TRAINED SCIENTIFIC MANPOWER AND QUALITY IN SCIENCE EDUCATION

By W. P. Palmer

Goroka Teachers' College

University of Papua New Guinea

ABSTRACT

The thesis of this paper is simple. Employers are dissatisfied with the number and quality of the graduates being produced in scientific and technological subjects by the Universities. The Universities are themselves dissatisfied with the scientific and mathematical knowledge of their own intake from the secondary schools.

The author's contention is that the problems lie in the lack of challenge of the existing secondary science curriculum, though the author recognises that change in the curriculum in the desired direction will necessitate selection or differentiated curricula with students' choice. Further problems arise in the resource base for primary and secondary science curricula. Finally improvements need to be made in both primary and secondary teacher training. In the latter case the improvements must involve the provision of increased resources to Goroka Teachers' College from the University which distributes its resources unequally.

INTRODUCTION

This paper will assume that it is the aim of any country to staff its institutions, including private business, with its nationals. At a recent seminar Narakobi stated this principle as one of the key aims for national development. At the same seminar Spencer (1984), who is employed by Bougainville Copper Ltd, pointed out the short—comings of the present science graduates from the universities. Effectively he said that many graduates are not capable of doing the jobs required of them. The thesis of this paper is that there is a problem in science and mathematics education starting at the lowest levels of the educational system and increasing in intensity and seriousness as the educational ladder is ascended. This problem must be solved so that sufficient competent national graduates will be produced in science, engineering and technology.

The problems of science education at the community school and provincial high school levels lie in the organisation of the educational system and the assumptions implicit in the construction of curricula. Government policies in these areas have been considerably influenced by the writings of F.E. Williams (1935) which

were later incorporated into C.W. Groves' book entitled "Native Education and Culture Contact in New Guinea". The main ideas in the book were put into practice whilst he was Director of Education from 1945 to 1958. Groves' theories may well have been appropriate to the 1930's and 1940's but they have become increasingly dated and increasingly inappropriate for a country which wishes to attain international standards for the modern sector of the economy.

In 1955. the Minister for Territories reaffirmed that the Australian educational policy in Papua and New Guinea was still based on the Williams/Groves ideal of a blending of cultures (Smith 1974). McKinnon (1965) admitted that there were difficulties and indicated that both cultures would be provided within the educational system leaving the choice to the individual. Present curricula are still however influenced by the Williams/Groves theories and the author considers that this hangover from the past is harmful to the speedy development of scientific ideas in Papua New Guinea.

The Williams/Groves theories will be briefly indicated by the following quotations (Groves, 1936, pp 23—24):—

"That the education necessary to this particular task of adjustment must be related to the world in which the native lives, giving recognition to indigenous culture where possible and desirable, linking itself in its programme to the native life; fitting its institutions into the native social background; and focusing its work and aims on the present interests and future needs of the native in his natural home. That is to say, there must be a nativization of the educational concept.

That a knowledge of the indigenous culture—material, social and spiritual—and of the extent and nature of the changes brought about in that culture by the contact situation, is

prerequisite to the working—out of a system of education fulfilling those requirements".

"The aim must be one of Cultural Differentiation . This implies the retention of all that is worth—while and indispensable of the old native culture, and its blending with those elements of European culture which are necessary to the future progress of the native peoples",

N.B.1. The term Cultural Differentiation is borrowed from the paper of F. E. Williams.

The problem with the theory of "Cultural Differentiation" applied to science education is that it is particularly in the area of western scientific thought that integration of culture is most difficult. Lip service has been paid to the concept in the

construction of secondary mathematical and scientific syllabi, but all that have been created are emasculated syllabi which fail to build concepts sufficiently well to allow for the further development of capable individuals. Nor does the author believe that Groves himself would be satisfied with the situation, for he writes (Groves, 1936, p 170):— "The immediate needs are to study the whole problem, to institute research projects, to plan wisely, and to proceed carefully and slowly. Native education must be regarded for a longtime as a laboratory, in which the course of the experiments being carried out may be changed and their nature modified as need arises and conditions demand".

This indicates that Groves would have been prepared to modify his views where it could be shown that the hypothesis was incorrect.

The Department of Education is responsible for the science and mathematics curricula in community, provincial high and national high schools. Their attitude to curriculum change might best be exemplified by the following quotation (Murray, Superintendent Inspection, Provincial High Schools, 1983).

