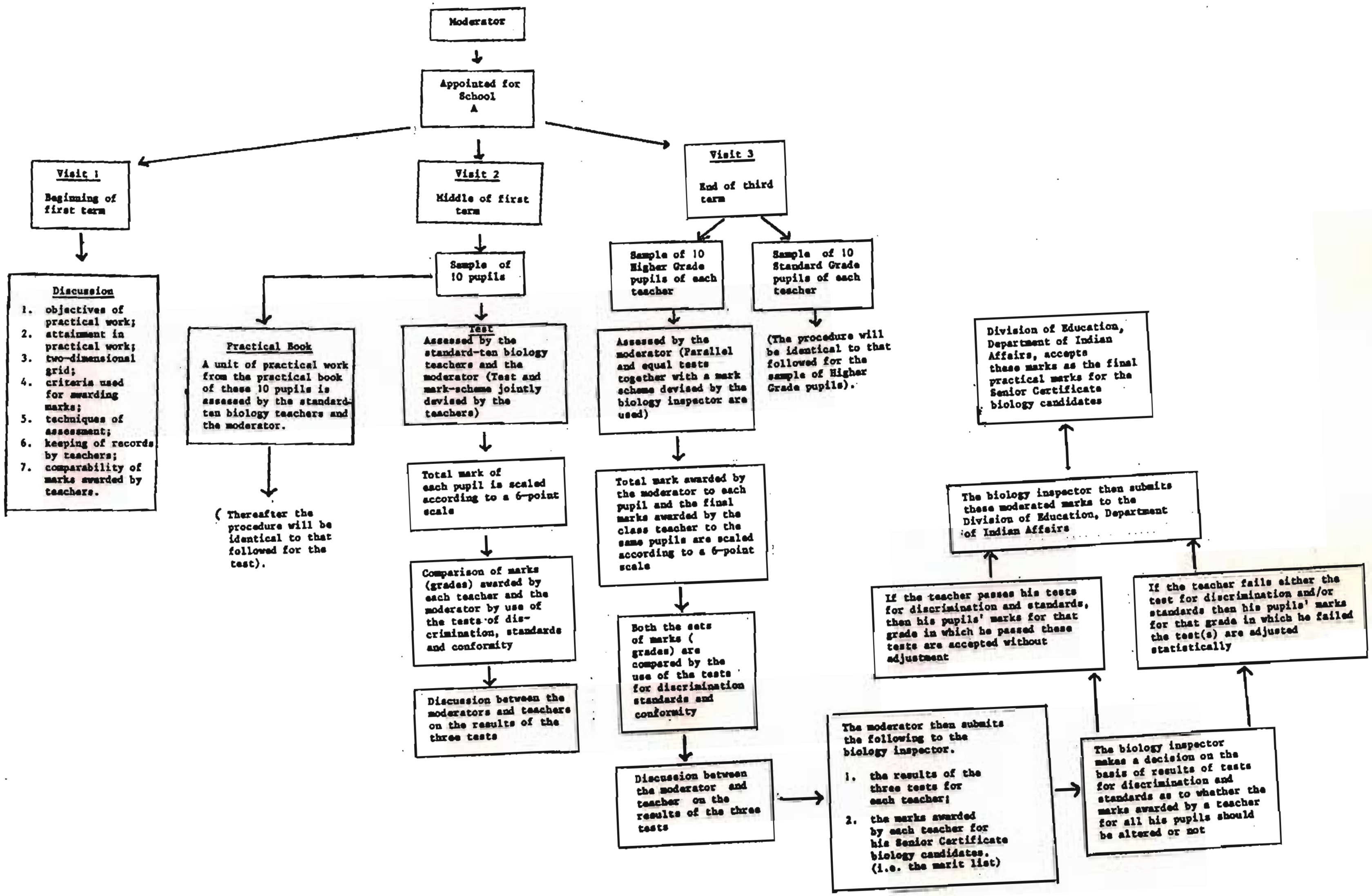
The various aspects indicated in the diagram will be discussed under specific headings.

11.3.1 Duties of a Moderator

The primary responsibility of the moderator is to ensure a uniform standard of awarding marks in practical work. In addition to this, the responsibility of the moderator is also to guide the teachers to achieve this uniform standard. To this end the moderator should encourage and help teachers in areas of objectives, criteria for awarding marks, weightings, assessment techniques, recording, etc. Therefore the duties of a moderator in the context of cumulative assessment is varied. He must make three visits to a school during the course of a year in order to achieve all that is expected of him. Through this constant contact with the moderator, the teachers are more likely to become aware of the national standard of awarding marks. The pupils will also become familiar with the moderator and so will not be confronted with a total stranger in the final stages of moderation. This is one of the problems of the practical control test, where the pupils face the examiners (who are total strangers to them) for the first time and this could be one of the factors that caused anxiety in pupils (p. 163).

The disruption of the teaching programme of the moderator and of teachers (in schools where moderation is to be conducted) should be kept to the minimum. Therefore certain visits to schools by the moderator, which will involve discussion with teachers, could take place outside school hours. The programme that is planned for moderation will have to take all these factors into account.

A SUMMARY OF THE SUGGESTED MODERATION PROCEDURE



11.3.2 The Programme of the Moderator at a School

The following programme indicated for a moderator at a school is identical to that which will be followed by all of them at all schools. In order to effectively put into practice the suggested programme of moderation, the moderator must make at least three visits, per year, to each of the schools that he is appointed to (i.e., the minimum of twelve visits to the four schools that he is in charge of). Of these three visits, one can be made outside school hours (i.e., the first visit) because it involves discussion with the teachers. In effect, the moderator will be away from school, during school time, for about eight days in the year. At present a teacher that is appointed as an examiner to conduct practical control tests is away during school time for about three weeks. Therefore in terms of time (i.e., being away during school time) and also from the point of view of educational value (i.e., in terms of guidance and ensuring uniformity of standards) it will be useful to follow the programme that is suggested for moderation in this study. This programme is discussed under the heading of each visit that a moderator will make to a school.

11.3.2.1 First Visit

A moderator's first contact with the principals of schools that he is going to visit should be made in the first few days of the first term. A visit should be arranged to meet the standard-ten biology teachers after school hours in their respective schools in order to discuss with them various aspects of practical work. This meeting should take place within the first four weeks of the first term so that the teachers could put into operation the ideas that would be suggested at this meeting. This meeting arranged in each of the schools also provides the moderator with the opportunity of familiarizing himself with the teachers and the school, i.e. he should gain insight into teaching principles, background knowledge of assessment of practical work of individual teachers, the facilities that are available at the school, etc. This will guide him in the amount of help that he can render to individual teachers at the respective schools. Some of the aspects that should be discussed at this meeting are:

(i) the objectives of practical work;

(ii) the nature of questions to use in assessing attainment of the objectives;

(iii) the importance of a two-dimensional grid;

(iv) criteria used for awarding marks;

(v) techniques of assessment;

(vi) keeping of records by teachers;

(vii) compatibility of marks awarded by teachers.

Written information on the above aspects should be sent out to schools by the biology inspectors prior to the moderator's first visit to these schools. The nature of this written information is implicit in the discussion that follows. The moderators would have received this information in addition to the information on the nature and mechanics of moderation at each school, from the biology inspector during the meeting prior to the agreement trial. This information must be carefully studied by the teachers and moderators in order that a meaningful discussion will ensue during this visit. This first visit should be made on a Saturday because an entire day is required for discussing the various aspects related to assessment of practical work. This discussion with the moderator must ensure that the teachers understand what is expected of them in the context of assessment of practical work. In this regard, the authors of the Schools Council Examination Bulletin 31 state, "a nodding acquaintance or partial understanding is worse than useless: it is potentially dangerous".(3)

11.3.2.1.1 Objectives of Practical Work

The teacher should be familiar with the objectives of practical work because these give direction to "the learning situations in which they normally place their pupils".(4) The suggested scheme of objectives of practical work (pp. 188-201) should be used as a basis for discussion. These should be carefully studied and understood by the teachers.

11.3.2.1.2 Assessment of Attainment of Objectives

Assessment of attainment in practical work should revolve around ascertaining the degree of mastery of knowledge and abilities, and the development of attitudes in pupils. To ascertain this, appropriate questions must be set or observations made. Examples of how this could be done are indicated from pages 188 to 201 of this study. This must be brought to the attention of the teachers. The teachers must also be made aware that each objective, as far as possible should not be assessed in isolation but in the context of an investigation (p. 201).

The teachers should be made aware of the problems of assessing attitudinal objectives in practical work for the Senior Certificate biology examination (see pages 111 to 113). The teachers should make every effort to provide learning situations for the development by pupils of the desirable attitudes listed from pages 197 to 201 of this study, but only the following which can be moderated should be assessed for the Senior Certificate biology examination:

(i) The pupil should be able to follow safety regulations in the laboratory.

(ii) The pupil should be able to use materials in the laboratory economically and with care.

(iii) The pupil should be able to keep his work-place neat and tidy.

The procedure to follow in assessing these will be indicated under assessment techniques (pp. 280-281).

11.3.2.1.3 The Importance of a Two-Dimensional Grid in Assessment of Practical Work

A two-dimensional grid for practical work is indicated on page 222 of this study. This grid will guide the teachers with regard to "what to assess" and in "what quantities to assess that which is to be assessed". The aim of the grid is to ensure that the assessment in any one year comprehensively covers the activities and content of the course, and the coverage is a balanced one. In this way content-validity could be ensured. At the same time, the teachers must be made aware that it is undesirable to interpret a two-dimensional grid too rigidly, since it is not possible to be precise in assessment situations with regard to the weightings that should be given to each content area and operational division (pp. 325-326). However, there are serious dangers that assessment of practical work will not serve its purpose unless some attempt is made by the teachers to decide "what is to be assessed" and in "what quantities it should be assessed". It is in this context, that the two-dimensional grid must be interpreted by the moderator during his discussions with teachers.

11.3.2.1.4 Criteria Used for Awarding Marks

Specifying criteria for the award of a particular mark (ranging from 0 per cent to 100 per cent) for the entire course work is impracticable. However, guidance could be provided to teachers by using examples from certain sections of the course work. For example, the following criteria should be used for awarding marks on the preparation and use of the microscope:

	Criteria	Marks
(i)	Correct placing of the microscope on the work-table (lamp or mirror on the opposite side to the person viewing it).	1
(ii)	Selection of the correct lens to start with.	1
(iii)	Correct light setting (using mirror and/or lamp correctly).	1
(iv)	Correct diaphragm setting.	1
(v)	Correct condenser setting.	1
(vi)	Orientation of the slide on the stage.	1
(vii)	Selection of the clearest spot on the slide for viewing.	1
(viii)	Correct focussing - coarse adjustment	1
(ix)	Correct focussing - fine adjustment.	1
(x)	Correct use of the pointer.	1
	Total	10

A similar procedure should be followed for awarding marks for the preparation of a slide of a blood smear:

	Criteria	Marks
(i)	Cleaning of the slides.	1
(ii)	Cleaning and sterilizing the finger.	1
(iii)	Quality of the smear (a thin spread).	1
(iv)	Staining (correct stain used).	1
(v)	Drying and removing excess stain.	1
	Total	5

Criteria that should be used for awarding marks for the transverse section of a stem are indicated on page 242 of this study.

Guidance should also be provided to teachers on the criteria to use in awarding marks to the different operational divisions that are indicated in the suggested scheme of objectives for practical work (pp. 188-201). This suggestion is in line with the procedure that is already followed by overseas examining boards.[(5)(6)] The suggested criteria for some of the operational divisions (i.e., b, c and d) are similar to the ones used in the Nuffield A-Level Biology. The maximum mark for each operational division is indicated as five but it could be modified to suit the assessment and the assessor.

(a) Knowledge of techniques, materials, specifics and classification that are basic to practical work

	Criteria	Marks
(i)	Exemplary, shows no difficulty in recalling knowledge that is basic to the course.	5
(ii)	Is able to recall all the essential knowledge but there are some minor omissions or misunderstandings.	4
(iii)	A little extra help is required in recalling knowledge.	3
(iv)	Considerable help is required in recalling knowledge.	2
(v)	Without help to recall basic knowledge the pupil is quite lost.	1

(b) Ability in the skill of using techniques and materials which are basic to practical work

	Criteria	Marks
(i)	Exemplary, shows no difficulty in carrying out the operation.	5
(ii)	Carries out all the essential operations but there are some minor omissions or errors.	4
(iii)	A little extra help is required but the operation is completed successfully.	3
(iv)	A considerable amount of help is required.	2
(v)	Without help at all stages of the operation the pupil will be quite lost.	1

(c) Ability to make appropriate observations and accurate recording of observations

	Criteria	Marks
(i)	Excellent. These records could be used as an example for pupils to follow.	5
(ii)	No serious faults. These records could be understood by an outside observer.	4
(iii)	Adequate, but an outside observer will need some additional information in order to understand these records.	3
(iv)	Additions or corrections will have to be made before these records can serve as a means of communication.	2
(v)	Inadequate. This work will have to be done again.	1

(d) Ability to handle results

	Criteria	
(i)	Perfect and exemplary.	5
(ii)	All the essential points are grasped. Minor omissions.	4
(iii)	Adequate but one major fault.	3
(iv)	Major misunderstandings but some insight is shown.	2
(v)	The pupil failed to grasp any of the main points.	1

(e) Showing desirable attitudes to practical work

The criteria for awarding marks are limited to those objectives which will be assessed within the context of the Senior Certificate biology examination. The criteria for awarding marks for these attitudes are along lines suggested by Duffey.[7]

1. The pupil should be able to follow safety regulations in the laboratory

	Criteria	Marks
(i)	Perfect and exemplary. Willingly obeys all safety regulations.	5
(ii)	With the exception of minor omissions all the essential safety regulations are followed.	4
(iii)	One major omission in obeying safety regulations.	3
(iv)	Willing to obey safety regulations only after being reminded.	2
(v)	Least willing to co-operate in this regard even after being reminded.	1

2. The pupil should be able to use economically and with care materials in the laboratory.

	Criteria	Marks
(i)	Exemplary. Willingly uses materials sparingly and handles materials in the laboratory with care.	5
(ii)	Generally the materials are used economically and handled with care.	4
(iii)	One major fault in the economic use and handling of materials.	3
(iv)	Willing to use materials economically and handle materials in the laboratory with care only after being reminded.	2
(v)	Least willing to co-operate in this regard even after being reminded.	1

3. Pupil should be able to keep his workplace neat and tidy

	Criteria	Marks
(i)	Perfect and exemplary. Willingly keeps his workplace neat and tidy.	5
(ii)	Generally keeps the workplace neat and tidy.	4
(iii)	One major fault in keeping his workplace neat and tidy.	3
(iv)	Willing to keep his workplace neat and tidy only after being reminded.	2
(v)	Least willing to co-operate in this regard even after being reminded.	1

The guidance that is given to teachers in specifying the criteria for the award of a particular mark will aid in ensuring comparability of standards of awarding marks between teachers in the same school and between schools. It will also ensure comparability of standards from year to year. It must be acknowledged that "in time the changing needs of society may lead to a change of objectives and also to a change in the criteria for success".[(8)]

11.3.2.1.5 Guidance on Techniques for Assessment

The various techniques that could be used in assessing attainment in practical work within the context of cumulative assessment has been discussed on pages 243 and 244 of this study. This information can be conveyed to the teachers who are given guidance in implementing these techniques. This aspect will be discussed in this section of the study.

11.3.2.1.5.1 Assessment of current exercises

The pupils are assessed as they perform the investigations which are prescribed in the practical syllabus, for the first time. The following example which is prescribed in the syllabus will be used to illustrate how this assessment could be carried out.

Excretory System (Mammal)

The following instructions should be given to pupils with regard to practical work on the excretory system:
Each pupil must do his own work and no references must be made to text-books or other sources. If help is required, this must be brought to the attention of the teacher. All responses must be in written form unless indicated otherwise. Use the dissected specimen of the rat and the longitudinal section of the kidney of a mammal in order to carry out the following activities:

(i) Examine the kidneys and associated structures in the dissected rat. What shape are the kidneys, and where are they situated? Identify the structures by which urine is removed from them and passed to the outside. Indicate this orally to the teacher. Make a fully labelled diagram (from your observation) of the urinary system. With what other system of the body is the urinary system associated? In what part of the system is urine stored before being passed to the outside? What must be a property of the walls of this structure? From which vessel does the artery supplying the kidney branch and which vessel does the vein from the kidney enter? What structures in your dissection suggest the source of the materials from which the kidneys produce urine? From the relationships of the arterial blood supply what prediction can you make about the pressure of the blood entering the kidney?

(ii) Examine the longitudinal section of the kidney of a mammal by the use of a hand lens. Draw a fully labelled diagram of this section. What is the difference in colour between the different zones of the kidney? What does this indicate in terms of the distribution of blood in the kidney? What evidence can you see of the way in which urine is collected and passed to the ureter?

The previous knowledge of pupils that is directly related to this section of practical work is on the circulatory system (done in practicals) and urinary system (read by pupils in their text-books prior to the practicals).

The operational divisions and behaviours assessed are:

(i) knowledge of specific facts: identification of structures;

(ii) ability in using apparatus: use of the hand-lens;

(iii) ability in observing and recording: recording by means of diagrams;

(iv) ability to handle results: explanations of relationship from observations, inference of function from observations of structures (and the reverse), interpretations from observations, prediction making;

(v) attitude: handling the dissected specimens with care.

The various activities that the pupils are engaged in while carrying out the above exercise (or any other exercise) could be assessed by using a structured mark scheme as in a specially designed test situation or in assessing the different operational divisions by using the criteria listed from pages 278 to 281. The writer suggests the use of the latter for assessing current practical exercises and the former for specially designed tests (see pp. 285-288). This is in line with the guidance that is given to teachers in the assessment of practical work in the Nuffield A-Level Biology.[9] The use of the operational divisions and the criteria for awarding marks for each of these (indicated from pages 278 to 281) are intended to help teachers to be as objective as possible in assessing current practical exercises, i.e., in identifying the activities that the pupils are involved in while doing the exercise, and the degree of mastery of those activities by individual pupils. This type of assessment serves a two-fold purpose:

(i) assessing individual performance of pupils;

(ii) information for adopting remedial measures, e.g., if a pupil is awarded 2 marks for "handling of results", this means, according to the criteria for the award of this mark (p. 279), the pupil has some major misunderstanding about how to explain or interpret his observations, etc. This pupil must be helped by the teacher to overcome this problem before the next practical exercise.

The teachers must be given the liberty to make assessments on current exercises of their own choice but a number of suggestions should be made to guide them:

(i) Individual work of pupils carried out in the laboratory should be assessed. Group work and work copied from other sources should not be included for assessment. To encourage pupils to do their own work, the procedure suggested for practical work on the excretory system (pp. 282-283) should be followed.

(ii) It will probably be convenient, under laboratory conditions to assess only one or two operational divisions on a particular exercise. It will in any case generally happen that a selected exercise offers particular scope for assessing only one or two operational divisions rather than the five. For instance "the ability to use techniques and materials" is hardly meaningful for the study of the skeletal systems of a mammal.

(iii) Teachers should inform their pupils when they are being assessed.

(iv) Care should be taken not to allow assessments of current exercises to interrupt the pupils' work unduly. Help should be given when required. The involvement of the teachers in assessing attainment must in no way diminish the quality and extent of their teaching. The teacher at the end of the practicals will know how much actual help he has given a pupil and he can award his mark accordingly.

(v) Care should be taken to ensure that a realistic spread of marks is awarded in a class for each operational division. A mark of 5 or 1 should not be under-used. However, if a small spread of marks is considered to be a true representation of the abilities of a class in practical work, it should then be used.

(vi) The mark allocated for each operational division in an exercise must be recorded separately in the form of a percentage. For example, if a pupil is awarded a mark of 3 (i.e., 3 out of a mark of 5) for handling of results, his mark must be reflected as 60 per cent for this operational division of that particular exercise. The procedure to follow in keeping records will be discussed from pages 289 to 293 of this study.

11.3.2.1.5.2 Specially designed practical tests

Each test exercise should aim at testing a whole investigation (i.e., include all the operational divisions). The duration of a test should not be longer than a double period (i.e., 70 minutes) and it should be conducted at the completion of each major topic e.g., ecology), provided that other assessment techniques were not used to assess this area. The results should be objectively marked, as far as possible. To promote this a highly structured mark scheme must be used. One example of a test which could be used is indicated below.

1. Plasmolysis

(i) Peel a piece of epidermis off the piece of rhubarb stalk. Prepare a slide in a drop of solution B (which is distilled water).

(ii) Examine this prepared slide under the microscope and find a group of clearly defined cells with red cell sap.

(iii) Add a drop of solution A (which is a 20 per cent NaCl solution) to one side of a cover glass and draw it under the cover glass with the help of filter paper. While doing so, watch what occurs under the microscope. Continue to add solution A until you see some changes.

(iv) Write down your observation.

(v) Now add a drop of solution B in the same way until you observe some changes under the microscope.

(vi) Write down your observation.

(vii) Explain the phenomenon observed when you used solutions A and then B.

(viii) What deduction could you make from this investigation that you carried out?

Operational divisions and behaviours tested are:

(i) skill in using techniques and materials: preparation of a slide, manipulation of the microscope;

(ii) ability to make appropriate observations and recording them accurately: observation and recording when solutions A and then B are added;

(iii) handling of results: explanation of the phenomena, and making a deduction;

(iv) attitude: leaving the work place neat and tidy.

Mark Scheme

	Criteria		Maximum marks
(i)	Preparation of slide:		
	Clearly defined epidermal cells	(2 marks)	
	Epidermal cells with some cortical		2
	cells but useful	(1 mark)	
	Correct amount of mountant used		1
	Air bubbles absent	(2 marks)	
	Air bubbles present but they do		2
	not interfere with observation	(1 mark)	
	Total		5
(ii)	Preparation and use of the microscope: (mark scheme for awarding marks for this aspect is indicated on page 277, but the maximum mark is reduced from 10 to 5 for this test, i.e., 10 x ½ mark)	Total	5

(iii) Procedure:

Using a dropper/pipette to place solution on slide.	1
Avoids flooding slide.	1
Uses filter paper correctly to draw solution under the cover slip.	1
Total	3

(iv) Observing and recording:

Cytoplasm breaks from cell wall	1
Decrease in volume of cell sap	1
Total	2

(v) No marks are allocated for this procedure because marks for a similar procedure are allocated in question iii.

(vi) Observing and recording:

Cytoplasm is pushed against the cell wall.	1
Increase in volume of cell sap.	1
Total	2

(vii) Handling of results:

Explanation - when solution A was used there was movement of water from cell sap into the solution (1 mark) i.e., from high water potential to low water potential (1 mark)	2
- When solution B was used there was movement of water from the solution into the cell sap (1 mark) i.e., from high water potential to low water potential (1 mark)	2
- If the terms "osmosis" and "plasmolysis" are used then each should be allocated a mark.	2
Total	6

(viii) Handling of results:

Deduction - When cytoplasm and its membrane separate liquids with different water potential (1 mark) then there is movement of water from high water potential to low water potential (1 mark) — 2

Total — 2

(ix) Attitude:

Keeping his work place neat and tidy (the procedure to follow in awarding marks for this are indicated on page 281)

Total — 5

The maximum mark for the test is 30. The procedure to follow in keeping records of test marks and the practical application of the two-dimensional grid will be discussed from pages 289 to 293.

11.3.2.1.5.3 Pupils' practical books

Pupils record the current practical exercises that they do in the laboratory in their practical books. The present study has indicated that the work recorded by pupils in these books is not their original work and as such it was not recommended as a source of assessment (pp. 156-157). To get the pupils to record their own observations and interpretations, etc., the following steps should be taken:

(i) The pupils must be instructed to record their own observations and interpretations, etc., in their practical books. However, this is not required of pupils whenever group-work is done because it involves group observation and interpretation. Anyway, group-work should not be included for assessment because it is individual attainment that is to be assessed.

(ii) Text-books and reference materials should not be used by pupils in the laboratory. In this way the teacher could ensure that pupils are not copying down materials from these sources into their practical books. If they require help they should consult the teacher.

