THE TRAINING OF SCIENCE TEACHERS IN PAPUA NEW GUINEA.

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Introduction

The Currie Report (1964) pointed out that:

So far as any one strand in the ‘seamless web’ of education can be picked out as of more fundamental importance than another it is the training of teachers/probably no other activity of the Administration is quite so important as this.

Klassen (1982) has also rated teacher education highly:-

Teacher education is a major element in a nation’s hope for educational progress.

Science and technology are seen as the way forward for most countries to develop their full economic potential. To achieve this, a high level of general education is required as well as a viable indigenous scientific community. (Yeboah-Ainankwah, 1984, p. 7).

In PNG two institutions prepare secondary science teachers. One is Goroka Teachers College which offers prospective teachers a Diploma in Secondary Teaching after a two year course from Grade 12. The great majority of secondary teachers take this course. The Faculty of Education offers a small minority a Bachelor of Education course which is influential, but the remainder of this paper will refer almost entirely to the GTC diplomates.

Teacher training or teacher education

One of the two quotations in the introduction refers to teacher education whilst the other refers to teacher training. Which of the two descriptions best fits the preparation of science teachers at GTC. The question is answered by considering which of Beeby’s stages of development the education system in PNG has now reached. Beeby (1966) describes the four stages of development of educational systems (stage 1, Dame School; stage 2, Formalism; stage 3, Transition; and stage 4, Meaning); these stages also describe the stages of development of the teachers who work in systems.

In the 1970s Musgrove (1976), Larking (1974) and Ilagi (1980) all indicated that they considered that Papua New Guinea was in the formalistic stage of development. In the mid 1980s the secondary system can be seen as moving towards stage 3 (the transition stage) where the gap between what teachers and pupils know is greater than it was
formerly, allowing the pupils more latitude to ask questions, though some observers might consider teachers were still at the formalistic stage (Weeks & Guthrie, 1984: 50).

The length of the courses at GTC is still very short (2 years) compared with three or four years elsewhere and the general standard of education of students at the start of these courses is not high. The content of GTC science courses is based on the topics that teacher trainees will have to teach rather than on what staff consider educated scientists should know. In fact, Guthrie (1983) gave the general opinion of GTC teachers as ‘good teachers professionally but lacking in detailed subject knowledge’. This is the description of a teacher at Beeby’s formal stage of development. GTC courses thus seek to train more than they seek to educate, regrettable though this may be.

Science curriculum: a history

Tables 1(a) and 1(b) which follow compare and contrast the curriculum changes in science over the past twenty five years both at GTC and in the provincial high schools (PHS). Significant events which may have effected the science syllabi are mentioned, as are confirmatory references. These tables may be considered as the major part of this paper. The Tables indicate:

(i) that quantitative ‘hard’ science decreased from 1968 to 1978 both at GTC and in PHSs.

(ii) that “hard” science may make a “come-back” through the provision of teachers capable of teaching it, but to 1985 it has continued to decline in PHSs.

(iii) Specialisation at GTC has decreased from 1968 reaching a nadir in the period 1975-78 but has increased since then.

(iv) Generalist teaching, introduced in 1975 with the intention of bringing PNG to an educational stage of “Meaning” in fact, because of its poor administration (Field, 1981), slowed PNG’s educational progress out of the formal stage. (NB. Actually, Field used McKinnon’s (1976) five stages, but the overall interpretation is the same).

The judgments on the curriculum are value judgments, but they will be illustrated using some specific examples. The 1969 GTC year III Physics syllabus was ambitious enough to include work on quantum mechanics, electronics and relativity. These topics, which are usually considered difficult, had disappeared from GTC curriculum by 1970 and have not reappeared. The syllabus states what was taught, but not how it was taught, or what understanding trainee teachers obtained. Perhaps in this case the syllabus was simply unrealistic in its expectations. However, year 3 of the PHS syllabus in 1971 included the laws of Chemistry and equations which does not seem an unreasonable level of understanding to expect after three years of secondary science, but this was omitted in 1975 syllabus revisions. The 1969 GTC syllabus for Chemistry II was classification of subs chemical language, a bonding interpretation of the periodic table and valency, sub—atomic chemistry, electro-chemistry, energy considerations and stoichiometry This goes well beyond the present GTC year 2 course requirements.

However in 1969 trainee teachers practically specialised in science perhaps spending 16 hours per week on it and it. is only in 1985 that there is a course for just seven trainee teachers with this amount of science. In the period 1976 to 1979 teachers spent only six hours on each subject. During the whole period the same qualification (the diploma in
secondary teaching) has been given, but the evidence above indicates that the scientific knowledge and skills which this diploma represents have varied widely over the period.