"I rate the content of the syllabuses as a minor issue in the question of standards and I go a step further and say that the more they are changed then the more harm is done".

Progress whilst such views are prevalent is impossible. Yet within the Education Department the problems of science and mathematics education have been well appreciated for many years. For example the former Secretary for Education (Tololo, 1977) writes:— "However we do believe and the evidence from tests, exams and research supports this belief — that Papua New Guinean students have a much more difficult task in reaching international standards in science and mathematics".

Thus the problem has been recognised, yet no action has been taken to solve it. Possible solutions are suggested later in this paper. The major faults with respect to science education in the national education system (Palmer, 1981) are a lack of science text books, lack of science equipment in schools, the non quantitative nature of the provincial high school curriculum, the emphasis on inspection rather than expert subject advice, a lack of resources for teacher education at all levels, and examinations which do not test a wide enough variety of skills.

It is pleasing to note that action has been taken on some of these faults, particularly with respect to science books, science equipment and also an improvement in the examination system.

The paper will consider in turn the quality of science education at each educational level, starting with the community school, and will attempt to indicate solutions to the problems of quality under the general headings of selection,improved resources, and improved teacher training.

SCIENCE AND MATHEMATICS IN COMMUNITY SCHOOLS

It is within the community schools that the foundations for science and mathematics are laid, and the overall assessment of standards of achievement at this level must be that standards are very low, though there is good work being carried out.

With reference to mathematics Roberts and Kado (1979) report:—

"The teachers generally had not had the time or the inclination to study the syllabus" (p 187).

“Almost without exception the teachers had no personal library and neither did the school have any up to date reference books” (p. 187).

“Clearly however, the schools in general lack a great deal of what can be regarded as basic and essential items of equipment” (p 190).

Wilson, M (1970) evaluates the progress of the “Three Phase Primary Science” (TPPS) syllabus for which curriculum planning had started in 1968. Basically it is an optimistic report which suggests only a few areas for concern as the project increased in size.

Maddocks (1975) looked at the effects TPPS had on achievement in Form 1 of the secondary schools and concluded that “if TPPS has any effect at the secondary level it is a meagre one. This is a worrying finding and confirmed some of Wilson’s earlier concerns. Wilson, A (1979) summarising the evidence to that time states that “It seems clear that while TPPS remains successful in many ways the major problem now facing improved implementation in the schools is the lack of supply of essential materials particularly in Grades 5 & 6”

More recently Kappey (1983) has looked at the capabilities of primary school pupils in science and has in general found them capable of carrying out experiments and drawing conclusions, but has found pupils unable to explain what they are doing, thus showing that many of the apparent problems in understanding science are linguistic. This may remind curriculum developers and teachers that attention has to be paid to the medium as well as the message.

The following comments by Roberts and Kada (1979) probably apply equally to science:— “Improved standards in primary mathematics education will mean improvements in secondary and tertiary level mathematics education and so to improved viability for rural development programmes and localisation effort”.

The literature cited indicates that the curriculum is, in itself, excellent, but primary school teachers, even those recently trained, perceived their own training to be inadequate (Wilson, A. 1979). Thus improvements required at the community school level in science education seem to relate to improved resources, better distribution of existing resources and greater emphasis on science content in courses for community school teachers.

STANDARDS IN SCIENCE AND MATHEMATICS AT PROVINCIAL HIGH SCHOOL

Previous papers (Palmer 1984a) and (Bunker & Palmer, 1983) have given detailed accounts of standards of mathematics and science in provincial high schools, citing a considerable literature.

Internationally, there are few studies of science or mathematics education which include Papua New Guinea. Ros (1984) has compared standards in five developing countries including PNG, whose standards compared unfavourably with the other countries selected. Later this year tests in science will be attempted by Grade 10 students in Papua

New Guinea provincial high schools as part of the “SISS Project’ and their levels of achievement will be compared with those of students in about thirty other countries. The results of this work should give rather better comparisons than are at present available.

Within PNG over the past ten years or so there is said to have been a general decline in standards at provincial high school level. Again the evidence for this is not conclusive. Ros (1983), in mathematics has measured standards regularly over the last twelve years and finds comparatively little change in his tests. Ross (1982) found that standards in mathematical and logical thinking had fallen over the previous six years. Shea (1978) summed up nine different pieces of research which generally indicated that Papua New Guineans had major problems in mathematics and science. This paper will accept this as being the overall position for provincial high school science.