(iii) Clear instructions must be provided for pupils in terms of what is expected of them in each practical exercise. This should be done by providing them with worksheets. An example of a worksheet is given on page 282 in relation to the excretory system.

(iv) Only sections of work completed in the laboratory must be collected for assessment.

If these steps are taken, then the practical books could be used to assess attainment of pupils in practical work. The use of practical books in the context of assessment of current exercises has been discussed from pages 281 to 285. The teachers should also choose specific units of work from the practical books for assessment provided they are the pupil's individual work. Two operational divisions that could be assessed through this procedure are:

(i) ability to make appropriate observations and record observations accordingly;

(ii) handling of results.

The qualities to look for under these operational divisions are listed on page 279. To assess attainment of pupils through the use of practical books, the writer suggests the use of the procedure indicated for assessing current practical exercises. That is, observation and recording, and handling of results indicated in the practical books could be assessed through the use of a five-point scale where the criteria for the award of a particular mark are clearly specified (p. 279). In this way uniformity of standard of awarding marks between teachers and schools could be ensured.

11.3.2.1.6 Keeping of Records by Teachers

Cumulative assessment requires the teacher to build up cumulative judgement about the performance of each pupil over a period of time before allocating the final mark per pupil. The greatest educational value of this type of assessment lies in monitoring the progress of individual pupils and adopting appropriate remedial measures when required. To meet these requirements keeping of records by teachers becomes essential. The particular choice of record cannot be haphazard, it must be appropriate to meet the declared aims and objectives, i.e., balanced assessment and checking on the progress of individual pupils. The type of record that is suggested below takes the above requirements into account. In order to keep this type of record the following are prerequisites:

(i) The teachers must be aware of and able to identify the activities that he is assessing. This has been described with suitable examples from pages 283 to 286.

(ii) These activities must then be categorised into the operational divisions (pp. 188-201). This has been described with suitable examples on page 286.

(iii) The marks awarded for each operational division must then be computed into a percentage. For example, if the maximum mark for "handling of results" in a test was 8 (pp. 287-288) and the pupil got a mark of 4 then his percentage mark for this operational division will be 50.

Then the details are written onto the record sheet. A separate record sheet must be filled in for each pupil. An example of a completed record sheet for a Higher Grade pupil is indicated on page 291. The graphs, all that appear in italics and the information that appear in the following rows must be filled in by the teacher:

(i) date of assessment;
(ii) assessment technique used;
(iii) attitude and activities assessed;
(iv) percentage marks attained by pupil.

The record sheet is self-explanatory.

RECORD SHEET - ASSESSMENT OF PRACTICAL WORK IN

SCHOOL *Burlington High* NAME OF PUPIL *Anandhan Rajgopaul* STANDARD *10 C* GRADE *Higher Grade*

MARK RANGE

Attainment of Pupil in Terms of the Mark Range.
Follow the following procedure:
For each assessment carried out indicate by a dot in the appropriate mark range, the attainment of the pupil in each operational division, listed on the left hand side of this page, then join the dots of each operational division to form a graph.

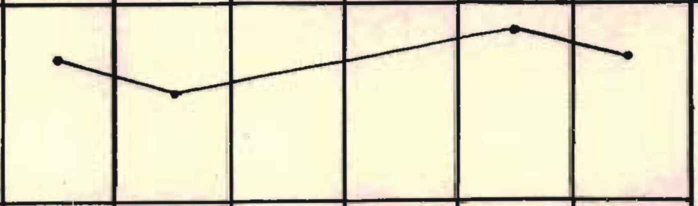
Computation of Marks (indicate the marks i

COLUMN A: Total mark for each operational division. This is computed by adding the percentage marks that appear in the row indicated by an arrow.

COLUMN: Mean mark for ea operational divi This is computed dividing the tot indicated in col A by the number times this opera division was ass

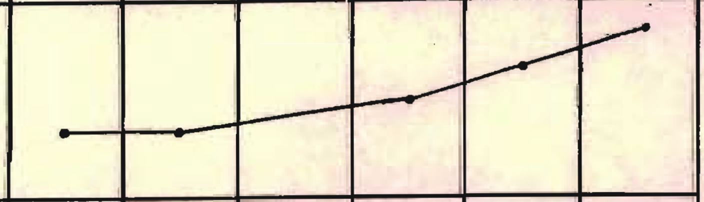
ASSESSMENTS

65% or over
55% to 64%
45% to 54%
35% to 44%
34% or less



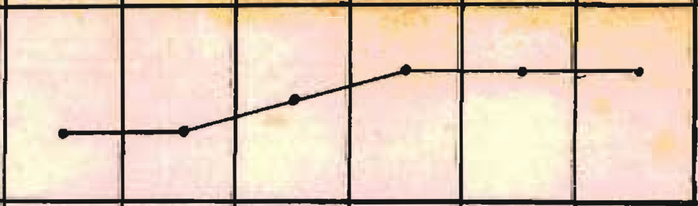
	1	2	3	4	5	6	COLUMN A	COLUMN
	8/2/79	27/2/79	-	-	20/5/79	8/8/79		
	Test	Current exercise	-	-	Current exercise	Test		
	Identification	Identification	-	-	Identification	Identification	244	61
	Diversity and unity	Flower	-	-	Structure and function	Ecology.		
	57%	52%	-	-	75%	60%	←	

65% or over
55% to 64%
45% to 54%
35% to 44%
34% or less



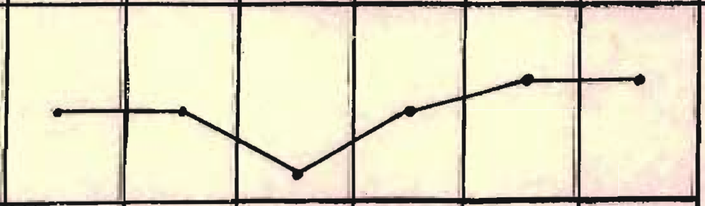
	1	2	3	4	5	6	COLUMN A	COLUMN
	8/2/79	27/2/79	-	16/4/79	20/5/79	8/8/79		
	As above	As above	-	Test	As above	As above		
	Slide prep, microscope use	Dissection	-	Slide prep., microscope use	Use of hand lens.	Use of microscope	275	55
	As above	As above	-	Experiment	As above	As above		
	42%	41%	-	52%	60%	80%	←	

65% or over
55% to 64%
45% to 54%
35% to 44%
34% or less



	1	2	3	4	5	6	COLUMN A	COLUMN
	8/2/79	27/2/79	15/3/79	16/4/79	20/5/79	8/8/79		
	As above	As above	Practical book	As above	As above	As above		
	Recording - diagrams	Recording - diagrams	Recording - diagrams -	Recording words	Recording - diagrams	Recording - words and diagrams	309	52
	As above	As above	Plant anatomy.	As above	As above	As above		
	35%	40%	52%	60%	62%	60%	←	

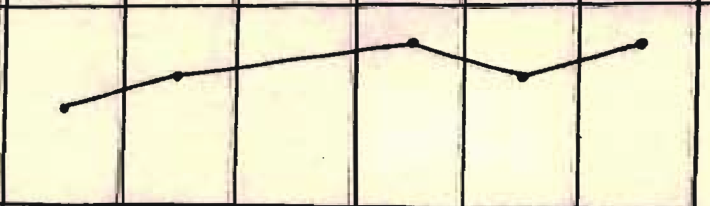
65% or over
55% to 64%
45% to 54%
35% to 44%
34% or less



Mark of 25% was excluded from the computation because it was extremely low when compared with the other marks.

	1	2	3	4	5	6	COLUMN A	COLUMN
	8/2/79	27/2/79	15/3/79	16/4/79	20/5/79	8/8/79		
	As above	As above	As above	As above	As above	As above		
	Explanation	Inference	Explanation inference	Explanation deduction	Explanation inference interpretation	Inference	273	55
	As above	As above	As above	As above	As above	As above		
	50%	52%	25%	50%	61%	60%	←	

65% or over
55% to 64%
45% to 54%
35% to 44%
34% or less



	1	2	3	4	5	6	COLUMN A	COLUMN
	8/2/79	27/2/79	-	16/4/79	20/5/79	8/8/79		
	Five-point scale	Five-point scale	-	Five-point scale	Five-point scale	Five-point scale		
	Tidiness	Tidiness	-	Tidiness	Handling with care	Handling with care	318	64
	As above	As above	-	As above	As above	As above		
	50%	60%	-	70%	58%	80%	←	

FINAL ATTAINMENT OF PUPIL (SUM OF WEIGHTINGS INDICATED IN COLUMN C) 56% = 39/70

When the total percentage mark for each operational division is being computed, "freak marks" (i.e., very low or high marks when compared with other marks for that operational division) should be excluded. For example, the record sheet indicates that the pupil has a mark of 25 per cent for "handling of results" when his practical book was assessed (i.e., for assessment 3). This mark is comparatively low when compared with the other marks for this operational division. Therefore this mark was excluded in the computation.

This record sheet indicates:

(i) that the teachers assessed the subject areas (content) suggested in the two-dimensional grid (p. 222) i.e., use of the microscope (assessment on ferns and experiments), slide preparation (assessment on ferns and experiment), experiment, plant anatomy, mammal structure and physiology (assessment on excretory system), diversity and unity (assessment on ferns), flower and ecology;

(ii) that the teachers assessed the five operational divisions indicated in the two-dimensional grid (p. 222)

(iii) the weightings suggested in the two-dimensional grid for the operational divisions have been taken into account but the same could not be done for the content areas, because of overlap of these in assessment situations;

(iv) that the pupil initially had problems in observation and recording (i.e., his diagrams were poor), and in the skill of using techniques and materials (i.e., preparation of slide, use of the microscope and dissection) - therefore he required help in these areas from the teacher;

(v) generally, after overcoming some initial problems, the pupil has made steady progress in the operational divisions;

(vi) the final mark attained by the pupil is 56 per cent or 39 out of 70 (70 is the maximum mark for practical work in the Senior Certificate biology examination in the Higher Grade);

(vii) pupils were assessed over a period of time through the use of a variety of techniques.

This record sheet which looks complex, will be found to be practicable and useful, because:

(i) it shifts the teachers focus from the class as a single entity to individual pupils;

(ii) it indicates the problem areas of individual pupils so remedial measures can be adopted;

(iii) it indicates not only the final attainment of pupils but also their progress towards it.

The above aspects are the "corner-stone" on which cumulative assessment should be based, if it is going to be of any educational value. It is in this context, that the form of recording that is suggested in this study should be conveyed to the teachers.

11.3.2.1.7 <u>Comparability of Marks Awarded by Teachers</u>

The present study indicates that there was variation in the standard of awarding marks among teachers in the same school (p. 185). Therefore the marks awarded to pupils by their respective teachers are not comparable. That is, pupils of equal merit are not awarded similar marks. To correct this, in addition to what has been suggested in the preceding sections of this study, the moderator should advise:

(i) the teachers in a school to set tests jointly for all the pupils;

(ii) that teachers should jointly award marks to a test i.e., each teacher awards marks for a section of the test for all the pupils;

(iii) that tests devised, administered and marked by individual teachers should be moderated by their colleagues;

(iv) teachers should jointly decide before hand which current practical exercise and work entered in practical books should be assessed for all the pupils;

(v) that colleagues should moderate marks given by a class teacher for work entered in the practical books, and for aspects of current practical exercises which do not require observation of manipulative skills in the laboratory;

(vi) that teachers should assess each other's pupils periodically through the use of tests and/or current practical exercises.

If the above procedures are followed, then the marks awarded to pupils are likely to be reliable and comparable.

From the foregoing discussion it is evident that the first visit of the moderator to the school is crucial because this guidance, if properly understood and practised by teachers, will ensure that the cumulative assessment procedure is valid, reliable and nationally comparable.

During this visit he also prepares the way for subsequent visits. He arranges a date for his second visit which must be in the middle of the first term. The teachers are informed of the programme and the procedure that he will follow during this visit. He should instruct each teacher to draw up a merit list based on the performance of his pupils in practical work. The merit list should be separate for the Higher Grade and Standard Grade pupils. Teachers should jointly prepare a practical test and structured mark scheme (for both the grades) based on work completed by pupils. The maximum mark for the Higher Grade and Standard Grade for this test should be 70 and 50 respectively (p. 250). The test must not be of more than two hours duration and a sample of five Higher Grade and five Standard Grade pupils will be assessed in this test. Within three days of the first visit the test paper and the mark scheme must be sent to the moderator, who will moderate and send it back to the teachers promptly. The teachers must then prepare enough copies of the test paper and one mark scheme for each teacher and the moderator. The teachers must also organise the laboratory and materials for the test which will be conducted for an unbroken period of two hours on the date fixed for the second visit. The pupils must bring in their practical books on this day.

11.3.2.2 Second Visit

The procedure followed by the moderator during his second visit to the school (i.e., during the school hours) is divided into two parts, i.e., conducting a practical test and assessing the practical books of pupils. The main purpose of this visit is to scrutinize the overall standard of awarding marks by teachers (i.e., in terms of discrimination, leniency or severity and consistency) and to advise them accordingly.

11.3.2.2.1 The Practical Test

During the moderator's second visit to the school he follows the procedure that was described for the agreement trial in conducting a test and using its results in appraising the overall standard of awarding marks by teachers (pp. 255-269). This is summarised as follows:

(i) He selects a representative sample of five Higher Grade pupils from the merit list of a teacher and five Standard Grade pupils from the merit list of the same teacher or another teacher. If there are less than six pupils in a particular grade at a school then all the pupils for that grade are included. The total number of pupils selected for the test is ten. The procedure to follow in selecting pupils is given on page 255 .

(ii) The organisation and administration of the test is given from pages 252 to 257.

(iii) Each assessor (i.e., the standard-ten biology teachers and the moderator) must assess independently the same pieces of work done by pupils in the test (p. 256).

(iv) The marks awarded to each pupil by different teachers in this test must then be entered onto separate validation sheets. These marks are then scaled according to a 6-point scale. The marks awarded by the moderator must also be entered onto the validation sheet of each teacher and scaled accordingly. Details of the format of a validation sheet, the procedure to be followed in entering the names of pupils and marks and the pattern followed in scaling, are given from pages 256 to 269.

(v) A comparison is then made between the marks awarded by each teacher and the moderator by the use of tests of discrimination, standards and conformity (pp. 261-269).

(vi) The results of these statistical tests are then discussed with each teacher. Any problems with regard to their overall standard of awarding marks are identified and ways of obviating these problems are suggested. For example, if a teacher failed his test of standards, then he will be advised not to be too lenient or too severe in awarding marks, as the case may be.

11.3.2.2.2 Pupils' Practical Books

On the completion of the discussion with the teachers on the test results, the overall standard of awarding marks by teachers to a unit of work in the pupils' practical books is then appraised. The following procedure is followed:

(i) The ten practical books of those pupils that are selected for the test are used for this purpose.

(ii) A unit of work (e.g., experiment: suction force of transpiration) that is reflected in the practical book of these ten pupils is selected for assessment.

(iii) Each assessor (i.e., the standard-ten biology teachers and the moderator), independently, assess this unit of each pupil's work. The abilities that must be assessed are: ability to make appropriate observations and accurate recording of observations; the ability to handle results (pp. 288-289). The five-point scales given on page 279 should be used to assess these abilities, i.e., the scale for observation and recording and the scale for handling results. These scales specify the criteria for the award of a particular mark. The maximum mark for each ability is five. If an assessor feels that the unit of work is very badly done by a pupil and the minimum mark on the scale should not be allocated to the pupil (i.e., 1 mark) then the assessor can award a zero mark for this work. No distinction is made between grades (i.e., Higher Grade and Standard Grade) in awarding these marks.

(iv) The total mark awarded to each pupil by the teacher and the moderator must be written onto a validation sheet. Each teacher fills in a separate validation sheet. The procedure to fill in this is identical to that indicated for the test. In order to use the tests of standards, discrimination and conformity the marks awarded must be converted to grades as follows:

Mark Range	Grade
9-10	1
7-8	2
5-6	3
3-4	4
1-2	5
0	6

These scaled marks must then be entered onto the validation sheets. Since the maximum mark is 10, this type of scaling is suitable instead of the one suggested on page 261 where the marks have a bigger range.

(v) The procedure that will be followed after this stage will be identical to that indicated for the test.

The advice given to teachers on their overall standard of awarding marks can be implemented by them in their future assessments. The marks already allocated by them in previous assessments could be adjusted by them. This is the sole responsibility of the teacher because the duty of the moderator during this visit is to guide them in the standard of awarding marks in terms of the national standard and not to adjust marks that are awarded by teachers.

The moderator must also arrange a date for his next visit to the school which will be at the end of the third term. The teachers should be informed of the procedure that he will follow and what he will require from the teachers during this third visit, i.e., merit list from each teacher for each grade, final practical marks allocated to pupils, facilities and materials that will be required for the test, etc. During this third visit the moderator will be required to spend a day in appraising the standard of awarding marks by each teacher at a school. Therefore the number of days that he will spend at a school will be dependent on the number of standard-ten biology teachers that are at that school. The majority of the schools have either one or two teachers.

11.3.2.3 Third Visit

The purpose of this visit to the school is to check the standard of awarding marks by teachers and if there is lack of agreement between the teacher's and moderator's marks then the teacher's marks are adjusted to bring them into line with the moderator's marks (i.e., the national standard). In order to do this all the moderators must use equal and parallel tests that are developed by the biology inspectors and they must assess a representative sample of Higher Grade and Standard Grade pupils of each teacher. These two aspects are discussed below under specific headings.

11.3.2.3.1 Equal and Parallel Tests

These tests as indicated earlier should be developed by the biology inspectors. The duration of each test should be two hours (for reasons, see pp. 249-250). The work selected for assessment must enable the moderator to make an informed judgement of the standard of teacher-awarded marks.

The characteristics of equal and parallel tests are as follows:[10]

(i) the same number of question items are included in each of the tests;

(ii) the same abilities and attitudes are assessed;

(iii) the same subject areas are assessed, although the example chosen from each subject area may be different for each test;

(iv) they have the same weightings in terms of operational divisions and content;

(v) the same overall time is given for completion of the test;

(vi) they have the same maximum marks per question and for the overall test.

The weightings that are given to the operational divisions must be within reasonable limits of that suggested in the two-dimensional grid in this study (p. 222). Each of the test papers must also be accompanied by a structured mark scheme. The writer suggests the construction of eight equal and parallel tests for each grade. This will make it possible for the moderator to use these eight tests in the four schools that he will visit (i.e., two tests per school). This aspect is discussed on page 308.

It is also important that these equal and parallel tests used in moderation should be of an appropriate level of difficulty and should discriminate between the candidates. Item analysis of tests which can be broken down into a series of right or wrong answers scoring 0 or 1 mark , has been described in detail by many authors. Ebel[11] and Brown, Hitchman and Yeoman[12] give straightforward descriptions of the process. The candidates are ranked according to their performance in the test as a whole and two sub-groups, the 27 per cent scoring the highest marks and the 27 per cent scoring the lowest marks, are then separated. The figure of 27 per cent allows the extreme groups to be both as large and as different as possible. Two indices, one of item difficulty, often called the "Facility Level F", and one of item discrimination, often called the "Discrimination Value D", can then be computed for each item. "F" is the percentage of correct answers by candidates in the top and bottom groups together, while "D" is the proportion of correct answers by candidates in the top group minus the proportion of correct answers by candidates in the bottom group.

$$F = \frac{\text{Number of correct responses in top 27 per cent} + \text{Number of correct responses in bottom 27 per cent}}{\text{Sum of number of candidates in each group}} \times 100$$

$$D = \frac{\text{Number of correct responses in top 27 per cent}}{\text{Number of candidates in top group}} - \frac{\text{Number of correct responses in bottom 27 per cent}}{\text{Number of candidates in bottom group}}$$

The most reliable and valid tests consist of items of medium difficulty F = 50, although a range of 30 to 70 is generally accepted.[13] Good items have a discrimination value of 0,4 or better.[14]

Since the practical test items do not contain single 0 or 1 mark items, their analysis will have to be modified. Facility level for each question in the practical test can be taken as the mean mark obtained by all the candidates, expressed as a percentage of the maximum possible mark[15] i.e.,

$$F = \frac{\text{Mean mark for the question}}{\text{Maximum mark for the question}} \times 100$$

For example, if the mean mark for the question was 10,20 and the maximum mark for this question was 15, then the facility level for this question will be 68,00 per cent. The discrimination index of a practical test item is simply the correlation between the mark on the question and the mark on the whole paper and this could be done by the use of the Pearson product-moment correlation coefficient for large samples ($N > 30$) or the Spearman's rank-order correlation for small samples ($N < 30$).[16] Each question item in the practical test contributes appreciably to the total mark (the variation in question marks is reflected in a similar but reduced way in the variation of the total marks) and the correlation between the mark on the questions and the mark on the paper is thus spuriously high. For this reason Nuttall and Willmott[17] suggest that a satisfactory discrimination index in this context should be higher than that required for an objective item and only values greater than 0,50 indicate that a question is showing adequate discrimination. This discrimination index of 0,50 or above seems appropriate for practical test items.

A facility index of 50 does not automatically mean that scores have been well spread across the available mark range of a question. Bunching of the scores will tend to reduce the discrimination of the question, but a poor discrimination index does not automatically mean that the scores are bunched.[18] It follows therefore, that a useful piece of information for describing the effectiveness of practical test items is the calculation of the standard deviation which will indicate the spread of marks. The Schools Council Examination Bulletin No. 3 indicates that the standard deviation of the marks of a test is expected to be about one-fifth of their range in order to allow for good discrimination.[19] The writer is of the opinion that this criterion could also be used to establish the discrimination of individual questions of the practical tests. Another procedure that is commonly used by research workers to discover whether each question is contributing its share to the paper's discrimination between candidates is through the recording of the mean mark in the form of histograms.[20][21] In order to do this candidates are ranked in order of total marks on the paper. The order is then divided into sixths from an "upper sixth" down to a "bottom sixth". The mean mark of each group for the question is then found and the results recorded in the form of a histogram. For each question the mean decreases from the top sixth to the bottom sixth, indicating good discrimination.

The mean, standard deviation and range taken together can be used to give an indication of the ability of a test to discriminate (see page 236 of this study).

We have seen that indices of facility and discrimination may be developed for practical test questions along similar lines to those used for many years in objective testing. They can be used to judge the effectiveness of questions in the practical test and also for selecting questions for future practical tests through pre-testing. Both of these are important in the context of moderation.

11.3.2.3.2 <u>Choosing a Representative Sample for the Test</u>

From a statistical point of view, if the sample is to be representative, then:[22]

(i) the sample mean should be neither too large nor too small when compared with the population mean;

(ii) the sample standard deviation must not be very much smaller than the population standard deviation.

Tables 11.1 and 11.2 indicate the position with regard to the means and standard deviations (after checking for bias) of teacher-awarded marks for the sample (selected through purposive sampling for the practical control tests) and the population from which this sample was chosen, at fifty-one schools. Not all the schools (i.e., fifty-four schools) are included for both the grades because some schools did not have both Higher Grade and Standard Grade candidates, or they had only one candidate in one of these grades.

TABLE 11.1: DIFFERENCE BETWEEN THE MEANS OF TEACHER-AWARDED MARKS FOR THE SAMPLE AND THE POPULATION

Difference between means of teacher-awarded marks for the sample and the population	Higher Grade		Standard Grade	
	Schools		Schools	
	Number	Percentage	Number	Percentage
Less than 1 mark	33	64,71	25	49,02
1 to 2 marks	14	27,45	24	47,06
above 2 but less than 3 marks	4	7,84	2	3,92
Total	51	100,00	51	100,00

TABLE 11.2: A COMPARISON OF THE STANDARD DEVIATIONS OF THE SAMPLE AND POPULATION WITH REGARD TO TEACHER-AWARDED MARKS

Grades	Sample Standard Deviations							
	Same as the population		Smaller than the population			Larger than the population		
	Schools		Schools			Schools		
	Number	Percentage	Number	Percentage	Range of difference	Number	Percentage	Range of difference
Higher Grade	3	5,88	3	5,88	1,46 to 1,94	45	88,23	0,35 to 4,66
Standard Grade	2	3,92	8	15,69	0,03 to 1,42	41	80,39	0,14 to 3,53

According to Table 11.1 and 11.2 :

(i) the sample means at the 51 schools is neither too large nor too small when compared with the population mean at each of these schools;

(ii) the sample standard deviation is not very much smaller than the population standard deviation at eight schools for the Standard Grade and three schools for the Higher Grade. (It is higher or the same at the remainder of the schools).