How are the teacher training syllabi and national syllabi interrelated? Firstly there have been no formal curricular links at least since 1975 when GTC became a part of the University of Papua New Guinea. Prior to 1975 the N.D.O.E could have insisted upon syllabus changes at GTC but there is no evidence to suggest that they used their power directly.

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The influences have thus been indirect, a GTC staff frequently help in the writing or revision of PHS units and the curriculum Unit of the N.D.O.E. may comment upon GTC courses. Also the standards which Grade 10 students in PHSs reach is very much dependent on the academic ability and motivation of their teachers, who are in the main produced at GTC. The above explains how it is possible to have cycles of decline or more hopefully cycles of improvement. Table 1(b) indicates that science teaching in PNG may now be on cycle of improvement and the syllabus of the latest Major Science/Minor Mathematics course indicates standards of science, not achieved since the early 1970’s may soon be achieved by some diplomates at GTC. What is now needed is parallel movement in the PHS Science Syllabus. When the new science text books are introduced country-wide this may indeed happen.

**Problems in understanding science**

The major changes in the curriculum described above seem to be the result of fundamental difficulties in understanding science experienced by national students and teachers. What are the causes of these difficulties? There seems to be no certain answer but some possible causes have been suggested which are:—

(a) **Cultural.** The shaping of the PHS science syllabus has used traditional local knowledge as a starting point where possible (Anon, 1981). This does not seem unreasonable since a basic principle of pedagogy is to move from the known to the unknown, yet it has its problems. Kola (1984) points out that traditional knowledge is acquired through practice by trial and error methods, whereas modern science, although requiring a knowledge base, is able to use logical explanation to predict outcomes of further ideas or experiments. Traditional knowledge is thus different in character from modern science and the two do no always fit comfortably together in a science syllabus. Secondly there is not one common culture within PNG, but there are about 700 different cultures, so there are wide variety of forms of traditional knowledge. Thus any specific use of local knowledge will only be meaningful to a small proportion of the pupils using the syllabus.

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Finally science is basically quantitative: traditional knowledge generally is not. The PNG Science syllabus has as one of the major aims, ‘exposure to scientific method’ (Anon 1981). Two quotations by science teachers follow, the first of whom uses his traditional knowledge to explain his science and the second of whom appears not to have understood the nature of science.
Modern science counts everything as if it were pigs. Anon (1981).
The trouble with you is you want to count everything. Why? Hayter (1982, p. 40)
These quotations perhaps illustrate how, depending on circumstances, local culture may help or hinder the understanding of science.

(b) Language. There are very great difficulties for learners who learn in a language other than their own. Some rise above these difficulties but for others language remains a permanent handicap. Kappey (1983) tested community school pupils with practical experiments having given them apparatus and instruction. He described the results as follows:

In general, pupils could successfully carry out the activities required of them. They were able to follow instructions, and they showed sufficient manipulative skills. They could work out what to do and could also draw correct conclusions from their observations and thus solve practical scientific problems. But when asked to use English more extensively to explain how they arrived at their conclusions, they were generally unable to do so. They even had difficulty with the apparently simple task of describing what they did. Clearly, the pupils’ difficulties arose from inadequate language ability - hardly surprising when they were using a second or even third language.

(c) The ability to make generalizations. Lancy (1979, pp.111-113) noted the problems high school students have in mathematics and science achievement. He also carefully indicated the wide diversity of cultural groups but considered that in the simplest societies, people were taught to notice differences which rather than similarities. This is a habit to difficulties is science, where the ability to make generalisations is important.

Kola (1984) refers to lack of ability to think which he considers to be caused by spoon-feeding at the University by lecturers and to memorisation by the students. He believes students should be trained to think. Work in PNG (Wilson & Wilson, 1981) indicates that few preliminary or foundation year students are capable of formal thought (in the Piagetian sense). The major conclusion reached is that students at this level should be given varied, rich and appropriate experiences. They should also be encouraged to think formally and express their understanding verbally to others.

(d) Other Learning Difficulties Other contributing factor to learning difficulties could be poor diet when young (Lancy, 1979), or the late age of commencement of formal education without preschool or nursery school experiences for young children. In the UK, the Plowden Committee (1966, para 344) were convinced that about five years of age was a suitable age to commence schooling and that suitable nursery schooling should be provided before this (HMSO, 1972). In PNG the National Education Strategy (1979, p. was reluctant to change the age of commencement of schooling from seven years old. The only alternative considered was to increase it to 9 years of age. There were no recommendations on nursery schooling. The lack of stimulation of PNG children prior to
the age of seven in preschools or community schools could well be a factor in slower cognitive development. Further research is needed.

