Introducing the Chemical Industry into the Science Curriculum in Papua New Guinea,

Ponnamperuma, A.C.W. & Palmer, W. P. (1987). Introducing the Chemical Industry into the Science Curriculum in Papua New Guinea, in *Education, Industry and Technology, Volume 3 in Science Technology and Future Human Needs series* (D.J. Waddington, editor), Pergamon Press, Oxford, pp.133-138.

ABSTRACT

Papua New Guinea is a young, developing nation, achieving independence in 1975. Industries which can be classified as chemical industries by western standards, are almost non-existent in Papua New Guinea. As yet, most of the raw materials it produces are exported to other countries to be processed or manufactured into useful products. However, some factories have already been built; more will be built in future. At this stage of the country's development, we can consider the mining industry and the processing of local primary products which utilise the basic techniques of chemical technology.

In this paper, we explain how the lower secondary school pupils are introduced to Chemical industry in Papua New Guinea, with particular reference to the mining and extraction of copper on Bougainville island.

Introducing the Chemical Industry into the Science Curriculum in Papua New Guinea

A. C. W. PONNAMPERUMA, Bena Bena High School, Papua New Guinea

W. P. PALMER, Goroka Teachers' College, Papua New Guinea

Papua New Guinea is a young, developing nation, achieving independence in 1975. Industries which can be classified as chemical industries by western standards, are almost non-existent in Papua New Guinea. As yet, most of the raw materials it produces are exported to other countries to be processed or manufactured into useful products. However, some factories have already been built; more will be built in future. At this stage of the country's development, we can consider the mining industry and the processing of local primary products which utilise the basic techniques of chemical technology. Amongst those industries which are in successful operation are copper and gold mining, beer brewing, the production and refining of sugar, ethanol production from sugar wastes, food processing, nail and wire products, polyurethene foam products, match manufacture, and many others. In recent times the export of copper concentrate from the Bougainville Copper Ltd. project alone, contributes about a third of the country's foreign exchange earnings.

In this paper, we explain how the lower secondary school pupils are introduced to Chemical industry in Papua New Guinea, with particular reference to the mining and extraction of copper on Bougainville island.

Science education in the secondary school system

The development of secondary education in Papua New Guinea dates from the late 1950s, and science became an integral part of the secondary school curriculum in the early 1960s when secondary education was mainly confined to the lower grades. At present, the secondary education system in Papua New Guinea, consists of two stages:

(i) The lower secondary level provincial high schools for young people aged 13—16 (grades 7—10). There are about 110 such high schools.

(ii) The upper secondary level national high schools for students aged 17— 18 (grades 11—12). There are four national high schools.

Science is studied by all students in grades 7 to 11. In addition, there are two applied science subjects available in provincial high schools, namely, agriculture and home economics.

In national high schools, at grade 12 about 60% of the students take up a major science course which can lead to further studies in science. Another 20% study minor science courses and the remainder do not study science. Major courses in science are centred around chemistry, physics and biology courses which are taught separately, while the minor courses in science consist of modules selected from three themes — human biology, evolution and technology.

Science curriculum in provincial high schools

The early syllabuses used in science teaching were developed overseas, in Australia and Sarawak, but work began on a secondary science syllabus designed for Papua New Guinea in 1965. The original science curricula developed in Papua New Guinea laid much emphasis on "academic science" similar to the formal science curricula used in developed countries.

The emphasis in science curriculum development in Papua New Guinea has been towards a "general" or an "integrated science" education for all, at the provincial high school level. The secondary students are introduced to more specialised branches of science such as chemistry, physics and biology in grade 12 at the national high school level. The provincial high school science course consists of 22 self-contained units:

Grade 7:

Unit 7.1 — Introduction to Science

Unit 7.2 — The Sun and the earth

Unit 7.3 — Matter

Unit 7.4 — Living and non-living things

Unit 7.5 — Heat energy

Unit 7.6 — Electricity

Grade 8:

Unit 8.1 — Changes in matter

Unit 8.2 — Energy in living things

Unit 8.3 — Electricity I

Unit 8.4 — Force, work and energy

Unit 8.5 — Growth and reproduction

Unit 8.6 — Science in Society

Grade 9:

Unit 9.1 — Air around us

Unit 9.2 — Electricity 2

Unit 9.3 — Communication

Unit 9.4 — Traditional technology (optional)

Unit 9.5 — Ecology

Unit 9.6 — Our body

Grade 10:

Unit 10.1 — Chemical technology

Unit 10.2 — Light

Unit 10.3 — Microbiology

Unit 10.4 — Geology

There are only three units on chemistry. These are the units on matter and particle theory (grade 7), changes in matter (grade 8) and chemical technology (grade 10).