The above findings are consistent with the results indicated in Tables 7.3 and 7.4 for twenty individual schools (pp. 174-175). These statistical measures indicate that the sample that is selected through purposive sampling (as in the agreement trial and for tests conducted by the moderator during his second visit to schools) in the practical control tests (p. 63) at each school is a representative sample of Senior Certificate biology candidates (in terms of teacher-awarded marks) in the respective schools. Therefore there is justification for the use of the marks that are awarded to a sample by the moderator, to adjust marks of all pupils in the population from which the sample came.

Closely linked with sampling is the standard error of the mean. All samplings have standard errors. The larger the sample, the smaller is the size of the standard error of the mean in relation to the units of measurement, and the more reliable the statistic.[23] This is because the size of the standard error of the mean is inversely proportional to the square root of the cases in the sample, and directly proportional to the standard deviation.[24] The standard error of the mean of the sample (for teacher-awarded marks and practical control test marks) and the population (for teacher-awarded marks) are indicated in Tables 7.3 and 7.4, for twenty schools that were selected at random. The results in these Tables indicate that the standard error of the means for the sample for teacher-awarded marks and for practical control tests are larger than the standard error of the means for the population. This suggests that if the sample size, (which ranged from 6 to 17 pupils) that is selected for the practical control test is increased in each school the mean and standard deviation will be more reliable. However, there are practical problems in increasing the sample size in a practical test situation where the test is externally set and administered and marked by the moderator. This aspect is discussed below.

Findings in this study indicate that there is a discrepancy in the standard of awarding marks among teachers in the same school (p. 185). This indicates that it is necessary to select a representative sample for each teacher at a school in order to moderate his standard of awarding marks to his pupils. In adjusting teacher-awarded marks statistically, the mean and standard deviation will be used (pp. 311-314) and since the maximum mark for practical work is different (the weightings given to the different operational divisions are also different) for the Higher Grade (i.e., 70 marks) and Standard Grade (i.e., 50 marks), then the computation of the mean and standard deviation will have to be separate for each of the grades. Implicit in this is that a representative sample of Higher Grade and Standard Grade pupils per teacher must be selected at each school.

There are also practical problems in selecting a large sample per teacher per grade at a school for the test. These are laboratory accommodation, availability of facilities and materials and the number that a moderator can cope with.

Against this background the following suggestions are made for choosing a representative sample for the test:

(i) A representative sample of Higher Grade and Standard Grade pupils per teacher per school must be selected from the merit list compiled by the teacher, through purposive sampling (p. 255). The findings in this study indicate that a representative sample can be selected through this procedure (p. 305).

(ii) The number of pupils that are selected for each grade per teacher must be limited to ten (i.e., twenty pupils are selected per teacher). At present ten pupils are selected per school for the practical control test. The results in Tables 7.3 and 7.4 (pp. 174-175) indicate that a representative sample of ten per grade can provide means and standard deviations which are neither too small nor too large when compared with the population means and standard deviations. For practical problems (p. 306) it is not possible to increase the number in the sample to beyond ten per grade per teacher.

(iii) Choosing ten pupils per grade per teacher through purposive sampling warrants the use of statistical techniques. In order to use the formula indicated below, the marks of pupils indicated on the merit list of the teacher must first be converted into grades according to the procedure suggested on page 261. Then a proportional representation from each grade must be selected. The number of pupils to select from each grade must be based on the following formula:[25]

$$\frac{\text{Number of pupils in the grade}}{\text{Total number of pupils in the merit list}} \times 10 \text{ (i.e., the maximum number to be selected for the agreement trial)}$$

Discretion must be used over fractions. The following grid illustrates the choosing of a proportional representation from each grade by using the above formula. It is important to include each grade in a sample.

Grade	1	2	3	4	5	6	Totals
Total	4	6	10	5	2	3	30
Sample	1	2	3	2	1	1	10

After the number of pupils that are to be selected from each grade are determined, then a representative sample must be selected from each grade. For example, there are 3 pupils to be selected from grade 3 (according to the grid). In this case the top, the middle and end pupil of grade 3 (based on marks indicated in the merit list) must be selected. In grade 1 it is best to select the top pupil and in grade 6 the bottom pupil (based on marks on the merit list). For grade 2 it is best to select the top and the middle pupil since the top of grade 1 and top of grade 3 are selected. For grade 4, the middle and the bottom pupil can be selected, while for grade 5 the bottom pupil can be selected. Discretion must be used in selecting a representative sample to ensure that the grades (based on marks awarded by the teacher) are represented both numerically and for quality. In this way the full range of candidates will be represented in the sample of 10. If there are fewer than 10 pupils for either grade then all the pupils must be included.

11.3.2.3.3 Assessment of Pupils' Performance

For one teacher, the moderator will assess a sample of ten Higher Grade pupils in the morning (i.e., between 9h00-11h00) and the sample of ten Standard Grade pupils in the afternoon (i.e., 13h00 and 15h00). If there are two standard-ten biology teachers at the school then he will have to revisit the school on the following day to assess the pupils of the second teacher. Generally the majority of the schools have either one or two standard-ten biology teachers. Implicit in this is the fact that the moderator will be generally using two equal and parallel tests per grade per school. This is why, it was suggested that the biology inspector must prepare eight equal and parallel tests to be used by each moderator at his four schools (p. 299). If there are more than two biology teachers at a school then the tests used by the moderator at another school ought to be repeated.

The organisation, administration and marking of the test will be identical to the procedure that was followed in the agreement trial and in conducting the test during his second visit to the school. The only difference is that the moderator and not the teachers will be assessing the performance of pupils in this test.

11.3.2.3.4 Entry of Marks onto Validation Sheets

After all the samples selected at a school are assessed, the moderator must enter the marks that he awarded to individuals in each sample on validation sheets. A separate validation sheet must be used for each sample that is selected. The marks awarded by teachers through cumulative assessment to the same pupils (i.e., the samples) must also be entered on these validation sheets. The format of these sheets will be identical to the one that was used in the agreement trial (p. 264). The only difference will be the substitution of the words "teacher" and "moderator" for the words "prospective moderators" and "biology inspector", respectively. The procedure followed in entering these marks, scaling and computing for tests of standards, discrimination and conformity are identical to those indicated for the agreement trial (pp. 261-269). The results of these tests must be indicated for each teacher per grade on the validation sheets (pp. 264-267). All this is done before the moderator leaves the school on the last day of testing. This is important because he has to give the teachers feedback with regard to their overall standard of awarding marks through cumulative assessment.

Without this feedback, the teachers will not know whether the final marks that they are awarding to pupils are in line with the standards of the Department. This information given to the teachers by the moderator must be treated in confidence and must not be revealed to the pupils.

The moderator then submits to the biology inspector these validation sheets, together with the merit list of each teacher (which reflects each pupil's Senior Certificate Examination number, name and marks awarded by the teacher).

11.3.3 Criteria Used in Judging Whether the Marks Awarded by the Teachers Should be Accepted or Not

The biology inspectors do not alter the teacher's merit order of the pupils even when teacher-awarded marks are adjusted by them. This aspect has been fully discussed on page 166. Therefore the results of the test for conformity cannot be used for judging whether the teacher's mark should be adjusted or not. The test for conformity indicates whether the teachers and the moderator are assessing for the same qualities (i.e., in general, if they are assessing for the same qualities then the rank order of candidates by the moderator and the teacher should be the same pp. 182-185). The results of tests for standards and discrimination must be used as a basis for making a decision on adjustment or non-adjustment of teachers' marks. Implicit in this, is that steps will be taken to correct teacher's marks if leniency or severity (indicated by the test for standards), or differential spreading of marks (indicated by the test for discrimination) is shown by the results of the tests. This will be the procedure that will be followed in this study and this aspect is discussed from pages 311 to 314. Against this background the following criteria must be used by the biology inspectors in judging whether the marks awarded by a teacher should be adjusted or not:

(i) If the teacher passes his tests for discrimination and standards, then his pupils' marks for that grade in which he passed these tests should be accepted as a component of the Senior Certificate biology examination.

(ii) If the teacher fails one or both these tests, then his pupils' marks for that grade in which he failed the test(s) must be adjusted statistically before being accepted as a component of the Senior Certificate biology examination.

The information for making this decision is present on the validation sheets that are submitted by the moderators.

11.3.4 Statistical Procedure to Adjust Teacher-Awarded Marks

The statistical procedure that is suggested for adjusting teacher-awarded marks is precise and the calculation can be done by a computer. The suggested procedure adjusts both the mean and standard deviation of the teacher awarded-marks to the mean and standard deviation of the moderator's marks, which represents the national standard. Therefore it corrects the teacher's marks for both leniency or severity and bunching or excessive spreading of marks simultaneously, without altering the teacher's rank order of pupils. This procedure could be used, provided that a representative sample is selected from the population[26] (i.e., the sample mean is neither too large nor too small when compared with its population mean; the standard deviation is not very much smaller than its population standard deviation - pp. 302-305). Statistical findings in this study indicate that purposive sampling which is used for selecting pupils for the test conducted by the moderators caters for selecting a representative sample from the population (p. 305). Within this context, there is justification for using the mean and standard deviation of the sample that was assessed by the moderator after correction for bias,[27] in adjusting the teacher-awarded marks of the population from which this sample came.

The first step in using this statistical procedure is to compute the means and standard deviations (which must be corrected for bias) of the marks awarded by the teacher and the moderator for the same sample. These marks are given on the validation sheets sent in by the moderators. Then using a standardisation formula (see below),[28][29][30] each of the marks awarded by the teacher is standardised to the desired mean and standard deviation, which in this case is that of the moderator's test. This statistical procedure, suggested for use in moderating teacher-awarded marks by some overseas research workers,[31] involves a linear trans= formation of values in one distribution to corresponding standard-score positions in another (i.e., direct scaling to a desired mean and standard deviation). The basis of a common method for scaling marks is to ensure that the deviation of a raw mark (X) from the mean (M) expressed in standard deviation units (SD) is the same as the deviation of the corresponding scaled mark (Xs) from the scaled mean (Ms), also expressed in standard deviation units (SDs). This may be expressed mathematically as:[32]

$$\frac{Xs - Ms}{SDs} = \frac{X - M}{SD}$$

or re-arranging

$$X_s = X \frac{SDs}{SD} - [\frac{SDs}{SD} M - Ms]$$

The procedure is illustrated by the following example:
Moderated mark of pupil, Xs = (to be computed)
Mean of marks awarded by moderator, Ms = 27,80
Standard deviation of marks awarded by moderator, SDs = 13,81
Final mark of pupil awarded by teacher, X = 23
Mean of marks awarded by teacher, M = 32,40
Standard deviation of marks awarded by teacher, SD = 13,19
The teacher according to the moderator's marks was lenient (his mean was 32,40 as compared with the moderator's 27,80) but adequately discriminating between pupils (the standard deviations of the teacher and the moderator are 13,19 and 13,81 respectively). A candidate awarded 23 marks by the teacher would get a moderated mark (standardised or scaled mark) of:

$$\begin{aligned} Xs &= 23 \left(\frac{13,8}{13,19}\right) - \left[\left(\frac{13,81}{13,19}\right) 32,40 - 27,80\right] \\ &= 24,08 \quad - [33,92 - 27,80] \\ &= 24,08 \quad - \ 6,12 \\ &= 17,96 \\ &= 18 \end{aligned}$$

This pupil's teacher-awarded mark of 23 becomes a moderated mark of 18; just as his teacher-awarded mark is below the teacher's mean mark of 32, so the moderated mark is below the adjusted mean mark (or moderator's mean mark) of 28.

Other adjusted marks are given in Figure 11.1 for a sample of ten pupils (Higher Grade; maximum mark is 70). The information on which Figure 11.1 is based is reflected in Figure 10.2 (p. 265 where the teacher (indicated as "prospective moderator") failed the test for standards. All the marks which were used to obtain the teacher's and moderator's (indicated as "biology inspector" in Figure 10.2) means and standard deviations, are shown in Figure 11.1. It can be seen that the teacher's order of merit is retained.

Pupil's name	Teacher's mark, X	Teacher's order of merit	Moderator's mark	Standardised mark (or moderated mark), Xs	Final order of merit
J	50	1	54	46	1
C	48	2	43	44	2
I	47	3	37	43	3
D	42	4	34	38	4
F	30	5	27	25	5
G	29	6	19	24	6
E	23	7	11	18	7
B	20	8	17	15	8
A	19	9	16	14	9
H	16	10	20	11	10
Mean	32,40	-	27,80	27,80	-
Standard deviation	13,19	-	13,81	13,68	-
Standard error of mean	4,40	-	4,60	4,56	-

FIG. 11.1 EXAMPLE OF TEACHER-AWARDED MARKS ADJUSTED STATISTICALLY

By using this procedure for adjustment, some of the pupil's moderated marks may be higher than their teacher awarded-marks, and some may be lower. Kennedy, from the Reading Educational Measurement Research Unit, states that "at first sight this may seem unfair, but there is no more reason to accept without adjustment the teacher's spread of marks than there is to accept his average, when his marks are compared with those of other markers".[33]

It is wrong that the mark of any candidate should be altered through the accident or luck of his having been included in the sample.[34] The purpose of moderation is to appraise the overall standard of teacher-awarded marks to the group as a whole and not to a few individual pupils.

The moderated marks are then submitted by the biology inspector to the Division of Education, Department of Indian Affairs. The Department is bound to accept these moderated marks as the final practical marks for the Senior Certificate biology examination.

In summary it could be stated that this suggested procedure of moderation should have a desirable effect on teachers, pupils and on the nature of practical work at schools. In addition to ensuring that the marks awarded to pupils are fair and of a comparable standard for all candidates, this procedure should promote correct teaching and learning methods and also the attainment of desirable objectives for practical work.

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CHAPTER TWELVE

RECOMMENDED PLAN FOR A VIABLE ASSESSMENT PROCEDURE FOR PRACTICAL WORK IN BIOLOGY AT THE SENIOR SECONDARY LEVEL

12.1 SUMMARY OF INVESTIGATION

12.1.1 An Overall View of the Field of Study

The primary aim of this investigation is to identify an efficient and appropriate method that can be used in measuring pupils' attainment in practical work in biology for the Senior Certificate Examination. At the outset of the investigation it was evident that the objectives of practical work could not be separated from assessment and moderation of teacher-awarded marks. Within this context three broad areas were investigated, i.e., objectives, assessment procedures and moderation. Since there were various factors which were related to assessment of practical work, these factors were also investigated in order to determine their practical implications.

The point of view taken in this study is that objectives, assessment procedures and moderation should be in line with the abilities and attitudes that pupils develop while doing current practical work at the senior secondary level in Indian high schools. This was done in order:

(i) not to disrupt the biology programme at schools and to avoid placing undue demands on the time of pupils and teachers;

(ii) to avoid the danger of imposing on the teachers and the Division of Education, Department of Indian Affairs, objectives, and assessment and moderation procedures which were not related to current practice in schools.

Therefore the scope of this investigation became limited, i.e., the investigation had to be based on what was being done in the schools and not in trying out any new procedures of assessment or moderation.

To gain information on various aspects of this study, the writer had to depend on leading writers in the field, teachers, examiners, biology inspectors, members of the Biology Subject Committee, as well as analyses of practical marks (i.e., teacher-awarded marks, practical control test marks, Senior Certificate theory and practical marks). The views of the writer also evolved as a result of:

(i) visits to schools;
(ii) discussions with senior biology teachers, examiners and biology inspectors;
(iii) conducting practical control tests as an examiner;
(iv) participating in conventions locally (i.e., Science and Mathematics Conventions) and overseas (i.e., Meeting of the Association of Science Education in Leeds in 1974 and the International Congress on the Improvement of Biology Education in Sweden in 1975);
(v) discussion with people involved in the assessment of practical work in Nuffield A-Level Biology.

The preceding chapters and the sections that follow comprise, therefore an amalgam of a study of relevant literature, personal research, first-hand observations and discussions.

On a critical examination of the evidence indicated in the preceding sections of this investigation the writer has come to the conclusion that cumulative assessment is the most efficient and appropriate method of assessing attainment in practical work in biology for the Senior Certificate Examination. It is also evident that the practical marks in biology that are awarded in the Senior Certificate Examination at present are not equitable and uniform for all candidates.

The most important findings and conclusions of this investigation will be listed and a recommended plan for a viable assessment procedure for practical work in biology will be offered. Since certain observations, conclusions and suggestions have already been made in the preceding chapters, it is not intended to repeat all of these in the present chapter.

12.1.2 The Most Important Findings of the Present Study

The present investigation has sought to collect empirical information hitherto lacking in various aspects of assessment of attainment in practical work in biology for the Senior Certificate Examination in Indian schools. The most important findings relating to objectives, assessment procedures and moderation are summarized below:

(i) The Division of Education, Department of Indian Affairs, has no defined aims and objectives for practical work. This has led to differences in approach to abilities and attitudes assessed in practical work.

(ii) There is discrepancy between the procedures that are used by different teachers in assessing the final attainment of pupils in practical work. Some teachers assessed the pupils through cumulative assessment while others used the final practical test.

(iii) Considering the views expressed by teachers, research workers, and in terms of fitness of purpose (i.e., assessing the final attainment of pupils adequately), this study suggests that cumulative assessment could provide the most efficient and appropriate measure of attainment in practical work.

(iv) There is variation in the overall standard of awarding the final marks for practical work among teachers in the same school and among schools. Therefore there is justification in moderating teacher-awarded marks in the context of the Senior Certificate Examination.

(v) The present form of moderation, which involves the use of practical control tests, is having an undesirable backwash effect on the nature of practical work in schools, on assessment procedures and on pupils.

(vi) No uniform pattern is followed in using the practical control test marks to judge the overall standard of teacher-awarded marks or to adjust them. Therefore the final marks allocated to pupils for practical work in the Senior Certificate biology examination are not equitable and uniform for all candidates.

(vii) Teachers said they preferred a moderation procedure which included a moderator who could guide them in assessment, and also maintain a uniform standard of awarding marks.

These findings together with suggestions in the form of recommendations have been dealt with in the preceding chapters of this study.

12.1.3 General Conclusion

In general, the findings in this study tend to substantiate previous overseas research results. They provide a systematic picture of some of the factors which affect assessment of attainment in practical work in biology. To improve the quality of teacher assessment of practical work and for it to gain national credibility, the findings in this study indicate that certain steps will have to be taken. Firstly the objectives of practical work must be clearly stated. Secondly the teachers must be given guidance on the techniques of assessment within the context of cumulative assessment. In this way the validity and reliability of assessment of practical work by teachers could be improved. Thirdly the moderation procedure must have a desirable backwash effect on practical work. The moderated marks that are awarded to all candidates for practical work in the Senior Certificate biology examination must be fair and comparable. Therefore the assessment of attainment in practical work involves a great deal of work and is a responsible task which should not be treated lightly. This responsibility is jointly shared by the teachers, the Division of Education, Department of Indian Affairs, and the Joint Matriculation Board. It is hoped that the findings in this study and suggestions made in it will answer some of the questions posed in the opening chapter.

12.2 RECOMMENDATIONS

12.2.1 Need for Practical Work to be an Integral Part of Biology Education

Biological Science is conceived as a product (knowledge) and process (method of inquiry) in this study, both of which are essential for a good understanding of this subject. This standpoint has profound implications for biology education because it shifts the emphasis from dealing only with the theoretical basis of biological science to including laboratory-centred activities. This shift in emphasis is reflected in the "new" biology courses for secondary schools in the United States of America,(1) United Kingdom,(2) Federal Republic of Germany,(3) Netherlands,(4) France,(5) Australia,(6) and Canada.(7)

An analysis of biology syllabuses of local education departments and divisions of education indicate a similar trend (p. 4). Another important factor that contributed to this trend in biology education is the work of educational psychologists (pp. 3-4). They provided new and challenging insights into the nature of learning. This trend in biology education indicates that there is no disagreement with the view that practical work should form an integral part of biology.

A considerable amount of practical work is undertaken by pupils at the senior secondary level in Indian schools. However, the nature of this practical work does not measure up to the contemporary trend. The "problem-solving" approach which involves such abilities as discerning problems, hypotheses construction, and designing experiments, forms an integral part of practical work of the Biological Science Curriculum Study projects[8] and the Nuffield A-Level Biological Science Project.[9] The findings in this study indicate that this approach is at present neglected in Indian schools. Therefore there should be a move towards reorganising practical work in schools, in such a way that it will allow for the development and assessment of problem-solving skills. The implication of this move will mean a distinct shift from the ability to simply recall routine investigations reflected in text-books to designing "new" investigations based on familiar techniques and principles. In this way "a sense of adventure, of investigating the unknown, is fostered; the appeal to experiment is used to test the value of an idea. The pupils make observations, they form hypotheses and then test them by experiment".[10] Investigatory work should also include a fair treatment of doubts and the incompleteness of science. This is in line with the nature of science. Suitable problems to which the text-books give no answer are readily found in biology. For example, the dispersal and survival of weeds on a piece of waste ground and the study of fauna and flora in a particular locality, come to mind. The format of investigations which take into account the suggestions made in this section of the study are given in the Biological Science Curriculum Study projects[11] and the Nuffield A-Level Biological Science Project.[12]

The Secondary School Examinations Council[13] (now the Schools Council) rightly points out that though pupils may forget much of what they are invited to learn, this taste of investigatory work is enjoyed and can be claimed as an educative experience. An important point, having great implications in the teaching of biology, is that a scientific attitude (which is indicated as an important outcome of biology education, in the syllabuses locally and overseas) cannot arise from dogmatic teaching, but from teaching and learning through the inquiry process. Learning through inquiry provides appropriate experience for development of such attitudes as making of honest and objective observations, and withholding judgement until careful analysis of all evidence.

In summary it could be stated that practical work which incorporates the problem-solving approach will rightly emphasise the tentative nature of biological knowledge and that biology education is an intellectual process with a never-ending quest. In this way, the pupils will recognise the scientific spirit as a continuing effort to refine and advance biological concepts through planned procedures of experimentation and observation, well seasoned with creative insight and intuition.

12.2.2 Practical Work Should be Assessed

Some examining bodies, locally and overseas, do not assess pupils' performance in practical work (pp. 43-49). This means that the problems of undesirable backwash effect that such assessment can have on practical work conducted at schools, and of having large-scale external practical examinations or moderation of teacher-assessment of practical work, do not arise. The merit of this, is in the freedom that it gives teachers in the choice of practical work to illustrate the theoretical basis of the course.

However, this policy of not assessing pupils' performance in practical work is questionable. Practical work is an integral part of the biology course not only in providing a basis for good understanding of the theoretical part of the course but also in developing abilities and attitudes which are considered desirable outcomes of the course. Therefore there should be some measurement of the extent these abilities and attitudes have been developed in the context of practical work. It is logical to insist that, since the abilities and attitudes developed in practical work are considered desirable outcomes of the course, an assessment of attainment and certification in the course cannot be complete unless assessment of these attributes is included. From this point of view, the writer therefore recommends that there is need for some measurement of pupils' performance in practical work.

The findings in this study indicate that the external practical examination (i.e., the practical control test which is a form of external examination, pp. 145-147) is having an undesirable backwash effect on the course practical work. This is consistent with the findings of research workers on the effect on course work, of external practical examinations conducted by some overseas examining boards. This has led to two major lines of development in some of the overseas countries. The first has been the replacement of the practical examinations by questions requiring written answers in the theory paper, which, it is claimed cannot be answered adequately except by candidates who have undertaken the required practical work (p. 9). The second line has been the introduction of the internal assessment of practical work, increasingly on a cumulative assessment basis (pp. 48-56).