The reasons outlined above indicate some possible impediments to the learning of mathematics and science in PNG. The Government however is aware that there are difficulties in the learning of mathematics and science and has provided some extra resources for that purpose (NPEP, 1983, p. 45).

In the small African country of Malawi, the Government is committed to producing both expert scientists and also a better level of understanding of mathematics and science amongst ordinary people (Chimango, 1984, p. 51-53). This commitment is indicated by the secondary curriculum in which more than one third of the time is given to mathematics and science.

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Even after the Waigani Seminar, the Government has not decided on a science policy nor yet even in which department such a policy would be decided (Kola, 1985). Some learning difficulties could be overcome if Government were more determined to have a science policy and pursue it energetically. Such a policy would insist upon a more quantitative secondary science curriculum and would ensure that more time in secondary schools was spent on science.

Science teaching surveys

Although research into the problems in science learning is not far advanced, there have been a number of surveys of science teaching at secondary level and some more general surveys which include science teaching. Particular aspects of five of these surveys will be mentioned so that some dynamic perspective of changes in science teaching can be obtained. The surveys being considered are:—


(c) Murphy (1983): A survey of all teachers in 49 high schools commissioned by the Faculty Planning Committee of Goroka Teachers College in 1982 to find out about areas of teacher shortage in high schools (to be called FPC 1982).

(d) Palmer (1984): A survey of new teachers who graduated in November 1982 carried out in 1983 to find out the particular problems of new high school teachers of all subjects. (to be called N.T. 1982).


Data form a number of the above surveys has been reworked for comparison. The first theme to be considered will be the composition of the teaching force in science in terms of whether they are national or expatriate and the levels of responsibility held. S.T. 1973 indicated that almost all science teachers were expatriate at that time. ST 1978 showed the proportions of expatriate and GTC trained
science teachers to be approximately equal. By 1982 about 72% of practicing science teachers were nationals from GTC, 4% nationals trained at Waigani and 21% were still expatriate (FPC, 1982). In the 1982 survey the levels of appointment of science teachers were obtained, 60% of the substantive subject master and senior subject master positions were held by expatriates, so expatriates remain influential in the organisation of the teaching of science.

The number of experienced national teachers (more then 5 years teaching) has increased nearly fourfold between the 1978 and 1982 surveys. Yeboah-Amankwah (1984) pointed at the necessity of viable indigenous scientific community, so it can be seen that within the teaching profession such a community is slowly being created.

ST 1977 took place in the middle of the Generalist Teaching phase of the science curriculum’s development. It can be calculated that at this time science teachers were teaching an average of 2.7 subjects per teacher whilst by 1982 science teachers were teaching 2.3 subjects per teacher. This result shows a slow but steady move to greater specialisation in schools. In terms of the degree of shortage of science teachers, F.P.C 1982 indicated headmaster saw science teachers as number two in terms of scarcity below practical skills and equal with agriculture. Palmer (1985, p. 23) suggests that agriculture is probably the area of greatest shortage followed by English, but there is considerable flexibility within the high schools, so results vary dependent on the method of analysis used.

It is hoped that the 1984 S.I.S.S. survey will provide greater information about the organisation of science teaching in high schools and also about specific problems in science teaching and learning. Wilson (1985) analysed a small portion of SISS 1982 on the opinion of Grade 9 and Grade 10 teachers on the science syllabi. Teachers consider there is too much material in Grade 10, criticise the Grade 10 chemistry unit and were generally worried about their own science background.

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In the NT 1982 survey, new teachers looked back on their courses and two comments on the science course at Goroka will be included as they indicate the new teachers honest realisation of the vastness of science and the lack of depth of their preparation to teach the subject.

Teacher 5

I really enjoyed my science courses at College. But I felt I really didn’t learn things in detail—which I would really like to do especially in chemistry and physics. If ever I get a chance to study one particular area in Science I will not let it pass by.

Teacher 44

Science is wonderful. Has helped me to understand many wonderful things that I never knew about. I am fortunate to be a science teacher. I’d love to do more science in the future using more concrete materials.
Conclusion

The message of this paper is of a “virtuous cycle” made possible by more specialised teacher training and a longer period of training teachers more nearly the autonomous professionals of the Beeby Stage 4 which should be the aim of the education system. In parallel with this there have to be major changes in the science curriculum, making science in provincial high schools more closely reflect the true nature of science. Husen et al (1978) in a thorough survey of teacher education in developing countries expressed this idea as one of his main recommendations which was:

A major focus of teacher training should be the development of teacher knowledge and ability in specific subject areas.