There are many reasons given for keeping the chemistry content low at provincial high school level. Firstly, the schools are not well equipped and the majority of science teachers at provincial high schools are Goroka Teachers' College graduates who are not at present trained to teach chemistry, other than that contained in the provincial high school syllabus. Further, chemistry is an "abstract science" which demands more "formal thinking". Piagetian research done with national high school students and the preliminary year students from the University of Papua New Guinea has shown that even at a more mature age than the 13 to 16+ age group at provincial high schools only a small minority of Papua New Guinea students are capable of such thought.' Since a large majority of students at provincial high schools are still at the "concrete stage" of thinking the introduction of highly abstract and conceptually difficult materials has been considered irrelevant for Papua New Guinea.

In the chemical technology unit taught at grade 10, students are introduced to industrial aspects of chemistry related to Papua New Guinea. This unit deals with industrial aspects of copper mining and extraction, the chemistry involved in the traditional methods of converting limestone to lime, the use of traditional and modern fuels in Papua New Guinea, and the chemistry involved in water treatment.

The Bougainville copper mining project has brought about significant changes in the country's

society and economy, and as such, the section on copper attempts to create an awareness and a basic understanding of the uses of copper and the chemical technology involved in its mining and extraction. In this section the students are introduced to the uses of copper based on its properties as an excellent conductor of heat and electricity and also on its resistance to corrosion. Students also investigate the physical and chemical properties of copper ore and copper concentrate samples.

The students are then introduced to the preliminary steps involved in the mining and crushing of copper ore. Simple models of ball mills are used to demonstrate the action of the ball mills used in crushing the ore to fine particles. The separation of copper ore from waste by oil flotation is also discussed. The students also investigate the presence of copper in Bougainville Copper concentrate using a test tube with ammonium hydroxide solution and the flame test for copper ions. The reduction of copper ore and the electrolytic refining of copper are also investigated.

Although introducing the students to chemical industry in their own country has its advantages, the students do encounter problems in understanding the chemical principles utilised in these industries. There are a number of reasons for these problems. Firstly, the lack of sufficient prior knowledge of the theoretical background of chemical reactions (for example, oxidation, reduction, electrolysis, etc) poses a major problem of understanding for students. Secondly, the lack of relevant supplementary reading materials suitable for Papua New Guinea students for whom English may be a third or fourth language also aggravates learning difficulties for students. Thirdly the provincial high school students, who are mainly "concrete thinkers", have problems visualising the real "industrial" situation, although models are used in some cases (for example, a ball mill). Lastly the geographical distribution of the provincial high schools in the country, coupled with the high costs of travel make it almost impossible for students to visit an industry such as the Bougainville copper project, to see industry for themselves.

Recently, one of the authors (WPP) designed a series of slides of the Bougainville copper mines showing the various stages of mining, crushing, and preparation of copper concentrate for export, which could be made available to teachers as a visual aid to help overcome some learning difficulties, arising from the students' inability to visualise the stages of the mining industry.

The provincial high school science curriculum advisory committee recognised some of the problems of teaching and learning this unit. They recommended the following aims and objectives:

Aim: 1. To improve general knowledge and understanding of chemistry.

2. To study the properties, chemical reactions and uses of familiar naturally occurring substances.

TOPIC	**SPECIFIC OBJECTIVES**
Extraction and Production	— to know that less reactive metals are more easily extracted from their ores than reactive metals; electrolysis and reduction.
Properties and	— to know the physical properties used to distinguish

between

uses metals and non-metals; Cu, Fe, Al, Pb, metals and their alloys.

— to know the uses of copper alloys; fuels.

— to understand the national and international economic importance of copper and crude oil.

Chemical reactions — to understand that metals have different chemical activity and this determines rate of corrosion, natural occurrence and ease of extraction.

Extraction — to understand the processes involved in the production

and Production of lime; the extraction of copper; the production of fuels from wood and crude oil

— to know that plastics and other useful products can be obtained from crude oil.

Chemical Reactions — to know that in a chemical change substances form new substances; changes in combustion of hydrocarbons;

neutralisation of acids by bases; reaction between acids and carbonates; smelting of copper; decomposition of calcium carbonate.

— be able to use simple word equations.

Natural Substances — to know that rocks contain useful substances; to understand the role waters play in dissolving naturally occurring substances; to know reactivity and solubility determine the form they occur.

The revised Chemical Technology Unit is to include more emphasis on chemical concepts which might help overcome some of the deficiencies of the existing unit. However, as Wilson and Wilson have pointed out, the success of any revision will depend to a large extent on the use of teaching strategies which will deliberately encourage the development of formal thought in students, and the level of understanding of the chemical concepts by the teachers themselves.'

Reference

1. Wilson, A. and Wilson, M. (1983) "The extent and development of formal operation thought among national high school and preliminary year students in Papua New Guinea".

Report to Department of Education, Waigani, Papua New Guinea, pp. 2—25.

Background Reading

Haddon-Smith K. (Aust) Pty Ltd, “Bougainville Copper”, Bougainville Copper Ltd. Printed in Singapore by Toppan Printing Co. Pty Ltd., pp. 4—17.

C.R.C. in Copper “Minerals to manufacturing”, Printer C. R. A. Limited, 55 Collins Street, Melbourne 3001.