MATHEMATICS AND SCIENCE AT THE TERTIARY LEVEL

Snell (1983), Priest (1983) and Blowers (1982) have all indicated the very great carry—over problems where low standards in secondary schools lead to low standards in tertiary education. The

following are mentioned as specific problems for PNG tertiary students, comprehension of English, rote learning, basic skills in mathematics and a lack of good study habits.

There is also now considerable evidence from “Piagetian” studies that less than 20% of students starting University education can think formally (Wilson, A and Wilson, M 1983), though general criticisms of the accuracy of “Piagetian” studies by Nagy and

Griffiths (1983) should be borne in mind. The author has noted previously (Bunker & Palmer, 1983) that the gap between PNG students and students from developed countries in achieving any given “Piagetian” level, seem less, in general, in more recent studies than in earlier studies. This evidence is extremely tentative but may indicate some general catching up by Papua New Guinean students. If this is so how can this trend be accelerated?

The “Piagetian” perspective has within it a “Catch 22” as has been well put by Phillips (1983). ‘If students are not ready, they cannot be taught. If they are ready they don’t need to be taught’. Phillips says that those designing tertiary curricula must provide students with experiences that get theta ready to change from concrete to formal thinking and then challenge the students to make that change. The author accepts this general theory and believes that improved science curricula at both secondary and tertiary levels can accelerate change between one “Piagetian” stage and the next. However, the key word is ‘challenge’ and it is at the provincial high school level that the science curricula lack challenge. It is thus at that level that curriculum change is most needed.

QUESTIONS OF SELECTION

The goals of quality education and equality in education can be seen to be opposition to one another. The National Department of Education, partly in response to political pressure and partly though following the policy of “Cultural Differentation” tends to give greater priority to producing many students with a very limited education rather than to producing fewer better students. The policy appears to succeed in producing sufficient qualified personnel in many subject areas but in science—related areas this is just not happening. Why is this? The major reasons why PNG is not producing enough high quality students in science and mathematics is that the overall curriculum does not sufficiently emphasise the importance of these subjects, nor does it challenge students sufficiently. In many subjects curricula are deadly dull. Ros (1984) points out that for mathematics three different syllabi have been tried in provincial high schools over the past twelve years ‘each progressively less academically demanding than the former’.

In science the syllabus has been “de MATH oligised” which has done for science in Papua New Guinea what demythologising has done

for, religion. The process of removing more difficult concepts from provincial high school science continues steadily with each revision of the syllabus. The logic of the curriculum planners appears to be to reduce the academic levels required by the syllabi continuously in order to make them more comprehensible to children of progressively lower ability.

SCEP is a useful and well- known curriculum development in Papua New Guinea which has sought to harmonise curriculum development within schools to the problems of the village community of which the schools are a part (Vulliamy 1981). It has been an expensive project in terms of resources, yet can claim considerable success. It is the author’s contention that an equally valuable aim for PNG is to produce high level manpower with scientific and technological skills. This aim could be achieved by funding a small number of “science” schools which would be specially equipped and staffed, and which would select students of high ability; Although an anathema to some, this idea has been tried with a measure of success in other developing countries, for example in Kano State, Nigeria. Curricula would have to be extended throughout the educational system, but the scheme should be cost effective as time in tertiary education be saved and this is extremely expensive, whilst costs in secondary schools are much lower, even if schools were given extra resources.

Alternatively provincial high schools should offer their pupils a choice of curricula so that some pupils could, after two years of general education at secondary level, specialise to a much greater degree than at present with perhaps the possibility of doing three separate sciences. The curriculum unit would need to write new syllabi and to organise new examinations. Regional secondary inspectors would have to certify that schools had sufficient resources to offer a variety of different courses, and movement of students between schools might be advantageous, rather than the duplication of costly facilities.

However, in some way the education system has to answer the problem that exists at the moment in mathematics and science. The problem is that the more able pupils who would in most systems be covering a demanding quantitative science syllabus from an early age do not have this option in Papua New Guinea. Unfortunately by the time the system demands more of them they have got set in their ways and much slower rates of progress have become their norm. This means that tertiary courses are long, expensive and, in the end, do not produce a high quality product. There are a wide variety of possible solutions, of which two possibilities are given above, but most involve selection or greater specialisation.