As far as the first approach is concerned (where there is a substitution of written examination to measure attainment in practical work), research evidence indicates that practical work measured through written examinations has low correlations with the same abilities assessed in a laboratory situation (p. 9). This supports the conviction that practical work involves abilities both manual and intellectual, which are in some measure, distinct from those used in non-practical work (p. 9). Therefore the writer recommends that to measure abilities and attitudes developed in practical work, practical assessment *per se* is mandatory. This should be assessed by teachers along lines suggested in this study (i.e., through cumulative assessment with guidance from moderators). This aspect is discussed in the next section of this study. This responsibility of assessment placed in the hands of the teacher, without the restrictive effects of external examination, should introduce new vitality into the nature and assessment of practical work. This is the point of view that is taken by the Schools Council in introducing school-based examinations for the CSE.(14) Mutual trust would be developed if the teachers were given full responsibility for the assessment of their pupils. Kerr states that "the granting of more responsibility to the teachers would be welcomed by many of them as recognition of their professional standards and status. If they were trusted, a high measure of integrity would emerge. The profession needs more autonomy of this kind".(15)

12.2.3 The Procedure to be Followed in Assessing Attainment in Practical Work

Assessment in practical work is in one sense an analytic process. In order to evaluate each pupil as objectively as possible, it is necessary to break down his total performance in practical work. This task is performed through precise statements of objectives for practical work which indicate the abilities and attitudes expected to be acquired by pupils by the end of the course practical work. The problem with this approach is that it implies that the whole person is comprised of isolated reactions.[16] Rogers[17] states that a way of redressing the balance is through cumulative assess= ment carried out by the pupils' own teacher who is in a unique position to see the pupil as a whole person as well as to aid with the assessment of his progress analytically. Cumulative assessment, "thus implies consideration of the teacher's image of the pupil as a person and it will include analytic processes which help towards this end".[18] It is against this background and from the findings in this study (pp. 239-240) that cumulative assessment was judged as potentially superior to other forms of assessment. Therefore the writer recommends this procedure for assessing attainment in practical work.

There are also several problems associated with cumulative assessment (e.g., pupil reaction; demands made on the teacher; pupil-teacher relationships) and these have already been discussed from pages 129 to 133. Suggestions for obviating these problems and at the same time building into this assessment procedure those qualities that are desirable (i.e., validity, reliability and comparability of marks), are indicated in respective sections of this study. Perhaps the most important questions to ask and answer in the context of assessing attainment are: "What should be assessed? In what proportion should it be assessed? How should it be assessed?" These three questions have already been answered in the preceding chapters of this study and appropriate suggestions have also been included in those chapters. These aspects will be briefly discussed in the following sections.

12.2.3.1. Objectives of Practical Work

The Schools Council Examinations Bulletin No. 27[19] while welcoming the emphasis and reorientation of practical work, draws attention to the lack of clear statements of objectives for practical work. It rightly states that "in the absence of such statements, any attempt at assessment of attainment in practical work can be nothing more than a shot in the dark".[20]

The present study has clearly underlined the need to define the outcomes of practical work in terms of behavioural objectives, and it has demonstrated that these objectives are a prerequisite for the measurement of attainment in practical work. Biology teachers should be encouraged to study the implications of the scheme of objectives for practical work that is suggested in this study (Chapter 8), especially for the purpose of conducting practical work in general and assessing attainment in practical work in particular. The objectives in the suggested scheme should not be seen in isolation, but must be viewed as inter= dependent within the context of investigatory work. It is only in this way that the overall purpose of practical work in biology could be achieved.

The taxonomies developed for the cognitive,[21] affective[22] and psychomotor[23] domains were used only as a guide in this study for formulating a scheme of objectives for practical work. The findings in this study suggest that distinctions between the three domains in developing objectives for practical work are highly artificial because of the fusion of the cognitive and affective, psychomotor and affective, and cognitive and psychomotor aspects in biological investigations.

The suggested scheme of objectives is not based on a priority of relationship between the objectives indicated under each operational division and between operational divisions, nor does it suggest a hierarchical sequence (i.e., taxonomy of objectives) because these are of limited value in the specific context of practical work in biology (pp. 202-207). It was considered more important to accentuate practical work objectives rather than a taxonomy.

It may be argued that practical work cannot be considered in isolation from theoretical work. This may well be so, but in biology education, where practical work has been clearly defined, one must assume that practical work does make a unique contribution to the teaching and learning of biology. This contribution must be further justified and defined by identifying those pupil abilities and attitudes which it fosters best. This is what has been proposed in this suggested scheme of objectives. Without these objectives, the teacher and the examining body will not be able to function in a meaningful way.

12.2.3.2 <u>The Two-Dimensional Grid</u>

A two-dimensional grid which gives a predetermined weighting to each subject area and operational division is suggested by the writer on page 222. The purpose of this grid is:

(i) to guide the teachers and the examining body in the proportional allocation of marks;

(ii) to show the teachers and pupils the areas of emphasis in the teaching and learning situations.

Although the operational divisions and subject areas indicated in this grid are different from each other, there are practical problems in following it rigidly in every assessment situation. This is because:

(i) each subject area is not assessed separately in an assessment situation;

(ii) a range of abilities and attitudes listed under the operational divisions can be exercised over a variety of subject areas.

For example, an investigation on the distribution of starch grains in a stem will involve:

(i) subject areas: knowledge and use of the microscope, slide preparation, cells, tissues and plant anatomy;

(ii) operational divisions: knowledge of techniques and materials, skill in using techniques and materials, ability to make appropriate observations and accurate recording, ability to handle results, and showing desirable attitudes to practical work.

Therefore it is undesirable to interpret a grid too rigidly for each assessment. The marks awarded to each component of an assessment will depend on the nature of the practical investigation. However, the final marks that are awarded to pupils must be according to the weightings that are indicated for the operational divisions in the grid. The procedure to follow in computing the final marks in terms of the weightings is indicated on pages 291 and 292. This will ensure that the final marks awarded to pupils are uniform among teachers and schools in regard to what is being assessed and the proportion of marks given. Therefore the aim of using the grid is to ensure that the assessments over the year cover the subject areas and operational divisions of the course comprehensively and that this coverage is a balanced one. This is extremely important in the context of the Senior Certificate Examination.

12.2.3.3 The Format of Cumulative Assessment

Suggestions that were made for implementing the cumulative assessment procedure in the preceding chapters of this study are summarized in the diagram that follows:

A SUMMARY OF PROCEDURES TO FOLLOW IN ASSESSING ATTAINMENT IN PRACTICAL WORK

Practical work covered in the standard-ten year must be assessed

↓

Internal assessment by the class-teacher

↓

<u>Assessment Procedure</u>

Cumulative assessment

↓

<u>Assessment Techniques</u>

1. Periodic tests
2. Current practical exercises
3. Records of practical work

↓

Each of the operational divisions should be assessed on at least four occasions in the context of investigat=ions

↓

Assessment must be spread over the first three terms

↓

<u>First Term</u>

1. Test
2. Record of practical work

<u>Second Term</u>

1. Test
2. Record of practical work
3. Current practical exercises

<u>Third Term</u>

1. Test
2. Current practical exercises

↓

Marks entered on practical record sheet for each operational division for each pupil

↓

<u>Final Teacher-Awarded Marks</u>

Sum of weighted mark for each operational division

↓

Moderation of teacher-awarded marks at end of third term

↓

Final practical marks for the Senior Certificate biology examination

The guidance that should be given to teachers by the moderator and the Division of Education, Department of Indian Affairs, in implementing the assessment procedure indicated in the diagram, is suggested in Chapters 9 and 11. According to the diagram on page 327 the following prerequisites must be met to achieve the declared aims of cumulative assessment (i.e., to assess the final attainment and to diagnose pupils' weaknesses in order to adopt appropriate remedial measures):

(i) An appropriate and adequate record for each pupil must be kept. This is important to provide the teacher and the pupil with a constant feedback on progress that the pupil is making and the areas where he requires help. It is also important to the teacher in building up a cumulative judgement upon the performance of each individual. The format of the type of record that should be kept is given on page 291.

(ii) The assessment must be made at appropriate times throughout the three terms of the standard-ten year (p. 244) in order to provide a feedback on the progress that pupils are making. The most valid information is likely to come from using a variety of techniques over the whole range of practical work and at suitable times during each of the three terms. The course work covered each term, the duration of each term and the recommendation that a moderator would visit the school during the course of a year were factors taken into account in suggesting the number and type of assessments for each term (see diagram, p. 327). This suggestion also allows for each assessment technique to be used at least twice during the period of assessment. Assessment of current practical exercises (i.e., assessing pupils while they are doing day-to-day practical work) and practical record books of pupils according to a five-point scale suggested in this study (pp. 288-289) will provide a useful corrective to the more specific measurements obtained by using specially designed tests (pp. 285-288). In particular they will offset the possiblity of a badly done practical test by a pupil of otherwise good ability (or the reverse). Since each assessment technique will not be assessing all the operational divisions (e.g., only recording and handling of results will be assessed through the use of practical record books of pupils) the writer has suggested that each operational division must be assessed on at least four occasions during the period of assessment. This number of assessments per operational division is consistent with the requirement of some overseas examining boards.[24] If each operational division is assessed over a variety of sections of the subject matter and at suitable times during the period of assessment, this ought to provide useful information on the progress that the pupil is making in attaining the activities that are listed under each operational division.

(iii) The final mark that is awarded to pupils must reflect their attainment of the range of abilities and attitudes that are listed under the operational divisions (Chapter 8). Therefore the weighting given to each operational division must be taken into account when awarding this final mark. The computation of this is given on pages 291 and 292.

This suggested procedure of cumulative assessment can be supported on both educational and administrative grounds for reasons given on pages 239 and 240. However, the full potential of this assessment procedure will not be realised unless the teachers are prepared to exploit the opportunities that it offers.

12.2.4 Moderation of Marks Awarded by Teachers Through Cumulative Assessment

Since teacher-awarded marks for practical work form a component of the Senior Certificate biology examination, they have to be moderated. This is to ensure that the marks awarded to all Senior Certificate candidates are equitable and uniformly awarded. To attain this goal the following suggestions and methods of implementation have been made in the preceding chapters of this study:

(i) The moderators must be selected in an agreement trial to ensure that they are "like-minded".

(ii) Equal and parallel tests with specified criteria for awarding marks must be used by moderators in order to appraise the overall standard of awarding marks by teachers.

(iii) Statistical measures with acceptable limits must be used in order to make judgements on whether a teacher's marks should be adjusted or not.

(iv) The marks that are to be adjusted, should be done using precise statistical methods.

One problem that was guarded against in choosing a moderation procedure in this study was the undesirable backwash effect that it can have on practical work, on teachers and pupils (pp. 145-150). Therefore the suggested moderation procedure has built into it:

(i) personal contact between the moderator and teachers;
(ii) personal contact between the moderator and pupils;
(iii) guidance to teachers on assessment;
(iv) appraisal of overall standard of awarding marks by teachers.

Implicit in this suggested moderation procedure is the improvement of the quality of teacher assessment and the learning situations in which pupils are placed, i.e., it will have a desirable backwash effect. This is in line with the views expressed by some overseas examining boards[25] that are using a moderation procedure similar to the one suggested in this study.

12.2.5 Weighting Theory and Practical

The weighting that is given to practical work in relation to the written paper in the Senior Certificate biology examination is 17,50 per cent (i.e., 70 out of 400 marks) and 16,67 per cent (i.e., 50 out of 300 marks) for the Higher Grade and Standard Grade respectively. This weighting given to practical work is inadequate when viewed against the following:

(i) the length of the practical syllabus that is to be covered in the course;

(ii) at least two periods (i.e., two out of the seven periods of biology per week) per week are set aside for laboratory work, i.e., 28,57 per cent of the total time for biology is used for practical work.

(iii) work load of teachers and pupils in practical work;

(iv) emphasis of practical work in the new trend in biology;

(v) organisation and administration of the moderation procedure;

(vi) abilities and attitudes that ought to be developed by pupils through practical work;

(vii) weightings given by overseas examining boards to practical work, e.g., Nuffield A-Level Biological Science - twenty-five per cent;[26] Israeli Matriculation Examination - thirty per cent.[27]

The writer therefore recommends that twenty-five per cent of the marks for the whole biology examination should be allocated for practical work for both the grades. This recommended twenty-five per cent is very close to the percentage time that is spent by pupils on practical work and is in line with the marks allocated for practical work by some overseas examining boards.[28] This increase in percentage of marks will reflect the important role of practical work in biology. It will also be seen as an act of fairness to the pupils who undertake a great deal of practical work and as an incentive to them.

12.2.6 The Assessment of Practical Work Within the Context of the Joint Matriculation Board

The Joint Matricultion Board issues certificates of matriculation exemption to holders of the Senior Certificate of the various education departments and divisions of education in the Republic of South Africa, provided that the candidates meet with the minimum requirements laid down by the Board. This Board has the responsibility of ensuring that equivalent standards are maintained in schools throughout the Republic of South Africa by a system of moderation (p. 57). In its examination regulations[29] it stipulates that biology will be assessed through a written paper of three hours duration and no provision is made for assessment of practical work. However, an analysis of the core biology syllabuses (i.e., for the Higher Grade and Standard Grade) of the Board indicates that it does recognise the unique value of practical work in the context of biology education.[30] This presupposes that practical work in biology can be assessed through a written paper. However, it does not prevent any department or division of education from assessing practical work *per se* provided that these marks are moderated by them. The Natal and Orange Free State Education Departments, and the Division of Education, Department of Indian Affairs are the only examining bodies in the Republic of South Africa that award marks for practical work as a component of the Senior Certificate biology examination. From research evidence (i.e., abilities assessed in practical work are somewhat different from those measured in written papers - p. 9) it is implicit that the marks awarded by the examining bodies are not comparable with the marks awarded by the remaining bodies that do not assess practical work. Therefore it is questionable whether the certificates of matriculation exemption issued by the Joint Matriculation Board to holders of the Senior Certificate of the different examining bodies (e.g., the Natal Education Department, the Transvaal Education Department) have a universal currency. To obviate this problem and from the standpoint of assessing attainment in biology (which involves assessing practical work as well as theory), the writer suggests that the Board must move towards making the assessment of practical work compulsory for all examining bodies. This assessment of practical work and its moderation should be along lines suggested in this study.

12.2.7 Training of Teachers in the Principles and Techniques of Assessment in Practical Work

Implicit in all the suggestions made in this study is the need for the training of teachers in the principles and techniques of assessment. This is consistent with the plea made by research workers in related fields of study.(31)(32)(33) Training should be given to all senior biology teachers. This is because they will be involved in assessing practical work at the senior secondary level and from their ranks will be selected the moderators. Two major lines of action should be taken. The first is to set up adequate in-service training in this area for senior biology teachers. The second is to make the formal pre-service training in the principles and techniques of assessment a larger component in teacher education.

It could be stated that improvements in the expertise "at the grass roots", level will lead to the improvement of quality of teacher assessments. This can only result in an easing of the problems at the national level because teacher involvement will be more significant in relation to the marks awarded to their own pupils. In such developments cumulative assessment has a contribution to make.

12.2.8 Further Research

This study indicates the potential of the suggested scheme for assessing attainment in practical work for the Senior Certificate biology examination. The ideal would have been to try out this suggested scheme in a sample of Indian Schools (i.e., control and experimental schools) in the Republic of South Africa. In an investigation of this kind, the biology inspectors, moderators, and standard-ten biology teachers and pupils will be involved. The Division of Education, Department of Indian Affairs will have to co-ordinate and communicate and apply the results of such research. Permission must also be obtained from the Joint Matriculation Board to conduct this research whereby certain selected schools will be exempt from the present procedure of assessing attainment in practical work for the Senior Certificate biology examination.

It is implicit from the foregoing discussion that this type of research by its very nature precludes individuals from undertaking the task. Eggleston and Kerr[34] state that, "the problems of carrying out research into different forms of internal assessment, and of communicating and applying the results of such research, are undoubtedly formidable". Therefore they suggest co-operative research, which will involve active participation of teachers, research workers and the examining board, into problems of assessment. This co-operative research carried out in schools is termed "action research" or "operational research" by Eggleston and Kerr[35] and it seems to be appropriate for the kind of inquiry required in the present study. This suggestion is in line with the views expressed by the Schools Council,[36] Lippit[37] and Young,[38] and with the procedure that is followed in research of this nature in the United Kingdom.[39][40][41][42] For example, a team of research workers and teachers in conjunction with the Joint Matriculation Board undertook an investigation into assessing attainment in practical work in the Nuffield A-Level Biology.[43]

Other advantages of this type of research are:

(i) effective communication between the examining board, educational researchers and practicing teachers;

(ii) educative effect on the personnel involved;

(iii) translation into action of the results obtained from research by the participants (i.e., the examining board and the teachers).

In this regard, Eggleston and Kerr[(44)] state that "the development of assessment techniques which are to be used by teachers to measure the attainments of their own pupils is undoubtedly the kind of problem which could with profit be approached by research of this kind".

The present trend towards co-operative research in the area of assessment, indicates that the research workers, the senior biology teachers and the Division of Education, Department of Indian Affairs, should try out the suggested scheme for assessing attainment in practical work in Indian schools. This should be carried out along the following lines:

(i) Twenty schools should be selected to conduct this experiment. This is in line with the number of schools that were used by the Transvaal Education Department for their "Matriculation Project".[(45)] These twenty schools should be comparable in respect of general academic achievement, size, socio-economic status, and situation.

(ii) Ten of the twenty schools should be termed experimental schools while the remaining ten schools should be referred to as control schools.

(iii) The pupils in the experimental schools should be assessed along lines suggested in this study (i.e., cumulative assessment with guidance from moderators). The pupils in the control schools should be assessed along lines which are presently being followed at schools.

(iv) At the end of the third term, equal and parallel tests should be used to moderate the marks awarded by teachers at these twenty schools. The moderation procedure should be along lines suggested in this study.

(v) Information on the assessment procedures used in the experimental and control schools should be collected from teachers and pupils through questionnaires and interviews.

(vi) The overall standard of awarding marks by teachers, pupil performance (based on the moderated marks), and feedback from teachers and pupils (i.e., through questionnaires and interviews) should be used to evaluate the procedure followed in assessing attainment in practical work in the experimental and control schools.

Valuable information can be collected for evaluation if this investigation is spread over two years at the twenty schools. It must also be pointed out that implementing an appropriate assessment procedure cannot wait upon the results of definitive research - there are urgent problems as indicated in this study, which require action immediately. Such action should be taken in the light of the best evidence which is currently available, even if this is not as adequate as one would wish it to be. It is therefore recommended that the suggested scheme for assessing attainment in practical work should be implemented immediately in the remaining schools (i.e., besides the experimental and control schools). Information gained from the investigation at the twenty schools, and from implementing the suggested scheme at the remaining schools, should be used in modifying the scheme so that an effective assessment procedure is developed. Implicit in this is that research and implementation of new assessment procedures need to go forward hand in hand, so that the questions for research can arise from problems in implementing the procedures, and findings from research can be taken into account when modifying these procedures or developing new procedures.

12.3 CONCLUSION

It is accepted in this study that practical work and its assessment through cumulative assessment is an integral part of biology education. Seen in this light, the Division of Education, Department of Indian Affairs has an important role to play in ensuring that the nature of practical work in schools measures up to contemporary trends, and the marks that are awarded for practical work to Senior Certificate biology candidates are equitable and uniform. To attain this end, the writer would like to reiterate some of his main contributions in this study for serious consideration. These are:

(i) the scheme of objectives for practical work;
(ii) the two-dimensional grid with proportional weighting for the content and operational divisions;
(iii) the format for cumulative assessment;
(iv) the procedure to select "like-minded" moderators;
(v) the procedure to follow in guiding teachers in assessment and in moderating teacher-awarded marks;
(vi) the statistical procedure to appraise the standard of awarding marks by teachers;
(vii) the statistical procedure to adjust teacher-awarded marks;
(viii) co-operative research into methods of assessing attainment in practical work.

These contributions offer opportunities for the most desirable reforms in assessing attainment in practical work, i.e., precision and liberalisation. In order to exploit these opportunities it requires the firm commitment of the Division of Education, Department of Indian Affairs, and its personnel to translate this commitment into action in schools. The responsibilities of the teacher in the suggested scheme of assessment are considerable, the demands made upon his time are substantial, but the rewards in terms of the increased quality and professionalism such experience can bring to an individual's teaching and assessment make them worthwhile.

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APPENDIX A

THE METHODS AND MATERIALS USED IN THE STUDY

An outline of the design and materials used in the study is given in Chapter 2. The purpose of using each material is discussed in relevant sections of the study. It is therefore not intended to repeat all of these in this Appendix. The materials that were used and the procedures that were followed in using them will be discussed below.

A.1 INFORMATION COLLECTED FROM THE DIVISION OF EDUCATION, DEPARTMENT OF INDIAN AFFAIRS

The writer spent six days in January, 1978 in the offices of the Division of Education, Department of Indian Affairs in order to collate the following information regarding Senior Certificate biology candidates who had written their examination at the end of 1977:

(i) the marks that were awarded to these candidates for the practical section of the Senior Certificate biology examination (after moderation);

(ii) the marks that were awarded to these candidates for the theory section of the Senior Certificate biology examination (before moderation);

(iii) the marks that were awarded to these candidates by their class teachers for practical work in the schools.

(iv) the merit list (which contained marks and the ranking of pupils according to their performance in practical work conducted by the teachers) submitted by class teachers;

(v) the practical control test marks and the teacher-awarded marks for those candidates who were selected for the practical control tests at certain schools.

The above information was collected separately for each school and the format of the forms that were used appear on pages 347, 348 and 349.

FORM A

MARK LIST FOR ALL SENIOR CERTIFICATE BIOLOGY CANDIDATES

School ______________________ No. of candidates: ________

Centre No.: ______________________ Higher Grade ________

Standard Grade ________

Candidate's examination number	Teacher-awarded marks (Maximum mark - 70 for Higher Grade and 50 for Standard Grade)	Senior Certificate practical marks for biology (Maximum mark - 70 for Higher Grade and 50 for Standard Grade)	Senior Certificate theory marks for biology (Maximum mark - 330 for Higher Grade and 250 for Standard Grade)

FORM B

MARK LIST FOR CANDIDATES SELECTED FOR THE PRACTICAL CONTROL TESTS

School ____________________ No. of candidates: __________

Centre No.: ____________________ Higher Grade __________

Standard Grade __________

Candidate's name	Candidate's examination number	Marks (Maximum mark - 70 for Higher Grade and 50 for Standard Grade)	
		Teacher-awarded marks	Marks awarded by examiners in the practical control test
Mean Marks			

FORM C

MARKS FROM MERIT LIST OF TEACHERS

School ______________________________ Grade ________________

Centre No.: __________________________

Candidate's examination number	Teacher-awarded marks (Maximum mark - 70 for Higher Grade and 50 for Standard Grade)	Candidate's examination number	Teacher-awarded marks (Maximum mark - 70 for Higher Grade and 50 for Standard Grade)

A.2 PRACTICAL CONTROL TESTS

The writer was appointed as an examiner by the Director of Indian Education in 1977 to conduct practical control tests at nine schools (pp. 27-28).

A.2.1 Meeting Between the Biology Inspectors and the Examiners Prior to the Practical Control Tests

This meeting was held a day prior to the commencement of the practical control test (i.e., 19.9.77). The biology inspectors briefed the twelve examiners that were appointed to conduct the practical control test (p. 20). Written instructions dealing with administrative matters and the procedure to follow when setting questions, were given to the examiners at this meeting. These instructions, together with those given to examiners in 1978 appear from pages 351 to 357.

PRACTICAL CONTROL TEST : BIOLOGY 1977

The following matters are listed for the information of all examining officials:

1. Report directly to the principal when arriving at the school.

2. Determine the number of absentees and deal with the matter as follows:

   2.1 A list of all absentees has to be prepared in triplicate.

   2.2 The principal submits the original and all doctors' certificates of pupils to the Director, hands one copy to the examining officer and retains the third copy for his records.

