

AN EXPERIMENTAL EVALUATION OF SOME ASPECTS OF SECONDARY  
SCHOOL SCIENCE CURRICULUM IN PAPUA, NEW GUINEA

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Summary

Reference: Vol.2 (1969) H3 (p.93)

5 Studies were undertaken.

- Study i - In 1965 Grade 10 population of science pupils were tested for readiness for further studies in physics, and the results were compared with that of groups of pupils in Grades 6 - 10 in Australia.
- Study ii - In 1967 the performance of Grade 10 Papua New Guinea pupils and Australian Grade 10 pupils on the Papua New Guinea School Arts and Science Exam were compared to identify the difference at the same grade level.
- Study iii - In 1968 a test of understanding science was used in a longitudinal study over a year of students studying science in a teachers' college. This provided data on the effectiveness of the teachers' college science course in developing students' understanding of the nature of science. The performance of the group on the pre-test at the completion of their Secondary School Science course reflected the effectiveness of the Secondary School Science Course.
- Study iv - In 1970 the Grade 10 population was tested with the 1967 test of readiness for further studies in physics, when in the intervening period 1967 - 70 the Secondary School Science syllabus had been modified. The performance was compared with the performance of the 1967 Grade 10 population. This enabled the assessment of the effects of innovation.

- Study v - In 1972 an analysis of common incorrect answers in multiple-choice questions science examination at Grade 9 and 10 levels revealed a pattern of behaviour termed "focussing", whereby pupils focussed on only part of the information in arriving at an answer. Subsequently, a test of focussing was developed to examine this behaviour among secondary and tertiary students in Papua, New Guinea.

## Report

### Introduction

In recent years there has been an increasing recognition of the importance of school science courses in developing countries. At the same time there has been an increasing awareness that the values, patterns of behaviour and basic assumptions of science are likely to be at variance with those of the particular non-Western community from which the pupils are drawn. (e.g. Stone 1967, Maddock 1968, Williams 1970). If a science curriculum is to be successful in such a situation, it must take cognizance of the attributes of the children who will study the curriculum. Accordingly, in this context, it becomes extremely important to gather data on the attributes of the pupils taking science so that this data can be used in the planning of the science curriculum. It is also important that the science curriculum be continually modified in the light of assessments of its effectiveness when it is used in classrooms with children.

### The Studies

In 1967 a series of studies designed to evaluate some aspects of the effectiveness of current secondary school science courses in Papua New Guinea were commenced. The conduct of these studies will be described briefly below, and the results obtained will be presented later.

Study 1 Performance on tests of readiness for further studies in physics. (Mackay 1968, 1969b; Mackay and Gardner 1969).

In 1967, an attempt was made to test the Grade 10 population of science pupils in Papua New Guinea with tests designed to test readiness for further studies in physics (Mackay et al. 1967). Detailed analysis of performance on each of the hundred multiple-choice items was undertaken, and the performance of the group compared with that of groups of pupils in Grades 6 to 10 in Australia. Individual interviews conducted with pupils in three Papua New Guinea High Schools soon after the testing were used to identify and elucidate the nature of some of the misconceptions, vocabulary difficulties, and conceptual difficulties evoked by the test items. These interviews were supplemented by tape-recorded group interviews conducted by science teachers immediately following the testing.

Study 2 Performance of Grade 10 Papua New Guinea pupils and Grade 10 Australian pupils on the 1967 Papua New Guinea School Certificate Science Examination. (Mackay 1968, 1969a).

Late in 1967, the science examination which had been completed a few weeks earlier by the population of Grade 10 science pupils in Papua New Guinea was administered to a sample of 540 Grade 10 pupils in Melbourne. A detailed analysis of performance on each question was undertaken to identify some of the differences between Papua New Guinea and Australian pupils at the same grade level.

Study 3      Understanding of the Nature of Science for Teachers' College students. (Mackay 1970).

In 1968, the Test on Understanding Science (Cooley and Klopfer 1961) was used in a longitudinal study over a year of a group of students studying science in a Teachers' College in Papua New Guinea. In addition to the results providing data on the effectiveness of the Teachers' College science course, in developing students' understanding of the nature of science, the performance of the group on the pretest provided an estimate of their level of understanding of the nature of science at the completion of their secondary school science course. Thus the results reflected on the effectiveness of the secondary school science course.

Study 4      Changes in science achievement accompanying a change in the science curriculum. (Mackay 1971).

In 1970 an attempt was made to test the population of Grade 10 pupils in Papua New Guinea with the same tests of readiness for further studies in physics used in the study in 1967 (described as Study 1 above). In the intervening period, the secondary school science syllabus had been modified as described by Maddock (1968), so that the pupils tested in 1970 had studied a different syllabus to those tested in 1967. Comparison of the performance of the 1967 and 1970 samples enabled the assessment of some of the effects of the innovation.

Study 5      Study of "Focussing" behaviour. (Mackay and Putt 1972).

As a result of analysis of common incorrect answers on multiple-choice questions on public examinations in science at the Grade 9 and Grade 10 levels in Papua New Guinea, a pattern of behaviour termed "focussing" was identified. This behaviour can be related to failure to achieve Piaget's formal operational stage, (Inhelder and Piaget 1958), as it involves the pupil focussing on only part of the information in arriving at an answer, rather than considering a number of pieces of information in conjunction to arrive at the correct answer. Subsequently a Test of Focussing was developed and used to examine the prevalence of focussing behaviour among secondary and tertiary students in Papua New Guinea.