RESOURCES FOR SCIENCE EDUCATION

The National Department of Education has now put the provision of resources for science education in schools as a major priority under the “Education III Programme”. There are separate programmes for science equipment and science book development, which are extremely welcome developments.

The equipment grant has had to be divided amongst about 112schools so that amount available to each school is small. Schools have been classified as small, medium or large and kits to the value of Kl400 per annum for large schools, 1 per annum for medium size schools and K500 per annum for small schools, each for a five year period, will be provided. In the first year, 1984, biology kits will be given to schools, followed by physics equipment in 1985, chemistry equipment in 1986, geology equipment in 1987 and miscellaneous equipment in 1988. (Deutrom, 1984). A considerable problem in the past has been the loss of science equipment from schools through breakage or theft and it is suggested that procedures for preventing these losses be tightened, though since there is a high degree of staff mobility this is easy to say, but difficult to accomplish in practice. A further problem is the tendency for secondary headmasters to spend very little on science equipment and this tendency may in fact be increased as headmasters may consider that what is provided nationally will be enough by itself. Other obvious problems, such as some schools already being well equipped are apparent, but there are not sufficient trained personnel to check school needs in detail, to prevent duplication. The plan has these obvious deficiencies, yet it should give basic equipment to all schools, some of which have virtually nothing at present. The plan is thus welcomed.

There is also a plan to fund one writer for two textbooks, one for grades 7 & 8 and one for grades 9 & 10. Again this seems eminently sensible as schools have had virtually no textbooks available until recently. Since 1983 two different Australian science textbooks have been trialed. This is progress as it shows that the negative thinking arising from Groves’ theory of Cultural Differentiation which positively discouraged students having overseas textbooks, is gradually disappearing. There is a final point on resources which the author feels is important. In PNG the system of inspection is a rather rigid one which tries to enforce government policy, whereas most countries also have subject specialist advisers regularly visiting schools, trying to encourage good practice in their subject areas. Funding is urgently required for specialist advisers in science to visit provincial high schools to improve teaching and to encourage teachers by discussion, persuasion and advice.

TEACHER TRAINING AND SCIENCE EDUCATION

It is fundamental to any improvement in science education that the quality of secondary science teachers must be improved. At present there is too little education distance between the newly trained teacher and the students being taught. The first and most fundamental improvement to be made is to give all student teachers a three year course after national high school. However this is expensive and government is unable to find resources for this. Within GTC, which prepares almost all secondary teachers, a course for double subject science was started in 1984 after several years of planning, which gave greater specialisation with few extra costs. The National Department of Education opposed the scheme and threatened not to register the teachers produced. This stopped the scheme for 1984 but further discussions indicate that it may be restarted with modifications in 1985.

Within the University of Papua New Guinea, G.T.C. receives a lower share of resources than that of either of the other two campuses of UPNG. In particular, GTC has eight less staff that the university's own committees recommend (Palmer l984b) but there appears to be no way in which matters can be rectified within the university. GTC has 20% of the university's students but only 2% of its ancillary staff. The ratio of senior to junior academic staff on the Taurama Campus is 1:1.1 whilst at GTC the ratio is about 1:6.

Students at GTC have least money spent on them by the university and the university's attitude to GTC seems at times to be one of indifference. Yet, as a teachers college, it has the capacity eventually to improve the quality of the university's intake, and thus the standards of the university as a whole. However the university continues to starve GTC of resources. Until this shortsighted policy is discontinued, the author can see little hope for the improvement in educational standards generally and science standards in particular.

CONCLUSION

There seems to be little argument about the fact that too few qualified scientists are being produced. Improvement of community school teacher training in science and of provision of equipment to community schools would help in the long term. Some selection or choice mechanism, so that a more quantitative science curriculum can be introduced in provincial high schools, seems to be essential. Although this seems inegalitarian it would makes use of the nation's own scarce resources — the talents of its indigenous people - and would develop them, so that Papua New Guineans could take over the skilled technical jobs which at present cannot be localised.

The National Department of Education is now taking action with respect to the provision of books and laboratory equipment but it should also consider appointing science advisers. The National Department of Education should work to encourage further specialisation in its schools and in teacher training. Finally the university should put its teacher training faculty as a priority in the allocation of resources.

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