3. In the event of a candidate refusing to do the test, such a candidate is given a zero mark. All cases of refusal to do the test must be reported to the Director in writing, counter= signed by the principal.

4. Marks: Schools should have a separate merit list available with a mark for each candidate. (An "a" in the marks column is not acceptable). A representative sample of pupils for the control test is then drawn from this list in such a manner that a good cross section of all pupils (and their teachers) is obtained.

   The official mark lists, as required by the examinations section, must be collected and handed in to me at the end of the test period.

   Testing officials use only the roneoed mark lists provided at the planning meeting. Observations made during the test and guidance given after the test must be recorded on the reverse side of these lists before submitting them to me.

5. Private candidates: Large numbers of private candidates will probably report at certain centres. (Official lists of names of these candidates will be handed to testing officials at the planning meeting).

   A sample of these candidates should be included in the group chosen for the test. (See par. 6.1.2 and 6.2.2).

6. Procedure in setting the questions

   6.1 Group Test:

      6.1.1 Not fewer than 10 and not more than 20 pupils should be chosen.

      6.1.2 Include from 1 to 4 candidates chosen from the list of external candidates in this group.

      6.1.3 Allocate 50% of the total marks for the test to slides, transparencies, experiments and models.

6.1.4 Spread the questions, as far as possible, over the entire syllabus of Stds. 9 and 10. (Include not more than 25% of standard 8 work.)

6.1.5 Differentiate clearly in the questions between Higher and Standard Grades. (separate questions).

6.1.6 Adhere, as far as possible, to the level-distribution of marks, e.g.

	Higher	Standard
Level I	25%	35%
Level II	35%	40%
Level III	30%	25%
Level IV	10%	0%
	100%	100%

6.1.7 Avoid questions which require purely theoretical knowledge. Features visible on the slides, transparencies, experiments and models should provide the foundation for the questions.

6.2 Laboratory Test

6.2.1 Five or six pupils should suffice for the laboratory test.

6.2.2 If possible, include a private candidate in this group.

6.2.3 50% of the marks should be allocated to this part of the test.

6.2.4 Any aspect of the prescribed practical work may be tested (See Circular I.E. 16 of 1977)

but: (a) Avoid over-emphasizing a single section
(b) Avoid duplication of questions.

6.2.5 Differentiate clearly between Higher and Standard Grades. (separate questions)

6.2.6 Adhere to the level-distribution of marks as given in 6.1.6.

6.2.7 The following aspects of the syllabus should be included in questions on the occasions listed below:

(a) First test (20.9.77)

Microscopy	:	Blood smear
Experiments	:	Brownian Movement (with microscope)
Human physiology	:	Digestive system and transport system
Plant Kingdom	:	Gymnospermae - External structure (SG) and questions on life cycle for (HG)
Animal Kingdom	:	Comparison - Exo & Endo-skeletons
Ecology	:	acids and bases - PH of soil

(b) <u>Second test</u> (21.9.77)

Microscopy	:	Cross section of dicotyledenous stem
Experiments	:	Diffusion (Potassium permanganate & water)
Human physiology	:	Gaseous exchange and transport systems
Plant Kingdom	:	Comparison - Monocotyledonous & Dicotyledonous plants
Animal Kingdom	:	Insecta - Mouthparts & metamorphosis
Ecology	:	Symbiosis - Mutualism, commensalism and parasitism

(c) <u>Third test</u> (22.9.77)

Microscopy	:	Leaf epidermis/Onion membrane
Experiments	:	Food tests (preferably plant organs)
Human physiology	:	Excretory and reproductive systems)
Plant Kingdom	:	Longitudinal section of flower (SG), Floral diagram (HG)
Animal Kingdom	:	Comparison - Osteichthyes & Reptilia
Ecology	:	Food chains, food webs and ecological pyramids

(d) <u>Fourth test</u>

Microscopy	:	Cheek epithelium
Experiments	:	Transpiration
Human physiology	:	Nervous system
Plant Kingdom	:	Comparison - Gymnospermae & Angiospermae
Animal Kingdom	:	Comparison - Aves & Mammalia
Ecology	:	Water and plant-water relations

<u>Fifth test</u>

Microscopy	:	Cross section of monocotyledonous stem
Experiments	:	Turgor/plasmolysis - with the aid of the microscope
Human physiology	:	Skeletal system
Plant Kingdom	:	Dissected flower - labelled parts
Animal Kingdom	:	Insecta - external character= istics and locomotion
Ecology	:	Atmospheric gases - cycles

(f) Sixth and further tests could contain any of the aspects already dealt with, but regrouped and preferably approached from a fresh viewpoint.

IMPORTANT

The following should be in my hands NOT LATER than FRIDAY 7.10.1977:

1. Merit lists as prepared by the schools.

2. Testing officials' mark lists completed for the sample tested at the school (including private candidates).

3. Official mark sheets (Examination Section) prepared by schools.

4. Lists of absentees from individual schools signed by the principals.

INSPECTOR OF EDUCATION

PRACTICAL CONTROL TEST : BIOLOGY 1978

The following matters are listed for the information of all examining officials:

1. Report directly to the principal when arriving at the school.

2. Determine the number of absentees and deal with the matter as follows:

   2.1 A list of all absentees has to be prepared in triplicate.

   2.2 The principal submits the original and all doctors' certificates of pupils to the Director within 10 days, hands one copy to the examining officer and retains the third copy for his records.

3. In the event of a candidate refusing to do the test, such a candidate is given a zero mark. All cases of refusal to do the test must be reported to the Director in writing, counter=signed by the principal.

4. Marks: Schools should have a separate merit list available with a mark for each candidate. (An "a" in the marks column is not acceptable). A representative sample of pupils for the control test is then drawn from this list in such a manner that a good cross section of all pupils (and their teachers) is obtained.

   The official mark lists, as required by the examinations section, must be collected and handed in to me at the end of the test period.

   Testing officials use only the roneoed mark lists provided at the planning meeting. Observations made during the test and guidance given after the test must be recorded on the report form before submitting it to me.

5. Private candidates:

   5.1 all private candidates are to undergo a complete test

   5.2 where few private candidates are involved they will have been informed to report on the day of the school's test

   5.3 where a large number of private candidates are involved, separate testing sessions have been arranged for them (refer to testing programme).

6. Sampling of candidates:

   Select test candidates of each teacher from the merit list from the top, middle and bottom range of marks to get a representative sample of HG and SG candidates proportionately.
   The sample selected will be involved in doing a complete test, i.e., the darkroom and the laboratory sessions.

7. Examination Schedules:

   These must be collected from the principals, including those for private candidates (if any). All details to be filled in by the principal of the private candidate's centre.

8. Entry of names of the selected candidates must be strictly according to the merit list on the mark sheets. A separate mark sheet must be submitted for the HG and SG candidates, with the school's and examiner's averages worked out for each.

   Important: Please submit the completed mark sheets together with the examination schedules and report within two days after the completion of the test at each school..

9. Test procedure: The test procedure is as follows:

   1. Dark room session - 08h30 to 09h00 - Diapositives and transparencies.
   2. 15 minutes break for pupils - 09h00 to 09h15.
   3. Laboratory session - 09h15 to 12h15 - Experiment, animals, dissection, ecology.
   4. 30 minutes lunch - 12h15 to 12h45.
   5. Laboratory session continued - 12h45 to 15h00 - Microscope, plants, flowers.

10. Procedure for test on Ecology (outdoor):

    On arrival at the school survey the situation and determine a site for the ecology question.

11. In your report comment on the availability and supply of specimens and materials in the laboratory at each school.

12. Completion of E 81 - certificate by examining officer in respect of absenteeism.

....

Inspector of Education

Besides the written instructions the following points were discussed at this meeting:

(i) group test and laboratory test;

(ii) choosing a representative sample for the test;

(iii) allocation of marks by examiners:

(iv) itinerary to be followed by the respective examiners.

The writer kept a record of the above points that were discussed at this meeting and these were discussed from pages 59 to 65 of this study. The following itinerary and testing schedule was followed by the writer during the practical control tests.

PRACTICAL CONTROL TEST ITINERARY AND TESTING SCHEDULE FOR THE SCHOOLS VISITED BY THE WRITER

Schools visited	Date of visit	Time						Number of candidates selected for the test	Examiners (denoted by letters)	
		Arrival	Departure	Choosing candidates and preparing materials for group test	Group test	Preparation of laboratory for laboratory session	Laboratory session		Conducted group test	Conducted laboratory test
A	20.9.77	9h30	14h30	9h35 – 10h00	10h00 – 11h15	11h15 – 11h35	11h35 – 13h50	20	A	A – questions 1 and 2; B – questions 3;4; 5 and 6
B	21.9.77	9h00	15h30	9h00 – 10h00	10h00 – 11h45	11h45 – 12h00	12h00 – 14h30	20	B	A – questions 2;4and5; C – questions 1 and 3.
C	22.9.77	8h00	14h25	8h30 – 9h00	9h00 – 10h10	10h10 – 10h30	10h30 – 13h10	20	A	A – questions 3 and 5; D – questions 1; 2 and 4
D	23.9.77	8h15	14h30	8h30 – 9h15	9h15 – 10h30	10h30 – 11h00	11h00 – 13h30	20	A	A – questions 1; 4 and 6; E – questions 2, 3 and 5
E	26.9.77	8h30	14h30	8h30 – 9h30	9h30 – 10h45	10h45 – 11h10	11h10 – 1h35	20	A	A – questions 3; 4 and 5; B – questions 1 and 2
F	27.9.77	8h15	14h45	8h30 – 9h30	9h30 – 10h45	10h45 – 11h15	11h15 – 13h40	20	A	A – questions 3; 4 and 5 B – questions 1 and 2
G	28.9.77	8h10	14h25	8h30 – 9h30	9h30 – 10h40	10h40 – 11h00	11h00 – 13h25	20	A	A – questions 2; 4 and 5 B – questions 1 and 3
H	29.9.77	8h15	15h30	8h30 – 9h30	9h30 – 10h45	10h45 – 11h30	11h30 – 14h00	20	A	A – questions 2; 3 and 5 C – questions 1 and 4
I	30.9.77	8h15	14h00	8h20 – 8h45	8h45 – 10h00	10h00 – 10h15	10h15 – 12h15	13	A	A – questions 4 and 5 F – questions 1; 2 and 3

Letter "A" refers to the writer. Letters "B" to "F" refer to other examiners that accompanied the writer. The letters for examiners are used consistently in this schedule. For example, examiner "B", always refers to the same person whenever it appears on the schedule.

A.3 EXAMINER'S REPORT

At the end of the meeting between the biology inspectors and the examiners (i.e., meeting prior to the practical control tests on 19.9.77), the senior biology inspector informed the examiners of the research study that is being undertaken by the writer and they were asked to assist him in whatever way they could. The writer elaborated upon his research study at this meeting and then enlisted their help in completing an examiner's report on the practical control tests that they were conducting. This report was to be returned to the writer after the completion of the tests. The examiners were invited to comment as fully and frankly as they wished on these tests. A few specific points on which they might wish to comment were suggested in this report.

The comments of examiners who were in the midst of the testing situation was considered to be extremely useful in this study. Their views would indicate to some extent the feasibility of the practical control test as a moderating instrument and its use as an external examination for assessing all Senior Certificate biology candidates. The examiner's report that was given to them appears on page 360.

EXAMINER'S REPORT

I hope that you will feel free to comment as fully and as frankly as you wish on the following points about practical control tests or any other points that occur to you:

1. What were the most important shortcomings of the tests that you observed?

....

....

....

....

2. What is the value of practical control tests?

....

....

....

....

3. What are the difficulties experienced in devising the tests?

....

....

....

....

4. What were the difficulties experienced in administering the tests?

....

....

....

....

5. General comments on practical control tests:

....

....

....

....

....

NAME OF EXAMINER

Table A.1 indicates the examiner's report returns.

TABLE A.1: EXAMINER'S REPORT RETURNS

Description	Examiner's report		Provinces represented			
			Natal		Transvaal	
	Number	%	Number	%	Number	%
Examiner's report given to examiners	11	100,00	9	100,00	2	100,00
Examiner's report completed and returned	9	81,82	8	88,89	1	50,00

A.4 DRAFT SCHEMES OF OUTCOMES OF PRACTICAL WORK

Each draft scheme of outcomes of practical work contained a list of abilities and attitudes that ought to be acquired by pupils at the senior secondary level. Three such draft schemes were developed by the writer. These are referred to as the first, second and third draft scheme in this study. The second draft scheme was a modification of the first, and the third a modification of the second. These were given to respondents (discussed below) for oral or written comments. They had to comment on the feasibility of pupils developing the abilities and attitudes listed in the draft schemes through current practical work. Their informal consensus of opinion indicated by their comments, was adopted in modifying the draft schemes. Since these draft schemes identified the abilities or attitudes under each operational division, they were used also as aids by the respondents when they filled in questionnaire B1 or B2 (pp. 380-381). The three draft schemes are included in the respective parts of this section.

A.4.1 First Draft Scheme of Outcomes of Practical Work

A list of outcomes of practical work that ought to be acquired by pupils at the senior secondary level was developed by the writer and the following sources of information were used for this purpose:

(i) literature survey;

(ii) analyses of biology syllabuses and circulars;

(iii) discussion with senior biology teachers and members of the Biology Subject Committee;

(iv) observing pupils doing practical work at schools (this observation was made while the writer supervised student teachers during practice teaching).

This list of outcomes is referred to as the first draft scheme in this study. A copy of this scheme appears from pages 361 to 365.

FIRST DRAFT SCHEME OF OUTCOMES OF PRACTICAL WORK (HIGHER GRADE AND STANDARD GRADE)

A. OPERATIONAL DIVISIONS OF PRACTICAL WORK

(a) Knowledge of techniques and materials (apparatus, chemicals, specimens and models) which are basic to the course.

(b) Ability to use techniques and materials (apparatus, chemicals, specimens and models) which are basic to the course.

(c) Ability to make appropriate observations and accurate recording of observations.

(d) Ability to interpret results and to make appropriate deductions and inferences.

(e) Ability to solve practical problems.

(f) Inculcation of desirable attitudes.

B. EXPLANATION OF THE OPERATIONAL DIVISIONS

(a) Knowledge of techniques, apparatus, chemicals, specimens and models

The activities under this heading involve the recall of knowledge of techniques and materials that are basic to the course. These include:

(i) recognising or identifying apparatus and chemicals by stating names and describing purposes in terms of use;

(ii) recognising or identifying biological models and organisms or parts thereof by stating names and recalling the functions of parts;

(iii) describing laboratory techniques that are basic to the course.

(b) Ability to use techniques and materials which are basic to the course

Under this heading the pupil would be required to show that he could use techniques and materials of which he had knowledge. When a pupil is presented with materials and a task with instructions, he must show care and ingenuity in selecting appropriate techniques and materials to execute the task.

These include:

(i) demonstrating that he can follow written or oral instructions correctly;

(ii) selecting the correct technique and materials for carrying out the operation;

(iii) performing simple operations correctly in relation to the task;

(iv) including safety precautions when carrying out the operation.

(c) Ability to make appropriate observation and accurate recording of observations

This heading covers the ability of the pupil to make accurate records of his observation of a specified experiment, set exercise or biological material based on topics and materials covered in the course. Observation could not be divorced from recording because the nature of recording will be dependent on the accuracy of observation. Therefore assessment should take into account the correspondence between observations and recording and also the effectiveness of recording in the form of short notes, sketches, diagrams, tabulation of results, or graphs. The quality of recording could be judged by taking into account the skill in handling and classifying information derived from observation. These include:

(i) evaluating the appropriate choice made by the candidates of the available methods of recording observations;

(ii) evaluating the extent to which the recording of observation is appropriate in terms of discrimination, comprehensiveness and accuracy.

(d) Ability to interpret results and to make appropriate deductions and inferences

This heading involves the interpretation of results in terms of making deductions and inferences from observation of an experiment, set exercise or biological material based on topics and materials covered in the course. The results here refer to direct observation which is not recorded and/ or records of observation. Interpretation of results include:

(i) making inferences from observations, e.g., inference of function from observation of structures;

(ii) making deductions from results, leading in some instances to formulation of generalizations and principles;

(iii) responding to problem questions based on results;

(iv) explaining related biological phenomena or principles based on topics covered in the course in terms of the results, e.g., use of carbon dioxide and the release of oxygen during photosynthesis by plants and the importance thereof to the biotic community.

(e) Ability to solve practical problems

This heading incorporates all the preceding divisions and the use of all the pupil's practical experience and skill in order to plan and execute new investigations based on familiar principles and techniques. The investigations are "new" because the pupils will be involved with unfamiliar materials or familiar materials in an unfamiliar context. When the pupil is provided with a problem and appropriate instructions he must be able to do the following:

(i) Identify the problem to be solved.

(ii) Provide the best testable, tentative explanation of the result provided in the problem (hypothesis).

(iii) Plan an experiment or investigation with the variety of materials that are provided to solve the problem.

(iv) Execute the plan. This will include the doing part, i.e., handling and using correctly the materials which they have selected, performing simple operations correctly, and using safety precautions.

(v) Make accurate observations and record these observations in terms of the problem to be solved.

(vi) Make appropriate deductions and inferences from results.

(vii) Respond to problem questions based on the result.

(viii) Explain related biological phenomena or principle based on topics covered in the course, in terms of the result.

(f) Inculcating desirable attitudes

The activities under this heading embrace all the desired qualities that will be displayed by pupils as they are seen in action when conducting practical work. If a pupil has acquired desirable attitudes through practical work, he should show the following qualities when he is in action in the laboratory:

(i) Persistence: in the determination of the pupil to see his work through to a successful conclusion.

(ii) Resourcefulness: in improvising, in searching out relevant information and in seeking advice.

(iii) Co-operation: in following safety regulations, in the careful and economic use of materials, leaving the work place neat and tidy, willing to work with peers in a group and in collecting and bringing in material for investigatory work when asked to do so.

(iv) Enthusiasm: in initiating new ideas and in making suggestions for further investigations.

(v) Sensitivity: in willingness to handle living things with care and in taking proper care of living things.

(vi) Fair-mindedness and tolerance: in withholding judgement until careful analysis of all evidence, in suspending judgements in the light of new evidence, in making honest and objective observations, being willing to listen attentively to opposing viewpoint, being generally cool and critical.

This first draft scheme was given to the members of the Biology Subject Committee in July 1977 and they were requested to make individual oral and written comments on it (p. 23). Prior to submitting this to them, they were informed by the writer at the Biology Subject Committee Meeting held on 26 July, 1977, about the research study that was being undertaken by him and their help was requested. The members of this Committee agreed to assist the writer in this regard. Written comments were handed to the writer personally while oral comments were recorded by the writer when he visited the members individually at their homes or in their places of employment. Table A.2 indicates the number of individuals who made comments with regard to this draft scheme.

TABLE A.2: THE NUMBER OF MEMBERS OF THE BIOLOGY SUBJECT COMMITTEE THAT COMMENTED ON THE FIRST DRAFT SCHEME OF THE OUTCOMES OF PRACTICAL WORK

Description	Members	
	Number	Percentage
First draft scheme given to members	12	100,00
Written comments made	2	16,67
Oral comments made	7	58,33

According to Table A.2, 75,00 per cent of the members of the Biology Subject Committee commented either orally or in a written form.

The first draft scheme was also given to fifty-two senior biology teachers at the Convention (p. 19). The abilities and attitudes listed on it were discussed with this group of teachers by the writer. A written record was kept of their oral comments made during this discussion. They then used the draft scheme as an aid in responding to questionnaire B1 (p. 380).

As indicated on page 362, the informal consensus of opinion indicated by the comments made by the members of the Biology Subject Committee and the senior biology teachers was adopted in modifying the first draft scheme.

A.4.2 <u>Second Draft Scheme of Outcomes of Practical Work</u>

The second draft scheme which is a modification of the first appears on pages 367 and 368.

SECOND DRAFT SCHEME OF OUTCOMES OF PRACTICAL WORK (HIGHER GRADE AND STANDARD GRADE)

Operational Divisions of Practical Work

(a) Knowledge of techniques and materials which are basic to the course.

(b) Ability to use techniques and materials which are basic to the course.

(c) Ability to make appropriate observation and accurate recording of observations.

(d) Ability to interpret observations and to make appropriate deductions and inferences.

(e) Inculcating desirable attitudes.

Explanation of the Operational Divisions

(a) Knowledge of techniques and materials

(i) Identifying apparatus and chemicals by stating names and describing purposes in terms of use.

(ii) Identifying processes, specimens and models or parts thereof and stating function(s) of parts of specimen or model.

(iii) Describing various laboratory techniques that are basic to the course.

(b) Ability to use techniques and materials which are basic to the course

(i) Selecting materials from those that are provided to carry out an investigation.

(ii) Ability in the skills of using various techniques, e.g., preparation of a wet mount, use of the microscope, setting up experiments.

(iii) Ability to explain the implications of the procedure and materials used.

(c) Ability to make appropriate observation and accurate recording of observations

(i) Recording microscopic and macroscopic observations appropriately in the form of diagrams (correct representation, accuracy, proportion) and labelling these correctly.

(ii) Recording microscopic and macroscopic observations appropriately (accuracy, comprehensiveness, discrimination) in the form of notes or describing these observations orally.

(iii) Recording observation accurately in the form of tables, illustrations and/or graphs.

(d) <u>Ability to interpret observations and to make appropriate deductions and inferences</u>

(i) Ability to explain observations (direct from the records that they have kept).

(ii) Ability to infer from observation, *viz.*, structure and function relationship and adaptations.

(iii) Ability to deduce (arrive at conclusions) from results that are obtained.

(iv) Ability to formulate generalizations and principles.

(v) Ability to make predictions.

(vi) Ability to respond to problem questions based on results.

(vii) Ability to respond to problem questions based on broader theory or principle (covered in the course) which is related to the present result, observation, explanation and/or deduction, e.g., starch with salivary amylase of man was kept at 40 degrees Celsius - must starch with saliva from an amphibian or a locust be also kept at the same temperature? Why?

(e) <u>Inculcating desirable attitudes</u>

If a pupil has acquired desirable attitudes through practical work, he should show the following qualities when in action in the laboratory:

(i) Persistence: in the determination of the pupil to see his work through to a successful conclusion.

(ii) Resourcefulness: in improvising, in searching out relevant information and in seeking advice.

(iii) Co-operation:

1. In following safety regulations in the laboratory.
2. In the careful and economic use of materials.
3. In leaving their work place neat and tidy.
4. In willing to work with peers in a group.
5. In collecting and bringing in material for investigatory work when asked to do so.

(iv) Enthusiasm: in initiative, in new ideas and in suggestions for further investigations.

(v) Sensitivity: in willingness to handle living things with care and taking proper care of living things.

(vi) Fair-mindedness and tolerance:

1. In withholding judgement until careful analysis of all evidence.
2. In suspending judgement in the light of new evidence.
3. In making honest and objective observations.
4. In willingness to listen attentively to opposing viewpoints.

This second draft scheme was given to the following respondents for oral comments and for using it as an aid in filling questionnaire B2:

(i) The eleven examiners at the meeting between them and the biology inspectors (p. 20);

(ii) The three biology inspectors (i.e., two from the Division of Education, Department of Indian Affairs and one from the Natal Education Department) at a meeting between them and the writer (pp. 21-22).

A record of the oral comments made by these respondents was kept by the writer. The writer also had an opportunity, during the practical control tests, to discuss the second draft scheme with nineteen standard-ten biology teachers who were at the schools where the writer conducted the tests. Their oral comments were also recorded by the writer.

As a result of the comments made by the examiners, biology inspectors and the teachers, the writer modified the second draft scheme. This modified scheme is referred to as the third draft scheme in this body.

A.4.3 Third Draft Scheme of Outcomes of Practical Work

The third draft scheme which is a modification of the second appears on pages 370 and 371.