### Summary Results

The results obtained from the five studies can be regarded under several headings.

(i) Identification of attributes of science pupils in Papua New Guinea

As indicated earlier, information on pupil attributes can provide an important base for the planning of instruction.

(a) Vocabulary difficulties

As a result of interviews conducted in conjunction with Study 1, it was apparent that many pupils experienced difficulty with words in the tests. Many of these words appeared to be so crucial for learning in science classrooms that it was considered that these vocabulary difficulties would be likely to seriously affect pupil learning. Subsequently, P.L. Gardner of Monash University has undertaken a further investigation of the scientific vocabulary of Papua New Guinea pupils.

(b) Common misconception and conceptual difficulties

A number of widely held misconceptions were identified in the results for Studies 1, 3 and 4. Although they are too numerous to be listed here, the following examples may illustrate the type of misconceptions identified:

1. Less than a quarter of the Grade 10 pupils in Study 1 recognized that the speed at each instant in a journey need not be the same as the average speed for the journey. For the 1970 sample in Study 4, less than a sixth of the pupils recognized this.
2. More than half the students in Study 3 answered that the principal aim of science was to "discover, collect and classify facts about animate and inanimate nature", as compared to less than one-sixth who recognized that the principal aim was to "explain natural phenomena in terms of principles and theories."
3. Two-thirds of the Teachers' College students in Study 3 regarded the statement that "scientists are generally geniuses" as true.

(c) Occurrence of focussing behaviour

The results of study 5 provide clear evidence for the existence of consistent patterns of focussing behaviour among some secondary school pupils in Papua New Guinea, and supports the evidence of Prince (1969) and others that many of the pupils have not attained Piaget's formal operational stage by the end of secondary schooling.

(ii) Comparison of the attributes of pupils in Papua New Guinea and Australian pupils

Cross cultural comparisons are fraught with difficulties. Nevertheless, information of a comparative nature can be useful in deciding in which ways 'imported' curricula need to be modified, and also in assisting teachers imported from another context to adjust to a new teaching context.

(a) Level of attainment in science

The results of Study 1 suggest that in terms of readiness for further studies in physics, science pupils in Papua New Guinea at the end of Grade 10 have reached about the same level of attainment as Australian pupils part way through Grade 9. Further support for the relatively poorer performance of Papua New Guinea pupils than Australian pupils in the same grade was found in Study 2.

(b) Understanding of the Nature of Science

The results of Study 3 suggest that at the end of Grade 10 in Papua New Guinea, the level of pupils' understanding of the nature of science was at about the same level as Australian pupils' at the end of Grade 6.

(c) Frequency of occurrence of patterns of focussing behaviour

In terms of the distribution of focussing scores obtained on the Test of Focussing, the results of Study 5 suggest that students in Papua New Guinea in their first year of tertiary education are equivalent to a group of Victorian pupils about four years younger. This supports the view of Prince (1969) that there is a lag in the achievement of Piagetian stages by children in Papua New Guinea when compared to children in Western society.

(d) Different conceptual and learning difficulties

The results of Studies 1 and 2 have indicated differences between pupils in Papua New Guinea and Australia in terms of their misconceptions and the topics which they find most difficult.

(e) Subsequent observation of similar learning difficulties among Australian pupils

In a number of cases, effects which have been apparent as a result of study of Papua New Guinea children have later been found to occur for Victorian pupils. This has been an additional payoff from the research. For example, testing of Victorian pupils for Study 5 revealed the existence of consistent patterns of focussing behaviour, and the results of Study 1 indicated that many of the misconceptions and difficulties apparent for Papua New Guinea pupils also occurred for Victorian pupils.

(iii) Identification of deficiencies in instruction

The identification of deficiencies in instruction provides a rational basis for curriculum revision. The five studies enabled the identification of deficiencies in a number of ways.

(a) Identification of areas in which post-instruction performance of pupils was less than might be desired

The results of all five studies provided information on topics and areas of the syllabus which pupil found difficult. Consideration of this performance revealed a number of areas in which the performance was less than would be desired and suggested a number of the curriculum where modification would be advantageous. The results also provide teachers with information which would enable them to identify likely difficult topics and concepts and to modify their teaching accordingly.

(b) Inadequacies in changes in pupil performance during the period of instruction

Study 3 revealed that there was no significant change in students' understanding of the nature of science during a year in which they studied science in a Teachers' College. This result suggests that, as teachers, these students would be unlikely to present an adequate picture of the nature of science to their pupils. This in turn suggests the need for changes in the Teachers' College science courses.

(c) Evaluation of the effectiveness of curriculum innovation

Comparison of the results from the 1967 and 1970 testings in Study 4 indicates that, whereas some small changes in performance on individual items were observed, there had been no overall improvement in performance on the tests concerned between the two testings. However, it must be recognized that the test employed covered only a small sample of possible outcomes of the science courses concerned. The data obtained provide a basis for subjective judgements to be made by balancing the apparent 'gains' identified against the apparent 'losses', and against other advantages and disadvantages which have accompanied the curriculum innovation, thereby assisting in the evaluation of the effectiveness of the innovation.

### Conclusion

This paper has only very briefly reported the results of five studies concerned with the evaluation of secondary school science curricula in Papua New Guinea. For more detailed results the reader is referred to the studies.

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