REFERENCES


Beeby, C. F. (1966), The Quality of Education in Developing Countries, Harvard University Press, Cambridge, Massachusetts, USA.


Collins G. (1982) Redefining the Role of Goroka Teachers’ College in the Continuing Professional Education of Teachers” (Mimeo).


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<tr>
<th>DATE</th>
<th>EVENT</th>
<th>PBS SCIENCE SYLLABUS</th>
<th>OTC SCIENCE SYLLABUS</th>
<th>REFERENCES</th>
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<tr>
<td>Prior to 1965</td>
<td>Virtually no secondary education</td>
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<td>1965a</td>
<td>P.H.S.'s started and secondary system expanded rapidly</td>
<td>Various syllabi and mainly courses of Physics, Chemistry,</td>
<td>Maddocks (1965)</td>
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<td>1966</td>
<td>OTC Science syllabus introduced for Grade 7 &amp; Grade 8.</td>
<td>3 year Science Course taught as 4 term subjects.</td>
<td>N.D.O.E. (1966)</td>
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<td>1968</td>
<td>Secondary Teacher Training starts at OTC (a)</td>
<td>Grade 9 and Grade 10 (level</td>
<td>S.D.O.E. (1968)</td>
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<td></td>
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<td>Science syllabus produced.</td>
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<td>Quantitative &amp; traditionally,</td>
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<td>Pressure to increase pressure to change syllabus (c).</td>
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<td>Interim science syllabuses produced. Less quantitative in subjects (a)</td>
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<td>1975</td>
<td>OTC become a part of UPMG (a)</td>
<td>New Grade 7 syllabus Jan. (1974)</td>
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<td>(c). New Grade 8 syllabus Jan.</td>
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<td></td>
<td></td>
<td>Similar to present syllabus.</td>
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<td></td>
<td>Significantly more non-quantitative than earlier</td>
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<td>1975 cont.</td>
<td>Generalist teaching (c) initiated. A properly planned.</td>
<td>5th term teaching to simplify science syllabi further.</td>
<td>UPMG introduced a third subject so that teachers received 5 hours per week of each subject over 2 years syllabi how vague about what was taught (c).</td>
<td>UPMG (1975)</td>
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<td>1987</td>
<td>Generalist teaching (c) initiated. A properly planned.</td>
<td>28 Primary School teachers given one year course to enable them to teach G.7 and G.8 classes in PBS (b).</td>
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<td></td>
<td></td>
<td>World Bank loan for expansion of OTC (a).</td>
<td>Academic standards of these teachers were generally low but many had very effective methodology.</td>
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<td>Continued revision of syllabus which continues to this day.</td>
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**Table 1 (b) cont.**

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<td>1979</td>
<td>A continued shortage of suitable candidates for teacher training.</td>
<td>Continued syllabus revision to 1984.</td>
<td>ORE maths &amp; science department obtain permission to run two subject maths, science courses. Education Secretary approves (a). By 1980 all ORE courses in all subjects for new entrants were two subject courses with 9 hours per subject returning to the pre-1975 structure.</td>
<td>(a) Toalolo 1981</td>
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<td>1982</td>
<td>Mid year-rating (per-annum). Economic conditions become tighter, making secondary teaching a more attractive career.</td>
<td>Examination now in November to be based on content material of syllabus as well as understanding.</td>
<td>Two subject courses with 9 hours per week per subject now standard.</td>
<td>(a) Deutrom 1981</td>
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<td>1984</td>
<td>Education III Project (a)</td>
<td>The school system has expanded greatly both due to more schools and also blocking up to Grade 10 so that most students starting complete courses.</td>
<td>Attempt to introduce subject specialization at ORE in Science called double subject Science (b) N.D.O.E. threatened not to register teachers. Course abandoned. (c) All FY students dropped in number but A criterion now required for admission.</td>
<td>(b) N.D.O.E. 1982 (c) ORE (d) Brown &amp; Palmer (1984)</td>
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<td>1985</td>
<td>Education III Project underway in Luderitsh. (b)</td>
<td>Science equipped to schools Grade 8 renewed, but no further changes to syllabus completed until new ORE science textbooks are printed in 1986.</td>
<td>Minor science minor maths courses introduced in cooperation with N.D.O.E. (a) 7.5 hours science, 4 hours maths). Course to start for existing science teachers in Schools from December 1985, (b) S. Orell (c) 1:5:2 Advanced Diploma.</td>
<td>(b) ORE (d) Collins 1982</td>
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