THIRD DRAFT SCHEME OF OUTCOMES OF PRACTICAL WORK (HIGHER GRADE AND STANDARD GRADE)

Operational Divisions of Practical Work

(a) Knowledge of techniques, processes and materials which are basic to practical work.

(b) Ability to use techniques and materials which are basic to practical work.

(c) Ability to make appropriate observations and accurate recording of observation.

(d) Ability to interpret observations (including the making of appropriate deductions and inferences).

(e) Showing desirable attitudes to practical work.

Explanation of the Operational Divisions

(a) Knowledge of techniques, processes and materials

(i) Identifying apparatus or chemical by pointing out or naming. Describing the purpose in terms of use.

(ii) Identifying processes, specimens and models, and stating functions of the parts of the specimen or model.

(iii) Describing various laboratory techniques that are basic to practical work.

(b) Ability to use techniques and materials which are basic to practical work

(i) Ability to select appropriate materials from those that are provided to carry out a specified task.

(ii) Ability to use various techniques and materials, e.g., preparation of wet mount, use of the microscope, setting up experiments.

(iii) Ability to explain the implications of the procedure and materials used.

(c) Ability to make appropriate observation and accurate recording of observation

(i) Recording microscopic and macroscopic observations appropriately (correct representation, in proportion) in the form of diagrams and to label them correctly.

(ii) Recording microscopic and macroscopic observations appropriately (accuracy, comprehensiveness, discrimination) in the form of notes or describing these observations orally.

(iii) Recording observation accurately in the form of tables, illustrations and graphs.

(d) Ability to interpret observations (including the making of appropriate deductions and inferences).

(i) Ability to explain in their own words from their observations: biological processes, changes, properties, structural features, classification and relationship.

(ii) Ability to infer from observation, viz., function from observation of structure, adaptation to habitat from observation of structure.

(iii) Ability to deduce (arrive at conclusions) from results that are obtained.

(iv) Ability to formulate generalisations and principles.

(v) Ability to make predictions.

(vi) Ability to respond to problem questions based on results/ observation.

(vii) Ability to respond to problem questions based on broader theory or principle (covered in the course) which is related to the present result, observation, explanation or deduction, e.g., starch with salivary amylase of man was kept at 40 degrees Celsius - must starch with saliva from an amphibian or a locust be also kept at the same temperature? Why?

(e) Showing desirable attitudes to practical work

If a pupil had acquired desirable attitudes through practical work, he should show the following qualities when in action in the laboratory:

(i) Persistence: in the determination of the pupil to see his work through to a successful conclusion.

(ii) Resourcefulness: in improvising, in searching out relevant information and in seeking advice.

(iii) Co-operation:

1. In following safety regulations in the laboratory.
2. In the careful and economic use of materials.
3. In leaving their work place neat and tidy.
4. In willingness to work with peers in a group.
5. In collecting and bringing in material for investigatory work when asked to do so.

(iv) Enthusiasm: in initiative, in new ideas and in suggestions for further investigations.

(v) Sensitivity: in willingness to handle living things with care and taking proper care of living things.

(vi) Fair-mindedness and tolerance:

1. In withholding judgement until careful analysis of all evidence.
2. In suspending judgement in the light of new evidence.
3. In making honest and objective observations.
4. In willingness to listen ...

This third draft scheme of outcomes of practical work was then given to:

(i) the nineteen standard-ten biology teachers at the nine schools (i.e., during the writer's revisit to the schools, when he administered the questionnaires);

(ii) the four examiners who gave weightings for the different operational divisions (p. 373).

They were asked to make oral comments on the third draft scheme and these were recorded by the writer. This group of teachers used this draft scheme as an aid in filling in questionnaire B2 and the examiners were required to give weightings to the operational divisions listed in the draft scheme.

The third draft scheme together with the comments made by these teachers and examiners was used as one of the sources for formulating objectives for practical work in this study.

A.5 INFORMATION ON OPERATIONAL DIVISION "e" TO RESPONDENTS OF QUESTIONNAIRE B2

Operational division "e" in questionnaire B2 is the "ability to plan or design new investigations based on familiar principles and techniques". The skills that this operational division involves are not given in either the first, second or third draft schemes which were used as an aid by respondents to fill in questionnaire B2. For this reason, information on this operational division was given to respondents who filled in questionnaire B2. This information is given below.

INFORMATION ON OPERATIONAL DIVISION "e"

Ability to plan or design new investigations based on familiar principles and techniques

For the most part the ability to be assessed here is the skill of the pupil in planning and preparing for new investigation rather than executing the plan. The pupil must use all his practical experience and skill in order to plan or design new investigation based on familiar principles and techniques. The investigation is "new" because the pupil will be involved with unfamiliar materials or familiar materials in unfamilair contexts. When a pupil is provided with the results of a practical exercise or experiment together with a problem related to it, the pupil must be able to do the following:

(i) Identify the problem to be solved.

(ii) Provide the best testable, tentative explanation.

(iii) Give an account of the materials, from those that will be available, that he will use in the investigation.

(iv) Give an account of suitable techniques that will be used in the investigation. Wherever possible a control must also be included.

(v) Provide an explanation of how the results would be presented or recorded and analysed.

A.6 WEIGHTING OF THE OPERATIONAL DIVISIONS BY EXAMINERS

Examiners who had more than two years of experience in conducting practical control tests were selected for weighting (i.e., specifying the percentage marks that should be given for each operational division) that was indicated in the third draft scheme. There were four examiners that fitted into this category (p. 28). Arrangements were made to meet them individually. They were already aware of the research study that was being carried out by the writer. Each examiner was provided with the third draft scheme of the outcomes of practical work to use as an aid in deciding the weighting that should be given for each operational division for assessment of practical work at the senior secondary level. This weighting was recorded by the four examiners on the following form:

WEIGHTING OF OPERATIONAL DIVISIONS (a) TO (e)

"Weighting" refers to the percentage of marks that should be given to each operational division listed below, in terms of the total, for assessment of practical work at the senior secondary level. Refer to third draft scheme of outcomes of practical work for the different operational divisions, i.e., (a) to (e).

	Higher Grade	Standard Grade
(a)		
(b)		
(c)		
(d)		
(e)		

A.7 QUESTIONNAIRE SURVEY

Four sets of questionnaires (i.e., questionnaires A, B1, B2 and C) were used in this study in order to gather information and opinions from senior biology teachers, biology inspectors and examiners on:

(i) abilities and attitudes that are developed by pupils through practical work at schools;

(ii) assessment of attainment in practical work;

(iii) moderation of teacher's assessments;

(iv) the multiplicity of factors that affect the nature of practical work at schools.

The following aspects related to the questionnaires used in this investigation have been discussed in relevant sections of this study:

(i) the reasons for including each questionnaire;

(ii) the purpose of each category in a questionnaire;

(iii) the purpose of each question included under each category.

The four sets of questionnaires could have been posted to the respondents. This would have been unsatisfactory. There would have been such problems as high proportion of non-replies, questionnaires returned incomplete or inaccurately completed. Behr (Behr, A.L.: Methods and Techniques in Educational and Psychological Research, Van Schaik, Pretoria, 1973. p. 79) points out some of these disadvantages in using the mail questionnaire. To obviate these problems, the writer preferred administering the questionnaires personally to the respondents. This direct contact with the respondents affords an excellent opportunity of combining perceptive observations with collection of data. Certain crucial aspects could be discussed, and comments and observations could be recorded. Although this is time consuming, it was considered the most appropriate way to collect valuable information for this study.

The visits to schools in order to administer the questionnaires provided an opportunity to have discussion with teachers on the following aspects:

(i) facilities and materials available at schools for practical work;

(ii) number of pupils per class unit at the senior secondary level;

(iii) feasibility of using practical record books as a source of assessment;

(iv) criteria for selecting a suitable assessment procedure;

(v) the backwash effects of practical control tests;

(vi) suggestions for assessment and moderation.

Discussions with biology inspectors, examiners and senior biology teachers when administering questionnaires to them, yielded valuable information on the following aspects:

(i) nature of practical work at schools;

(ii) abilities and attitudes that are attained through practical work at schools;

(iii) moderation of teachers' assessments;

(iv) criteria for selecting a suitable assessment procedure.

Records were kept of all discussions with the respondents. These were then used to check and supplement the facts and general opinions that were recorded by them in the questionnaires.

The questionnaires that were used in this study were initially administered to three standard-ten biology teachers from three different schools. This pilot survey indicated that:

(i) the length of each questionnaire was found to be adequate;

(ii) teachers understood the questions and were able to supply the information that was required.

As a result of this pilot survey the questionnaires were adopted for use in the investigation. Questionnaires A, B1, B2 and C appear from pages 376 to 390.

QUESTIONNAIRE A

INFORMATION FROM SENIOR BIOLOGY TEACHERS - 5TH NATIONAL CONVENTION FOR TEACHERS OF SCIENCE AND MATHEMATICS - 14TH JULY 1977

A. GENERAL INFORMATION

Dotted lines, e.g. ...., are for you to fill in the relevant information as required. Wherever there is a block, e.g. ☐, merely insert an 'X' in it next to the appropriate response.

1. Name of school ....
2. Your sex: Male ☐ Female ☐
3. Professional qualification(s): ....
4. If graduate, then state the biological science courses completed for your degree:

   ....

   ....
5. If under-graduate/Diploma/Certificate, then state the biological science courses in which you specialised:

   ....

   ....
6. Years of teaching experience:

   Less than 1 ☐
   1 ☐
   2 to 3 ☐
   4 to 5 ☐
   6 to 7 ☐
   8 to 9 ☐
   10 ☐
   more than 10 ☐

7. Experience in teaching biology in the senior secondary level:

    Less than 1 year ☐
    1 year ☐
    2 to 3 years ☐
    4 to 5 years ☐
    6 to 7 years ☐
    8 to 9 years ☐
    10 years ☐
    more than 10 years ☐

B. Please list below, in any order, those abilities and attitudes which you think pupils have attained during their current practical work in biology (Higher Grade and Standard Grade) at the senior secondary level.

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C. Respond to each of the following questions by ticking one of the three statements that are given. If you do not agree with any of the three then write down your statement where it is indicated "others (specify)". Also provide a reason(s) for making a particular response to a question.

1. What is your response to assessing the final attainment of pupils in practical work through the exclusive use of cumulative assessment?

   (i) whole-hearted support;
   (ii) support with some reservation;
   (iii) strong opposition;
   (iv) others (specify) ....
   Reason(s) ....
   ....

2. What is your response to assessing the final attainment of pupils in practical work through the exclusive use of the final practical test?

   (i) whole-hearted support;
   (ii) support with some reservation;
   (iii) strong opposition;
   (iv) others (specify) ....
   Reason(s) ....
   ....

3. What is your response to assessing the final attainment of pupils through the exclusive use of practical books of pupils?

   (i) whole-hearted support;
   (ii) support with some reservation;
   (iii) strong opposition;
   (iv) others (specify) ....
   Reason(s) ....
   ....

4. What is your view with regard to using the practical control test to moderate teacher-awarded marks?

   (i) whole-hearted support;

   (ii) support with some reservation;

   (iii) strong opposition;

   (iv) others (specify) ....

   Reason(s) ....

   ....

QUESTIONNAIRE B1

Name of School ....

The range of practical skills, knowledge, intellectual skills and attitudes that pupils ought to attain through practical work at the senior secondary level (Higher Grade and Standard Grade). These are listed below (column 1) in six categories or operational divisions. Please read the instructions in column 2 and 3, and respond to them accordingly.

Column 1	Column 2	Column 3
Range of practical skills, knowledge, intellectual skills and attitudes listed in six major categories or operational divisions..	Indicate by a tick in this column opposite those operational divisions which you think are attained by pupils through practical work currently being done at schools	General Comments
(a) Knowledge of techniques and materials (i.e., apparatus, chemicals, specimens and models) which are basic to the course		
(b) Ability to use techniques and materials which are basic to the course		
(c) Ability to make appropriate observations and accurate recording of observations		
(d) Ability to interpret results and to make appropriate deductions and inferences		
(e) Ability to solve practical problems		
(f) Inculcating desirable attitudes		

QUESTIONNAIRE B2

Name of Examiner/Teacher ....

Name of School ....

The range of practical skills, knowledge, intellectual skills and attitudes that pupils ought to attain through practical work at the senior secondary level (Higher Grade and Standard Grade). These are listed below (column 1) in six major categories or operational divisions. Please read the instructions in column 2 and 3 and respond to them in the respective columns or sub-columns. Sub-columns A and B refer to Higher Grade and Standard Grade respectively.

Column 1	Column 2		Column 3	
Range of practical skills, knowledge, intellectual skills and attitudes listed in six major categories or operational divisions	Indicate by a tick in the sub-column opposite those operational divisions which you think are attained by pupils through practical work currently being done at schools		General comments	
	A (H)	B (S)	A (H)	B (S)
(a) Knowledge of techniques and materials (i.e., apparatus, chemicals, specimens and models etc.) which are basic to the course				
(b) Ability to use techniques and materials which are basic to the course				
(c) Ability to make appropriate observations and accurate recording of observations				
(d) Ability to interpret results and to make appropriate deductions and inferences				
(e) Ability to plan or design new investigations based on familiar principles and techniques				
(f) Desirable attitudes				

QUESTIONNAIRE C

INFORMATION COLLECTED FROM STANDARD-TEN BIOLOGY TEACHERS ABOUT ASSESSMENT OF PRACTICAL WORK

SECTION 1

A. General

Dotted lines, e.g. ...., are for you to fill in the relevant information as required. Wherever there is a block, e.g., ☐, merely insert a tick in it next to the appropriate response.

1. School ....
2. (a) Name of the teacher ....
   (b) Sex ....
3. (a) Qualification(s) ....
   (b) Major subjects (bio. sc.) ....
4. (a) Teaching experience .... yrs.
   (b) Experience of teaching biology in the senior secondary level .... yrs.
5. Experience in teaching biology in Std. X .... yrs.

B. Cumulative Assessment (Continuous Assessment)

Unless stated otherwise, the following questions refer to the mark that you submitted per candidate for practical work in biology to the Division of Education, Department of Indian Affairs (teacher-awarded marks).

(a) Was the mark submitted for each candidate based only on a final test written by the pupils in the third term or on cumulative assessment (continuous assessment)? Cumulative assessment. ☐ Only on final practical test. ☐
Any others (specify) ....

(b) What procedures/techniques were used in order to assess pupils in practical work through cumulative assessment? (e.g., practical tests, oral tests, observing pupils while carrying out a task, practical books, etc.)
....
....

(c) In which year(s) of the senior secondary level were the marks accumulated?

In the Std. 10 year only ☐. In the Std. 9 and 10 years ☐.
In the Std. 8, 9 and 10 years ☐.

Comments on course work covered in cumulative assessment (i.e., standard 8, 9 and 10 work that was assessed) ....
....
....

(d) What outcomes of practical work did you look for when awarding marks through cumulative assessment?

Higher Grade	Standard Grade

(If each outcome was weighted separately - include this in the form of a percentage next to each outcome mentioned.)

(e) Abilities and attitudes:

(1) There is a block before each ability or attitude. Place ticks in the blocks against those abilities and attitudes attained by pupils through current practical work. You can indicate whether the ability or attitude is attained by pupils offering biology at the Higher Grade (by placing a tick in the block marked $\boxed{H}$) or by pupils offering biology at the Standard Grade (by placing a tick in the block marked $\boxed{S}$). Tick both the blocks if this ability or attitude is attained by candidates offering biology at the Standard Grade and the Higher Grade. Place a cross in the appropriate block if this ability or attitude is not attained by candidates through current practical work.

(2) The blocks at the end of each ability or attitude refer to whether you had taken into account the ability or attitude in assessing the final attainment of the candidates in practical work. If you differentiated between Standard Grade and Higher Grade when assessing this ability or attitude then place a tick for "S" and "H" in the blocks $\boxed{S|H}$. If you assessed that ability or attitude only for the Standard Grade or Higher Grade

then place a tick in the separated blocks, e.g., [H] or [S]. Place a cross in the appropriate block if this ability or attitude was not taken into account in assessing the final attainment of candidates.

(A) Knowledge of techniques, processes, and materials which are basic to practical work

[S|H] (i) Identifying apparatus or chemicals by pointing out or stating the name and describing the purpose in terms of use. [S] [H] [S|H].

[S|H] (ii) Identifying specimens, process and models and stating the functions of the parts of the specimen or model. [S] [H] [S|H].

[S|H] (iii) Describing various laboratory techniques that are basic to practical work (e.g., describing orally or in a written form the procedure followed in testing a green leaf for starch). [S] [H] [S|H]

(B) Ability to use techniques and materials which are basic to practical work

[S|H] (i) Selecting materials from those that are provided to carry out an investigation. [S] [H] [S|H]

[S|H] (ii) Ability in the use of various techniques, e.g., section cutting and preparation of a wet mount, use of the microscope, setting up experiments. [S] [H] [S|H]

[S|H] (iii) Ability to explain the implications of the materials and procedures used. [S] [H] [S|H]

(C) Ability to make appropriate observation and accurate recording of observation

[S|H] (i) Recording microscopic observations, appropriately in the form of a diagram and labelling this diagram correctly. The criteria upon which this form of recording will be assessed are: Correct representation, accuracy and proportion. [S] [H] [S|H]

S|H (ii) Recording microscopic observations appropriately in the form of notes or describing these observations orally. The criteria upon which this form of recording will be assessed are: Accuracy, comprehensive=ness and the degree of discrimination shown. S H S|H

S|H (iii) Recording macroscopic observations in the form of a diagram and labelling this diagram correctly. The criteria upon which this form of recording will be assessed are: Correct representation, accuracy and proportion. S H S|H

S|H (iv) Recording macroscopic observations appropriately in the form of notes or describing these observations orally. The criteria upon which this form of recording will be assessed are: Accuracy, comprehensiveness and the degree of discrimination shown. S H S|H

S|H (v) Recording observation accurately in the form of tables, illustrations or graphs. S H S|H

(D) <u>Ability to interpret observations (including making appropriate deductions and inferences)</u>.

S|H (i) Ability to explain in their own words from their observations: Biological processes, changes, properties, structural features, classification and relationship. S H S|H

S|H (ii) Ability to make inference from direct observation, e.g., to interpret the function of an organ from observing its structure. S H S|H

S|H (iii) Ability to deduce (arrive at conclusions) from results that are obtained. S H S|H

S|H (iv) Ability to formulate generalizations and principles. S H S|H

S|H (v) Ability to make predictions. S H S|H

S|H (vi) Ability to respond to problem questions based on results/observation. S H S|H

[S|H] (vii) Ability to respond to problem questions based on broader theory or principles (covered in the course) related to the present result, observation, explanation or deduction, e.g., starch with salivary amylase of man was kept at 40 degrees Celsius - must starch with saliva from an amphibian or a locust be also kept at the same temperature? Why? [S] [H] [S|H]

(E) Ability to plan or design new investigations based on familiar principles and techniques

The pupil must use all his practical experience and skill in order to plan or design new investigations based on familiar techniques and principles. The emphasis is on planning rather than executing the plan. The following skills are involved:

[S|H] (i) To identify the problem to be solved. [S] [H] [S|H]

[S|H] (ii) Provide a testable, tentative explanation (hypothesis) of his observation of the practical exercise or experiment, in relation to the problem. [S] [H] [S|H]

[S|H] (iii) To describe the materials that will be used in the investigation. [S] [H] [S|H]

[S|H] (iv) To describe the procedure and techniques that will be used in the investigation. Wherever possible a description of a control must also be included. [S] [H] [S|H]

[S|H] (v) Provide an explanation of how the results would be presented or recorded and analysed. [S] [H] [S|H]

(F) Inculcating desirable attitudes (qualities displayed as a result of acquiring desirable attitudes)

[S|H] (i) Persistence: in the determination of the pupil to see his work through to a successful conclusion. [S] [H] [S|H]

[S|H] (ii) Resourcefulness: in improvising, in searching out relevant information and in seeking advice. [S] [H] [S|H]

(iii) Co-operation:

S|H 1. In following safety regulations. S H S|H

S|H 2. In the careful and economic use of materials. S H S|H

S|H 3. In leaving the work place neat and tidy. S H S|H

S|H 4. In willingness to work with peers in a group. S H S|H

S|H 5. In collecting and bringing in material for investigatory work when asked to do so. S H S|H

S|H (iv) Enthusiasm: in initiative, in new ideas and in suggestions for further investigations. S H S|H

S|H (v) Sensitivity: in willingness to handle living things with care and taking proper care of living things. S H S|H

(vi) Fair-mindedness and tolerance:

S|H 1. In withholding judgement until careful analysis of all evidence. S H S|H

S|H 2. In suspending judgement in the light of new evidence. S H S|H

S|H 3. In making honest and objective observations. S H S|H

S|H 4. In being willing to listen attentively to opposing viewpoints. S H S|H

C. <u>Views with Regard to Cumulative Assessment</u>

What are your views with regard to cumulative assessment in terms of:

(a) Amount of work and time involved ....
....

(b) Your dual role of teacher and assessor ....
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(c) Maintaining standards between teachers at the same school
....

(d) Maintaining standards between schools ....
....

(e) Provision of constant feedback (progress) ....
....

(f) Chances of failure and success of a candidate ....

....

(g) Content covered ....

(h) In terms of objectives assessed ....

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(i) Variety of techniques used ....

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(j) In terms of discriminating between pupils ....

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(k) Pupil's reaction ....

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(l) General Comments on cumulative assessment ....

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SECTION 2

FINAL PRACTICAL TEST

1. Why did you conduct a final practical test?

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2. What advantages does the final practical test have over cumulative or other forms of practical assessment?

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3. What are the difficulties encountered in devising a final practical test?

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4. What are the difficulties in administering a final practical test?

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5. What outcomes did you look for when assessing pupils' performance in a final practical test?

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6. General Comments:

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SECTION 3

PRACTICAL CONTROL TEST

1. What are the advantages of the practical control tests?

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Comments:

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2. What effect did the practical control test have on your internal assessment of practical work?

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3. What effect did the practical control test have on the practical work in your course?

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4. What effect did the practical control tests have on your pupils?

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5. What are your recommendations or lines of guidance for future moderation of teacher-awarded marks in practical work?

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6. Any other comments:

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A.7.1 Procedure Followed in Administering the Questionnaires

The questionnaires were administered personally by the writer to the following respondents:

(i) Questionnaires A and B1 were administered to fifty-two senior biology teachers from forty-seven high schools in the Republic of South Africa at the Fifth National Convention for Teachers of Science and Mathematics (pp. 24-25).

(ii) Questionnaire B2, which is a modification of questionnaire B1 (pp. 88-89) was administered: to the eleven examiners at a meeting between the examiners and the biology inspectors which was held a day prior to the practical control test (pp. 20-21); to the three biology inspectors at a meeting between them and the writer (pp. 21-22); to the nineteen standard-ten biology teachers when the writer visited them at their respective schools (p. 21).

(iii) Questionnaire C was administered to the nineteen standard-ten biology teachers at the same time as questionnaire B2 (p. 21)

The following uniform pattern was followed in administering all the questionnaires:

(i) An explanation was given to the respondents on the nature of the research study that was being undertaken by the writer.

(ii) They were assured that no individual or institution will be identified in this research study.

(iii) They were requested to clarify any point that they were not clear about with the writer.

(iv) Each questionnaire, together with the relevant materials was presented to the respondents (i.e., questionnaire B1 with the first draft scheme; questionnaire B2 with the second or third draft scheme and information sheet on operational division "e".

(v) The respondents were then asked to read the instructions and fill in the questionnaires.

(vi) Any queries and comments of the respondents, and personal observations were recorded by the writer.

(vii) Whenever small groups were responding to the questionnaires (the eleven examiners; the three biology inspectors; the senior biology teachers at schools), each completed questionnaire was checked for accuracy of the data that was recorded. If there were any doubts, then the writer clarified this with the respondents individually before taking leave of the group.

The nineteen standard-ten biology teachers were visited at their respective schools in the months of October and November, 1977. The duration of time spent at each school during a single visit was about four hours. The administration of the questionnaires (i.e., questionnaire B2 and C) and the checking of the questionnaires for accuracy of data recorded, took about two hours and the remaining time was spent on discussion with the teachers on aspects listed on page 374. Prior to a visit to each school, arrangements were made with the principal and the standard-ten biology teachers at a time suited to them. The following schedule was followed in visiting the nine schools.

A SCHEDULE INDICATING THE VISITS OF THE WRITER TO THE NINE SCHOOLS

Date of visit	School Number	Time	Number of teachers
25.10.77 1.11.77	1 1	13h00 - 17h00 7h30 - 10h30	2 1
27.10.77	2	13h00 - 16h45	2
28.10.77	3	13h00 - 16h30	2
31.10.77	4	7h30 - 11h45	1
2.11.77	5	13h00 - 17h00	2
3.11.77	6	8h00 - 11h45	1
7.11.77	7	13h00 - 17h00	4
11.11.77	8	8h00 - 12h00	2
14.11.77	9	13h00 - 17h00	2
Total	-	-	19

According to the schedule, school number 1 was visited twice. This second visit was made because one of the teachers at this school was absent during the writer's first visit. This is one of the problems that a research worker will have to face if questionnaires are to be administered personally to all members of a sample as was done in this study.

The schedule followed in administering questionnaires A, B1 and B2 to the other respondents (i.e., those besides the standard-ten biology teachers) is indicated in Chapter 2. The time that was taken to fill in questionnaire A and B1 or B2 was twenty and twenty-five minutes respectively.

APPENDIX B

STATISTICAL METHODS

B.1 STANDARD DEVIATION AND STANDARD ERROR OF MEAN

B.1.1 Standard Deviation

When the number of cases (scores) was smaller than 30 ($N < 30$) the following formula was used (in order to correct the standard deviation for bias) (Downie and Heath, 1970, p. 57)

$$\text{Standard deviation (SD)} = \sqrt{\frac{\Sigma d^2}{N - 1}}$$

where d = deviation from the mean

= $x - \bar{x}$ (where x is the score; and $\bar{x}$ the mean = $\frac{\Sigma x}{N}$)

and N = the number of scores (cases).

(see Tables 7.3, 7.4 and 7.5, pp. 174-176).

When the number of cases (scores) was larger than 30 ($N > 30$) the following formula was used (Downie and Heath, 1970. p. 58)

$$\text{Standard Deviation (SD)} = \sqrt{\frac{\Sigma d^2}{N}}$$

Definition of each symbol is the same as above.
(See Table 7.1, p. 169).

B.2 STANDARD ERROR OF MEAN

The following formula was used (Downie and Heath, 1970. p. 161)

$$\text{Standard error of mean } (S_{\bar{x}}) = \frac{SD}{\sqrt{N - 1}}$$

(See Table 7.1, p. 169).

B.3 DIFFERENCE BETWEEN MEANS - CORRELATED DATA FOR LARGE SAMPLE (z-TEST)

When two sets of scores for the same individuals are considered, the data are said to be correlated. In this case the standard error of the difference between the two means, $\bar{x}_1$ and $\bar{x}_2$ is defined by:

$$S_{D_{\bar{x}}} = \sqrt{S_{\bar{x}_1}^{2} + S_{\bar{x}_2}^{2} - 2(r)(S_{\bar{x}_1})(S_{\bar{x}_2})}$$

where $S_{\bar{x}_1}$ and $S_{\bar{x}_2}$ are the standard errors of the means, and

r = coefficient of correlation for the two sets of scores.

The z score is given by

$$z = \frac{\bar{x}_1 - \bar{x}_2}{S_{D_{\bar{x}}}}$$

$$= \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{S_{\bar{x}_1}^{2} + S_{\bar{x}_2}^{2} - 2(r)(S_{\bar{x}_1})(S_{\bar{x}_2})}}$$

(Downie and Heath, 1970. pp. 174-175)

The z scores are used in making tests of significance. A z score of 1,96 taken at each end of the normal curve cuts off 5 per cent of the total area and a z score of 2,58 similarly taken cuts off 1 per cent of the area. If the obtained z score lies between these two points, the null hypothesis is rejected at the 5 per cent level. If the obtained z score is greater than 2,58, the null hypothesis is rejected at the 1 per cent level of significance (Downie and Heath, 1970. p. 168).

For example, the alpha level in Table 7.1 (p. 169) is set at 0,01 significance level and the obtained z scores are -8,53 and -14,03 for the Higher Grade (N = 467) and Standard Grade (N = 301) respectively. Since these $|z|$ scores are greater than 2,58, the null hypothesis that there is no significant difference in the standard of awarding marks between the teachers and examiners is rejected for both the grades at the 0,01 significance level.

B.4 THE WILCOXON'S MATCHED-PAIRS SIGNED-RANKS TEST

The Wilcoxon's matched-pairs signed-ranks test is a nonparametric test which is used to test a null hypothesis (Downie and Heath, 1970. p. 267). It is appropriate to use this test when the number of cases or scores are small (N < 30) and the data are correlated (Downie and Heath, 1970. pp. 265-268).

To illustrate this test, data for school F (Table 7.3, p. 174) was used.

TABLE B.1: MARKS AWARDED BY THE TEACHER AND THE EXAMINER TO HIGHER GRADE CANDIDATES IN SCHOOL F (TABLE 7.3)

Candidates	Teacher-awarded marks	Mark awarded by examiner (Practical control Test marks)	d	rank of d	Rank with less frequent signs
a	57	56	1	1,5	
b	56	49	7	7	
c	50	42	8	8,5	
d	47	42	5	6	
e	45	42	3	5	
f	41	42	-1	-1,5	1,5
g	40	42	-2	-3,5	3,5
h	36	28	8	8,5	
i	35	35	0	-	
j	33	35	-2	-3,5	3,5
					T = 8,5

The data in this Table is presented along the lines indicated by Siegel (Siegel, 1956. p. 79).

d = difference between the pairs of marks

(i) All the d's without regard to sign are ranked. The smallest d is given rank 1, and the rank of 2 is given to next smallest, etc. If there is no difference between a pair of scores (e.g., candidate "i") then that pair is dropped from the analysis.

(ii) If two or more d's are of the same size then such tied cases must be assigned the same rank. The rank assigned is the average of the ranks which would have been assigned if the d's had differed slightly. For example, the d's for candidates "g" and "j" are of the same size. Both these d's are given the average of the two ranks, this being 3,5 (i.e., $\frac{3 + 4}{2}$ = 3,5). The next smallest d is 3. This is given a rank of 5. These ties have a negligible effect on T, the statistic on which the Wilcoxon test is based (Siegel, 1956. p. 77).

(iii) Then to each rank is affixed the sign of the difference. This will indicate which ranks arose from negative d's and which ranks arose from positive d's.

(iv) The T value is then calculated in the last column. T = the smaller sum of like-signed ranks. That is, T is either the sum of the positive ranks or the sum of the negative ranks, whichever sum is smaller. According to Table B.1 the sum of the negative ranks are smaller, and therefore T = 8.5.

(v) N is equal to number of pairs (10 in Table B.1) minus number of pairs whose d is zero (1 in Table B.1) viz., N = 9 in Table B.1.

(vi) If an observed T value is equal to or less than the value given in Table G (this Table is given in: Siegel, 1956. p. 254) under a particular significance level for N, the null hypothesis is rejected at that level of significance. The null hypothesis that is being tested for school F (Table 7.3, p. 174) is: "There is no significant difference in the standard of awarding marks between the examiners and teachers".

The rejection of the null hypothesis is set at 0.01 level of significance (α = 0,01).

Table G (Siegel, 1956. p. 254) shows that for N = 9, a T of 8,5 is higher than the value given for T in the Table (i.e., the Table value for T is 2 at 0,01 level of significance). Therefore the null hypothesis is accepted, concluding that there is no significant difference in the standard of awarding marks by the teacher and the examiner for the school.

The T values and N's (i.e., the number of pairs minus the number of pairs whose d was zero) which were used to read the critical values of T from the Table are given in Tables 7.3, 7.4 and 7.5 (pp. 174-176).

B.5 CORRELATION COEFFICIENTS

B.5.1 Pearson Product-Moment Correlation Coefficient

The machine (raw score) formula for the Pearson product-moment correlation coefficient is

$$r = \frac{N\Sigma XY - (\Sigma X)(\Sigma Y)}{\sqrt{[N\Sigma X^2 - (\Sigma X)^2]\,[N\Sigma Y^2 - (\Sigma Y)^2]}}$$

where X and Y are pairs of scores and N the number of pairs. (Downie and Heath, 1970. p. 93).

The formula was used to compute the correlations of teacher-awarded marks and practical control test marks for large samples (Higher Grade - 467 candidates, Standard Grade - 301 candidates - see Table 7.1 (p. 169).

B.5.2 Spearman Rank-Order Correlation Coefficient

The Spearman rank-order correlation is one of the most widely used nonparametric techniques. It is a measure of association which requires that both variables be measured in at least an ordinal scale so that the objects or individuals under study may be ranked in two ordered series. This statistic is used when the samples are small ($N < 30$).

The following equation was used to compute the rank-order correlation.

$$p = 1 - \frac{6\Sigma D^2}{N(N^2 - 1)}$$

where N = the number of pairs

p = rho, the rank-order correlation coefficient

ΣD^2 = the sum of the squared differences between subjects' ranks

(Downie and Heath, 1970. p. 123)

To compute the Spearman rank-order correlation coefficient, the data for school J (Table 7.3, p. 174) is used. In this example the marks awarded by the teacher and by the examiner (i.e., in the practical control test) for 10 candidates are used.

TABLE B.2: MARKS AWARDED BY THE TEACHER AND THE EXAMINER TO STANDARD GRADE CANDIDATES IN SCHOOL J (TABLE 7.3)

Candidates	Teacher-awarded marks	Marks awarded by examiner (Practical control test marks)	R1	R2	D	D^2
a	23	25	4	1	3,00	9,00
b	19	13	6	6	0,00	0,00
c	16	11	10	7	3,00	9,00
d	26	23	1	2	1,00	1,00
e	18	17	7	4	3,00	9,00
f	25	8	2	9	7,00	49,00
g	20	19	5	3	2,00	4,00
h	17	9	8,5	8	0,50	0,25
i	24	16	3	5	2,00	4,00
j	17	7	8,5	10	1,50	2,25
						ΣD^2 = 87,50

To obtain the coefficient, the following steps were followed:

(i) The teacher-awarded marks were ranked in column R_1 by assigning the rank of 1 to the highest score. Wherever two individuals tied with scores (e.g., candidate h and j) the ranks assigned were the average of the ranks which would have been assigned if the scores had differed slightly. For example candidates h and j would occupy ranks 8 and 9, therefore they are ranked as 8.5 (i.e. $\frac{8 + 9}{2} = 8{,}5$). Too many ties will affect the size of the correlation coefficient (pp. 400-402); but one tie does not justify the use of the formulae that are available to correct this tie (Downie and Heath, 1970. p. 123).

(ii) The mark awarded by the examiner was ranked in column R_2, again in the same way as was done for the first set of scores.

(iii) The difference between the two sets of ranks (column D), was obtained. The sign of this difference is of no importance, since these differences are squared in the next operation.

(iv) Each of these differences was squared (column D^2) and then the squares were summed.

(v) Then the value for rho was computed by applying the equation given on page 398.

$$p = 1 - \frac{6(87{,}50)}{10(10^2 - 1)}$$

$$= 1 - \frac{525}{990}$$

$$= 1 - 0{,}53$$

$$= 0{,}47$$

i.e., rho = 0,47 (Siegel, 1956. p. 206)

If there is a relatively large proportion of tied observations in the X and Y variables (refers to R1 and R2 respectively in Table B.2) then the following formula must be used in computing rho.

$$\text{rho} = \frac{\Sigma x^2 + \Sigma y^2 - \Sigma d^2}{2\sqrt{\Sigma x^2 \, \Sigma y^2}}$$

$$\text{where } \Sigma x^2 = \frac{N^3 - N}{12} - \Sigma Tx$$

$$\Sigma y^2 = \frac{N^3 - N}{12} - \Sigma Ty$$

(Siegel, 1956. p. 207)

T is the correction factor:

$$T = \frac{t^3 - t}{12}$$

where t = the number of observations tied at a given rank.
(Siegel, 1956. p. 207)

To illustrate the computation of the Spearman rank-order correlation coefficient, where the proportion of ties is large, the data for school J (Table 7.4, p. 175) are used.

TABLE B.3: MARKS AWARDED BY THE TEACHER AND THE EXAMINER TO HIGHER GRADE CANDIDATES IN SCHOOL J (TABLE 7.4)

Candidates	Teacher-awarded marks	Marks awarded by examiner (Practical control test marks)	R1	R2	D	D^2
a	50	48	1	1,5	0,5	0,25
b	36	22	5,5	10	4,5	20,25
c	48	48	2	1,5	0,5	0,25
d	31	29	7,5	5	2,5	6,25
e	42	31	3	4	1,0	1,00
f	37	35	4	3	1,0	1,00
g	36	25	5,5	6	0,5	0,25
h	30	19	9	12	3,0	9,00
i	28	22	10	10	0,0	0,00
j	31	24	7,5	7,5	0,0	0,00
k	24	24	11,5	7,5	4,0	16,00
l	24	22	11,5	10	1,5	2,25
						ΣD^2 = 56,50

Now with 3 sets of tied observations on the X variable, where t = 2 in each set, we have

$$\Sigma x^2 = \frac{N^3 - N}{12} - \Sigma Tx$$

$$= \frac{(12)^3 - 12}{12} - \left(\frac{2^3 - 2}{12} + \frac{2^3 - 2}{12} + \frac{2^3 - 2}{12}\right)$$

$$= 143 - 1,5$$

$$= 141,50$$

Now with 3 sets of tied observations on the Y variable, where t = 2 for 2 sets and t = 3 for 1 set, we have

$$\Sigma y^2 = \frac{N^3 - N}{12} - \Sigma T y$$

$$= \frac{(12)^3 - 12}{12} - \left(\frac{2^3 - 2}{12} + \frac{2^3 - 2}{12} + \frac{3^3 - 3}{12}\right)$$

$$= 143 - (0{,}5 + 0{,}5 + 2)$$

$$= 143 - 3$$

$$= 140$$

Corrected for ties, $\Sigma x^2 = 141{,}50$ and $\Sigma y^2 = 140$. From the addition shown in Table B.3, $\Sigma D^2 = 56{,}50$. Substituting these values in the formula given on page 400, we have

$$\text{rho} = \frac{141{,}50 + 140 - 56{,}50}{2\sqrt{(141{,}50)(140)}}$$

$$= \frac{225}{281{,}50}$$

$$= 0{,}80$$

When N is 10 or greater, the significance of the Spearman coefficient may be tested by the use of the following formula:

$$t = \text{rho}\sqrt{\frac{N - 2}{1 - \text{rho}^2}}$$

(Siegel, 1956. p. 212)

The equation above yields a t - value which is interpreted from the t-table where df = N - 2.

For example, the significance of rho = 0,799 can be computed as follows:

$$t = rho \sqrt{\frac{N - 2}{1 - rho^2}}$$

$$= 0,799 \sqrt{\frac{10}{1 - 0,799^2}}$$

$$= 0,799 \sqrt{\frac{10}{0,362}}$$

$$= 0,799 \sqrt{27,624}$$

$$= 0,799 \quad (5.256)$$

$$= 4.20 \quad (p < 0,01)$$

For N from 4 to 30, Table P of the Appendix (Siegel, 1956. p. 284) gives the value of rho (which is essentially the same to that given by the above formula), which has an associated probability under H_o of p = 0,05 and the value of rho which has an associated probability under H_o of p = 0,01. If the observed value of rho equals or exceeds the value tabled, that observed value is significant at the level indicated.

B.6 TESTING THE DIFFERENCE BETWEEN PROPORTIONS FOR CORRELATED DATA

B.6.1 The "z" Test

The data from Table 4.5 (p. 100) for dimension "Cv" are used to illustrate the computation of this statistic. The data indicates that:

(i) seventeen teachers stated that this dimension was attained through current practical work but it was not assessed by them;

(ii) one teacher stated that this dimension was attained through current practical work and it was also assessed;

(iii) one teacher stated that this dimension was not attained through current practical work and it was not assessed;

(iv) no teachers indicated that this dimension was not attained through current practical work and not assessed by them.

This data will have to be tabulated into a two-by-two table as shown below:

		Assessed: No	Assessed: Yes	
Attained	Yes	a 17	b 1	18
	No	c 1	d 0	1
		18	1	19

This two-by-two table indicates the responses of 19 individuals.

The test of significance (i.e., z test) is made by using the following formula:

$$z = \sqrt{\frac{(a - d)^2}{a + d}}$$

(Downie and Heath, 1970. p. 194)

Substituting the values from the two-by-two table in the formula, we have

$$z = \sqrt{\frac{(17 - 0)^2}{17 + 0}}$$

$$= \sqrt{\frac{289}{17}}$$

$$= 4{,}12 \quad (p < 0{,}01)$$

If the z score is 2,58 (or larger), the p = 0,01 level of significance will have been reached (McNemar, 1955. p. 58). If the z score lies between 1.96 and 2,58, the p = 0,05 level of significance will have been reached (Downie and Heath, 1970. p. 168). The formula may be safely used for any size sample provided a + d (i.e., of the two-by-two table) is 10 or more (Guilford and Fruchter, 1973. p. 166; McNemar, 1959. p. 60).

Where the sum of a + d is lower than 10, then X^2 with a correction (for continuity) could be applied (McNemar, 1959. p. 230). However, when the cell frequencies are less than 5, and especially when they are around 2, even correction for continuity is not acceptable, and a method known as Fisher's exact method must be used (Downie and Heath, 1970. p. 204). According to Table 4.5 (p.100) where the sum of a + d was lower than 10, some of the cell frequencies were zero. Therefore the p was calculated directly by the use of the "Fisher Exact Probability Test" (Siegel, 1956. pp. 96-104)

B.6.2 The Fisher Exact Probability Test

The Fisher exact probability test is an extremely useful nonparametric technique for analysing discrete data (either nominal or ordinal). The data from Table 4.5 (p. 100) from dimensions Ai and Aii are used to illustrate the computation of this statistic. The responses must be represented by frequencies in a two-by-two table as follows:

		Assessed: No	Assessed: Yes	
Attained	Yes	a 0	b 19	a+b 19
	No	c 0	d 0	c+d 0
		a+c 0	b+d 19	n 19

The p is calculated directly by the use of the following formula:

$$p = \frac{(a+b)\,!\;(c+d)\,!\;(a+c)\,!\;(b+d)\,!}{n!\;a!\;b!\;c!\;d!}$$

(Siegel, 1956. p. 97)

The exact probability (p) that these 19 cases should fall in the four cells as they did may be determined by substituting the observed values in the above formula:

$$p = \frac{19!\;0!\;0!\;19!}{19!\;0!\;19!\;0!\;0!}$$

$$= \frac{1}{1} \quad \text{(i.e. } 0! = 1 \text{ - see Siegel, 1956. p. 287)}$$

$$= 1{,}00$$

We determine that the probability of such a distribution of frequencies under H_o is p = 1,00. H_o is rejected if the p is smaller than the level of significance (i.e. the α level). Significance level set in this study is 0,01 (i.e. the α level). In the above example H_o is accepted because the p is larger than 0,01.

B.7 The Establishment of Binomial Confidence Limits Through the Use of Fisher and Yates Statistical Tables

The 19 standard-ten biology teachers from the 9 schools are treated as a random sample in this study (pp. 32-34). In making valid inferences as regards the population (e.g., estimating population parameters from sample values) the standard error of a proportion (S_p) could be calculated as follows:

$$S_p = \sqrt{\frac{pq}{N}}$$

where N = number of cases in the sample

p = proportion in the category of interest

q = 1 - p

(Guilford and Fruchter, 1973. pp. 142-144)

The standard error of a proportion yields a confidence interval for the proportion as follows:

$p \pm (2.58)\ S_p \quad (p > 0{,}01)$

(Ferguson, 1966. p. 158)

This interval enables an unbiased estimation of the population proportion from the sample proportion. For example, if $p \pm (2{,}58)\ S_p = 0{,}69 \pm 0{,}23$, then this indicates that with repeated sample of the same size (19 teachers) from the population (88 teachers), the probability that the sample proportion will fall within the limits 0,46 and 0,92 is greater than 0,99 (i.e., $p < 0{,}01$).

In order to calculate the standard error of a proportion and to yield a confidence interval the number of cases in the sample (N) must be large (> 30) and, Np and Nq, must be greater than 10. (Downie and Heath, 1970, p. 188; Gourevitch, 1966, p. 273). The sample of standard-ten biology teachers in this study is small (i.e., 19 teachers) and the frequency of responses in Table C.1 (p. 420) indicates that Np or Nq for each dimension will have a smaller value than 10. In such cases Cochran (Cochran, 1963. p. 58) states that the limits for p may be found from the binomial tables. He states that Table VIII1 in Fisher and Yate's Statistical Tables (Fisher and Yates, 1957. p. 61) gives binomial confidence limits for p for any value of N and he regards this as a useful alternative to the ordinary bionomial tables. An example below shows how the bionomial approximation is computed from the Fisher and Yate's Statistical Tables:

<u>Example</u>: There were 3 out of the 19 teachers that stated that dimension D iii (Table C.1 p. 420) could be attained by pupils (Higher Grade) through current practical work. In this case the following information is required in order to use the table:

a	(affirmative responses)	=	3
N	(number of cases in the sample)	=	19
p	(proportion i.e. $\frac{a}{N}$)	=	0,158

Entering the table with a = 3, p = 0,158 we find that the limits of expectation at probability level of 5 per cent (i.e., 2½ per cent at each end of the tail) are 0,034 and 0,396. To obtain these limits the tabulated values were firstly interpolated by linear interpolation and the values arrived at were divided by N. In a similar way the limits of expectation at probability level of 1 per cent (i.e., ½ per cent at each end of the tail) are computed, giving values of 0,019 and 0,469. The first and second figures at each probability level (at 5 per cent or 1 per cent) indicate the lower and upper limits respectively.

If "f", the sampling fraction, is 5 per cent and more, an adjustment to the lower and upper limits is required (Cochran, 1963. p. 58). In this study f = 0,216 or 21,590 per cent and adjustment is needed. The adjustments to these limits are made by the use of the following formula:

$$\hat{P}_L = p - (\sqrt{1-f})\ (p-p1)$$

$$\hat{P}_U = p + (\sqrt{1-f})\ (p2 - p)$$

where $\hat{P}_L$ = lower limit of expectation

$\hat{P}_U$ = upper limit of expectation

p = proportion $(\frac{a}{N})$

f = $\frac{\text{sample}}{\text{population}}$

p1 = lower limit of tabulated value

p2 = upper limit of tabulated value

(Cochran, 1963. p. 58)

The adjusted limits for the example that was chosen are indicated below:

(i) Probability level of 5 per cent ($p < 0{,}05$)

$\hat{P}_L$ = 0,158 - (0,885) (0,158 - 0,034) = 0,048

$\hat{P}_U$ = 0,158 + (0,885) (0,396 - 0,158) = 0,369

(ii) Probability level of 1 per cent ($p < 0{,}01$)

$\hat{P}_L$ = 0,158 - (0,885) (0,158 - 0,019) = 0,035

$\hat{P}_U$ = 0,158 + (0.885) (0,469 - 0,158) = 0,433

What inference can be made from these confidence limits? We can state with repeated random samples of the same size (from the population under study) the chances are 95 in 100 or 99 in 100 that the sample proportions (in terms of their affirmative responses to dimension D iii) will fall within a band limited by 0.048 and 0,369 (for $p < 0{,}05$) and 0,035 and 0,433 (for $p < 0{,}01$) respectively. As one might expect, the band for 99 per cent is less than that for the 95 per cent confidence interval.

For a $> \frac{1}{2}$ N one has to enter the Fisher and Yates table with $a' = N - a$ (Fisher and Yates, 1957. p. 61). For Example, there were 16 teachers that indicated that dimension F v (Table C.1, p. 420) can be attained by pupils through current practical work in schools. In this instance firstly the bionomial confidence limits for a'= 3 (N - a, i.e. 19-16 = 3) is established for the probability levels of 1 per cent and 5 per cent according to the methods already suggested. Once the confidence limits for a' = 3 are established then these values are used to set confidence limits for a = 16 as follows:

(i) For probability level of 5 per cent ($p < 0{,}05$), subtract the confidence limits set for a' = 3 from 1 (the sum of proportions give a maximum value of 1).
e.g., 1 - 0,048 (lower limit for a' = 3) = 0,952
(upper limit for a = 16)
1 - 0,369 (upper limit for a' = 3) = 0,631
(lower limit for a = 16)

(ii) For probability level of 1 per cent ($p < 0,01$) the confidence limits for $a = 16$ are established in a similar way as indicated above.

For $a = 0, 1 - P^{1/N}$ is the greatest probability that is allowable (P = probability).
(Fisher and Yates, 1957. p. 61)

For example, there were 19 teachers who stated that dimensions Ei - Evii (Table C.1, p. 420) could not be attained by pupils through current practical work. It is still possible to assign an upper limit (one tailed) to the probability although there was no affirmative answer. For probability level of 5 per cent ($p < 0,05$), the upper limit to the probability is $1 - (0,05)^{\frac{1}{19}}$ or 0,129 (after adjustment). For probability level of 1 per cent ($p < 0,01$), the upper limit to the probability is $1 - (0,01)^{\frac{1}{19}}$ or 0,190 (after adjustment). If 19 teachers indicated that a dimension (e.g., dimension Ai, Table C.1, p. 420) was attainable then the table must be entered with $a' = N - a$ (i.e., 19-19 = 0). After the upper limit for $a' = 0$ is established and the appropriate adjustment is computed, then this value is substructed from 1 to provide the lower confidence limit for $a = 19$ (which is also one tailed).

According to the procedure that has been just described, the writer developed Table B.4 (p. 410) which gives the binomial confidence limits for the probability levels of 1 per cent ($p < 0,01$) and 5 per cent ($p < 0,05$) for $N = 19$ (number of cases in sample) $a = 0$ to 19 (occurrence in form or responses) and $n = 88$ (population of standard-ten biology teachers in the Republic of South Africa). Table B.5 (p. 411) is also developed along similar lines for $N = 16$.

TABLE B.4

BINOMIAL CONFIDENCE LIMITS (LIMITS OF EXPECTATION) FOR PROBABILITY LEVELS OF ONE PER CENT ($p < 0,01$) AND FIVE PER CENT ($p < 0,05$) FOR N = 19

Frequency of occurrence or responses a	Proportions (p) a/N	Binomial confidence limits at probability levels of 1 per cent and 5 per cent.							
		Lower limit ($\hat{P}_L$) indicated in proportions (Value/N)				Upper limit ($\hat{P}_U$) indicated in proportions (Value/N)			
		$p < 0,01$		$p < 0,05$		$p < 0,01$		$p < 0,05$	
		Before Adjustment	After Adjustment	Before Adjustment	After Adjustment	Before Adjustment	After Adjustment	Before Adjustment	After Adjustment
0	0,0000	-	-	-	-	0,2150	0,1900	0,1460	0,1290
1	0,0530	0,0003	0,0060	0,0010	0,0070	0,3330	0,3010	0,2610	0,2370
2	0,1050	0,0050	0,0160	0,0130	0,0230	0,4070	0,3720	0,3330	0,3070
3	0,1580	0,0190	0,0350	0,0340	0,0480	0,4690	0,4330	0,3960	0,3690
4	0,2100	0,0380	0,0580	0,0610	0,0760	0,5270	0,4900	0,4560	0,4280
5	0,2630	0,0620	0,0850	0,0920	0,1120	0,5830	0,5460	0,5130	0,4840
6	0,3160	0,0890	0,1150	0,1250	0,1480	0,6330	0,5920	0,5660	0,5370
7	0,3680	0,1210	0,1500	0,1630	0,1860	0,6810	0,6450	0,6160	0,5870
8	0,4210	0,1550	0,1850	0,2020	0,2270	0,7260	0,6910	0,6650	0,6370
9	0,4740	0,1920	0,2240	0,2440	0,2700	0,7680	0,7340	0,7110	0,6840
10	0,5260	0,2320	0,2660	0,2890	0,3160	0,8080	0,7760	0,7560	0,7300
11	0,5790	0,2740	0,3090	0,3350	0,3630	0,8450	0,8150	0,7980	0,7730
12	0,6310	0,3190	0,3550	0,3840	0,4130	0,8790	0,8500	0,8370	0,8140
13	0,6840	0,3670	0,4040	0,4340	0,4630	0,9110	0,8850	0,8750	0,8520
14	0,7370	0,4170	0,4540	0,4870	0,5160	0,9380	0,9150	0,9080	0,8880
15	0,7890	0,4730	0,5100	0,5440	0,5720	0,9620	0,9420	0,9390	0,9220
16	0,8420	0,5310	0,5670	0,6040	0,6310	0,9810	0,9650	0,9660	0,9520
17	0,8950	0,5930	0,6280	0,6670	0,6930	0,9950	0,9830	0,9870	0,9770
18	0,9470	0,6670	0,6990	0,7390	0,7630	0,9970	0,9940	0,9990	0,9930
19	1,0000	0,7850	0,8100	0,8540	0,8710	-	-	-	-

TABLE B.5

BINOMIAL CONFIDENCE LIMITS (LIMITS OF EXPECTATION) FOR PROBABILITY LEVELS OF ONE PER CENT ($p < 0{,}01$) AND FIVE PER CENT ($p < 0{,}05$) FOR N = 16

Frequency of occurence or responses	Proportions (p)	Binomial confidence limits at probability levels of 1 per cent and 5 per cent.							
		Lower limit ($\hat{P}_L$) indicated in proportions (Value/N)				Upper limit ($\hat{P}_U$) indicated in proportions (Value/N)			
		$p < 0{,}01$		$p < 0{,}05$		$p < 0{,}01$		$p < 0{,}05$	
a	a/N	Before Adjustment	After Adjustment	Before Adjustment	After Adjustment	Before Adjustment	After Adjustment	Before Adjustment	After Adjustment
0	0,0000	-	-	-	-	0,2500	0,2260	0,1700	0,1540
1	0,0620	0,0003	0,0060	0,0010	0,0070	0,3950	0,3630	0,3100	0,2860
2	0,1250	0,0060	0,1700	0,0150	0,0250	0,4730	0,4400	0,3900	0,3650
3	0,1870	0,0270	0,0420	0,4050	0,0540	0,5350	0,5020	0,4570	0,4250
4	0,2500	0,0440	0,0640	0,0720	0,0890	0,6300	0,5940	0,5430	0,5150
5	0,3120	0,0750	0,0970	0,1100	0,1290	0,6540	0,6210	0,5860	0,5600
6	0,3750	0,1080	0,1330	0,1520	0,1730	0,7140	0,6820	0,6460	0,6200
7	0,4370	0,1470	0,1750	0,1950	0,2180	0,7640	0,7330	0,7010	0,6760
8	0,5000	0,1900	0,2200	0,2460	0,2700	0,8100	0,7800	0,7540	0,7300
9	0,5620	0,2360	0,2670	0,2990	0,3240	0,8530	0,8350	0,8050	0,7820
10	0,6250	0,2860	0,3180	0,3540	0,3800	0,8920	0,8670	0,8480	0,8270
11	0,6870	0,3460	0,3790	0,4140	0,4400	0,9250	0,9030	0,8900	0,8710
12	0,7500	0,3700	0,4060	0,4570	0,4850	0,9560	0,9360	0,9280	0,9110
13	0,8120	0,4650	0,4980	0,5430	0,5750	0,9730	0,9580	0,9600	0,9460
14	0,8750	0,5270	0,5600	0,6100	0,6350	0,9940	0,9830	0,9850	0,9750
15	0,9370	0,6050	0,6370	0,6900	0,7140	0,9997	0,9940	0,9990	0,9930
16	1,0000	0,7500	0,7740	0,8300	0,8460	-	-	-	-

B.8 RANGE ESTIMATES

The Schools Council Examination Bulletin No 5 (1965. pp. 24-29) gives a description of this statistical procedure. Much of this is indicated below:

"The general characteristics of range estimates can easily be seen by considering the distribution curve, in which the variable is shown along the horizontal axis and a uniform distribution of probability along the vertical. In the uniform (or linear, or rectangular) distribution elementary integration shows that the expected position of the kth member of a sample of n is $k/(n+1)$, and that its variance is $k(n-k+1)/(n+1)^2 (n+2)$, which becomes $n/(n+1)^2 (n+2)$ at either extreme when k is 1 or n. The expected interval between the kth and the hth member is $(k - h)/(n+1)$, with a variance of $(n + h - k + 1) (k - h)/(n+1)^2 (n+2)$ and the expected position of the mid point is $(h + k)/2(n+1)$, with a variance of $[(n+1)(n+h-k+1) - (n-h-k+1)^2] / 4(n+1)^2(n+2)$. Where h and k are symmetrical, so that $h + k = n + 1$, the interval becomes $(n+1 - 2h)/(n+1)$ and its variance $2h (n+1 - 2h)/(n+1)^2 (n+2)$. Where $h = 1$ and $k = n$ these reduce further to $(n-1)/(n+1)$ and $2(n-1)/(n+1)^2 (n+2)$, the expected value and the variance for the range. Similarly for the mid point the symmetrical case gives ½ for the expected value and $n/2 (n+1) (n+2)$ for the variance. For the mid point of the range, or mid range, the variance becomes $1/2 (n+1) (n+2)$. The correlation between the hth and the kth members is $\sqrt{h(n-k+1)/k(n-h+1)}$, which becomes $h/(n-h+1)$ for the symmetrical case, and $1/n$ for the ends of the range, where $h = 1$.

These results can all be easily obtained by direct integration, but for other distributions quadrature is needed". Tables B.6, B.7 and B.8 (pp. 416-418) give them for the normal distribution. "The general features, however, can be seen for any distribution by considering the linear case in conjunction with the distribution curve. The expectations and variances cannot, of course, be directly transferred since an interval on the vertical axis is large or small on the horizontal axis according to whether the relevant part of the distribution curve is flattish or steep, but it is easy to allow for this. For example it is clear from the formula given above that in the linear or uniform distribution the mid range is a much better estimator of the location parameter than either the mean or the median, particularly when the sample is large. But this is not so for the normal or for any distribution where the curve is very flat towards the extremes, so that a small variation on the vertical axis corresponds to a large one horizontally. Again for large samples the range is a very good estimator of the scale parameter in the uniform distribution, but a poor one for the normal and similar curves that flatten towards the extremes". For small samples, on the other hand, the range and the mid point are quite good estimators for the normal curve, as may be seen in Tables B.6 (p. 416) and B. 8 (p. 418). "This is because with small samples the flatter parts of the curves are not much frequented. For the same reason these estimates are much more robust, in the sense of being independent of the precise shape of the distribution, for small samples. For samples of 4 the range factor is 2,06 for the normal, and 2,08 for the uniform distribution. This is the reason for preferring sub samples of 4 or 5 rather than sub samples of 10, which are more efficient if the distribution is normal, when the loss of degrees of freedom is taken into account".

Normally the efficiency of the range as an estimator of scale can easily be calculated from Table B.6 (p. 416). The results are as follows:

Sub-sample size n	Efficiency (a)	(b)	(c)	(d = 1/c)
	%			%
2	87,50	1/2	43,80	151
3	90,50	2/3	60,30	129
4	91,30	3/4	68,40	121
5	90,50	4/5	72,40	118
6	89,30	5/6	74,40	116
7	87,80	6/7	75,30	115
8	86,10	7/8	75,30	115
9	84,40	8/9	75,00	115
10	83,00	9/10	74,70	116
20	69,10	19/20	60,60	123
30	60,00	29/30	58,00	131
40	53,50	39/40	52,20	138
50	48,60	49/50	47,60	145
100	34,70	99/60	34,30	171

(Schools Council Examination Bulletin No. 5, 1965. p. 25)

"The second column gives the efficiency of the range estimates within sub-samples. The factor in the third column allows for the loss of degrees of freedom between sub-samples. The fourth column is the product and gives the overall efficiency of the range estimate for the normal case. The second column reaches its maximum for n = 4, and the fourth column for n = 7 or 8.

But the distribution of grade differences may depart considerably from the normal (apart altogether from its being a stepped curve), so that the point about robustness indicates sub-samples of four or five rather than seven or eight. The fifth column shows the efficiencies in terms of standard deviations instead of variances. Thus for sub-samples of four the range estimates are 21 per cent more widespread than the estimates from sums of squares. This is the price to be paid for the benefit of having much easier arithmetic. It arises mainly from the loss of degrees of freedom. Where it not for this the 21 per cent would be less than 5 per cent."

The critical values of 12 and 10 for the tests of conformity and standards respectively suggested for a sample of 20 candidates in Chapter 3 (p. 76) needs modification for smaller sample sizes as follows (The Schools Council Examination Bulletin No. 5, 1965. p. 25; The West Yorkshire and Lindsey Regional Examining Board, Assessment in a Nutshell, 1975. pp. 9-10).

Total sample	Number in sub-groups	Number of sub-groups	Number eliminated from sample	Conformity criterion	Standards criterion
20	4	5		12	10
19	3	6	1	10	9
18	3	6		10	9
17	4	4	1	9	8
16	4	4		9	8
15	5	3		8	7
14	4	3	2	7	6
13	4	3	1	7	6
12	4	3		7	6
11	5	2	1	6	5
10	5	2		6	5
9	3	3		5	4
8	4	2		5	4
7	3	2	1	4	3
6	3	2		4	3
5	5	1		3	2
4	4	1		3	2

The reason for choosing 12 as the limiting value for the conformity test (for sample of 20) is that it corresponds to a correlation of 0,72 where the sums of ranges for grades are 16 - that is, where the candidates are fairly well spread (The Schools Council Examination Bulletin No. 5, 1965. p. 25). This is within satisfactory limits, it is usually obtained in practice. When the candidates are more homogeneous the correlation is of course lower, but it is in any case the error of variance and not the correlation that really matters, and it is the error of variance that is limited by the critical value of 12.

The reason for choosing 10 as the limiting value for the standards test (for sample of 20) is that it represents a permissible variation of ½ grade per candidate. For 20 candidates, therefore, there may be a difference of 10.

These limiting values and the criterion set for the discrimination test (p. 76) have been arrived at from evidence obtained through extensive trials by the Schools Council (Schools Council Examination Bulletin No. 5, 1965. p. 3)

TABLE B.6: MOMENTS OF THE RANGE OF A NORMAL DISTRIBUTION

Sample size n	Moments			
	A	B	C	D
2	1,128	0,727	0,995	3,869
3	1,693	0,787	0,646	3,286
4	2,059	0,774	0,523	3,188
5	2,326	0,747	0,466	3,169
6	2,534	0,719	0,435	3,170
7	2,704	0,694	0,418	3,176
8	2,847	0,672	0,407	3,184
9	2,970	0,653	0,401	3,192
10	3,078	0,653	0,398	3,200
25	3,928	0,502	0,410	3,275
100	5,015	0,366	0,472	3,390

A is the mean, and B the variance. C is the third moment divided by $B^{\frac{3}{2}}$, and D the fourth moment divided by B^2.

(Schools Council Examination Bulletin No. 5, 1965. p. 27)

TABLE B.7: EXPECTED VALUES OR ORDER STATISTICS FROM A NORMAL DISTRIBUTION

Rank	Sample size					
	2	3	4	5	6	7	8
1	0,5642	0,8463	1,0294	1,1630	1,2672	1,3522	1,4236
2	-0,5642	0,0000	0,2970	0,4950	0,6418	0,7574	0,8522
3		-0,8463	-0,2970	0,0000	0,2015	0,3527	0,4728
4			-0,0294	-0,4950	-0,2015	0,0000	0,1525
	9	10	11	12	13	14	15
1	1,4850	1,5388	1,5864	1,6292	1,6680	1,7034	1,7359
2	0,9323	1,0014	1,0619	1,1157	1,1641	1,2079	1,2479
3	0,5720	0,6561	0,7288	0,7928	0,8498	0,9011	0,9477
4	0,2745	0,3758	0,4620	0,5368	0,6028	0,6618	0,7149
5	0,0000	0,1227	0,2249	0,3122	0,3883	0,4556	0,5157
6	-0,2745	-0,1227	0,0000	0,1026	0,1905	0,2673	0,3353
7	-0,5720	-0,3758	-0,2249	-0,1026	0,0000	0,0882	0,1653
	16	17	18	19	20		
1	1,7660	1,7939	1,8200	1,8445	1,8675		
2	1,2847	1,3188	1,3504	1,3799	1,4076		
3	0,9903	1,0295	1,0657	1,0995	1,1309		
4	0,7632	0,8074	0,8481	0,8859	0,9210		
5	0,5700	0,6195	0,6648	0,7066	0,7454		
6	0,3962	0,4513	0,5016	0,5677	0,5903		
7	0,2338	0,2952	0,3508	0,4016	0,4483		
8	0,0773	0,1460	0,2077	0,2637	0,3149		
9	-0,0773	0,0000	0,0688	0,1307	0,1870		
10	-0,2338	-0,1460	-0,0688	0,0000	0,0620		

(Schools Council Examination Bulletin No. 5, 1965. p. 28)

TABLE B.8: VARIANCE OF THE MIDPOINTS OF RANGES AND SYMMETRICAL INNER RANGES (BETWEEN RANKS k AND n-k+1) FOR THE NORMAL DISTRIBUTION

Sample size	k	n-k+1	Variance of midpoint	Standard deviation of midpoint	Standard deviation of mean
4	1	4	0,2982	0,5461	0,5000
	2	3	0,2982	0,5461	
8	1	8	0,2048	0,4526	0,3536
	2	7	0,1513	0,3890	
	3	6	0,1493	0,3864	
	4	5	0,1682	0,4102	
12	1	12	0,1721	0,4148	0,2887
	2	11	0,1148	0,3388	
	3	10	0,1015	0,3186	
	4	9	0,1002	0,3165	
	5	8	0,1008	0,3175	
	6	7	0,1175	0,3343	
16	1	16	0,1544	0,3929	0,2500
	2	15	0,0975	0,3122	
	3	14	0,0818	0,2860	
	4	13	0,0764	0,2764	
	5	12	0,0756	0,2750	
	6	11	0,0778	0,2789	
	7	10	0,0826	0,2872	
	8	9	0,0904	0,3007	
20	1	20	0,1430	0,3782	0,2236
	2	19	0,0872	0,2951	
	3	18	0,0709	0,2663	
	4	17	0,0641	0,2532	
	5	16	0,0612	0,2474	
	6	15	0,0607	0,2464	
	7	14	0,0617	0,2484	
	8	13	0,0641	0,2532	
	9	12	0,0680	0,2608	
	10	11	0,0734	0,2709	

(Schools Council Examination Bulletin No. 5, 1965. p. 29)

APPENDIX C

AN ANALYSIS OF THE RESPONSES OF STANDARD-TEN BIOLOGY TEACHERS TO THE OPERATIONAL DIVISIONS AND THEIR DIMENSIONS THAT ARE DEVELOPED AND ASSESSED IN PRACTICAL WORK

The nineteen standard-ten biology teachers had to respond to questionnaire C (section 1, B, e. pp. 383-387) with regard to those operational divisions and their dimensions that are developed by pupils and assessed by the teachers in their respective schools. These responses were analysed and are presented in Table C.1.

TABLE C 1 : THE RESPONSES OF STANDARD-TEN BIOLOGY TEACHERS TO THE OPERATIONAL DIVISIONS AND THEIR DIMENSIONS THAT ARE DEVELOPED AND ASSESSED IN PRACTICAL

...s (represented ... dimensions ...n numerals).	GRADES S and H = Standard Grade and Higher Grade S = Standard Grade H = Higher Grade	The operational divisions and their dimensions that are developed through current practical work at schools.				The operational divisions and their dimensions that are ... by the teachers in the assessment of attainment of pupi...		
		TEACHERS		SCHOOLS		TEACHERS		SCHO...
...imensions		NUMBER	PERCENTAGE	NUMBER	SCHOOLS REPRESENTED	NUMBER	PERCENTAGE	NUMBER
i	S and H	19	100,00	9	1 to 9	19	100,00	9
ii	S and H	19	100,00	9	1 to 9	19	100,00	9
iii	S and H	19	100,00	9	1 to 9	6	31,58	5
i	S and H	15	78,95	7	1; 3; 5; 6; 7; 8; 9	5	26,32	5
ii	S and H	19	100,00	9	1 to 9	19	100,00	9
iii	S and H	19	100,00	9	1 to 9	19	100,00	9
i	S and H	19	100,00	9	1 to 9	9	47,37	6
ii	S and H	19	100,00	9	1 to 9	9	47,37	6
iii	S and H	19	100,00	9	1 to 9	19	100,00	9
iv	S and H	19	100,00	9	1; 1 to 9	19	100,00	9
v	S and H	18	94,74	8	1; 2; 3; 4; 5; 7; 8; 9	1	5,26	1
i	S and H	19	100,00	9	1 to 9	8	42,10	5
	H	0	0,00	0	-	11	57,89	7
ii	S and H	16	84,21	9	1 to 9	5	26,32	5
	H	3	15,79	3	5; 8; 9	14	73,68	8
iii	S and H	0	0,00	0	-	0	0,00	0
	H	3	15,79	2	1; 5	3	15,79	2
iv	S and H	0	0,00	0	-	0	0,00	0
	H	0	0,00	0	-	0	0,00	0
v	S and H	0	0,00	0	-	0	0,00	0
	H	0	0,00	0	-	0	0,00	0
vi	S and H	13	68,42	5	1; 2; 3; 7; 8	3	15,79	3
	H	6	31,58	6	2; 4; 5; 6; 8; 9	15	84,21	8
vii	S and H	10	52,63	4	1; 2; 3; 7	7	36,84	3
	H	9	47,37	6	2; 4; 5; 6; 8; 9	12	63,16	8
i - v	S and H	0	0,00	0	-	0	0,00	0
	H	0	0,00	0	-	0	0,00	0
i	S and H	12	63,16	8	1; 2; 4; 5; 6; 7; 8; 9	1	5,26	1
	H	0	0,00	0	-	0	0,00	0
ii	S and H	0	0,00	0	-	0	0,00	0
	H	12	63,16	6	1; 5; 6; 7; 8; 9	2	10,53	2
iii - (1)	S and H	19	100,00	9	1 to 9	19	100,00	9
	H	0	0,00	0	-	0	0,00	0
iii - (2)	S and H	19	100,00	9	1 to 9	19	100,00	9
	H	0	0,00	0	-	0	0,00	0
iii - (3)	S and H	19	100,00	9	1 to 9	19	100,00	9
	H	0	0,00	0	-	0	0,00	0
iii - (4)	S and H	18	93,74	9	1 to 9	0	0,00	0
	H	0	0,00	0	-	0	0,00	0
iii - (5)	S and H	18	93,74	9	1 to 9	0	0,00	0
	H	0	0,00	0	-	0	0,00	0
iv	S and H	0	0,00	0	-	0	0,00	0
	H	0	0,00	0	-	0	0,00	0
v	S and H	16	84,21	9	1 to 9	0	0,00	0
	H	0	0,00	0	-	0	0,00	0
vi - (1)	S and H	13	68,42	7	1; 4; 5; 6;7 7; 8; 9	0	0,00	0
	H	0	0,00	0	-	0	0,00	0
vi - (2)	S and H	13	68,42	7	1; 4; 5; 6; 7; 8; 9	0	0,00	0
	H	0	0,00	0	-	0	0,00	0
vi - (3)	S and H	13	68,42	7	1; 4; 5; 6; 7; 8; 9	0	0,00	0
	H	0	0,00	0	-	0	0,00	0
vi - (4)	S and H	13	68,42	7	1; 4; 5; 6; 1; 8; 9	0	0,00	0
	H	0	0,00	0	-	0	0,00	0