AN EVALUATION OF A DISTANCE-TEACHING APPROACH TO SCIENCE TEACHER EDUCATION

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Abstract

This study examines the role played by science education in developing countries and finds that the effectiveness of science education in promoting either economic or social development is limited by the shortage of trained science teachers. The way that distance teaching helps overcome this problem is discussed and projects which use distance teaching for science teacher education are identified. One such project, the Emergency Science Programme (ESP) of Guyana, is described.

The Emergency Science Programme is comprehensively evaluated. This includes, (1) an intrinsic evaluation based on a content analysis of the curriculum materials and on a key-word analysis of students' reports of the materials, (2) a context evaluation based on interviews with participants of the programme, and (3) two performance evaluations. In the first of these the performance of ESP trained teachers is compared with that of an equivalent group of college-trained science teachers using a variety of measures including supervisors', head teachers' and pupils' assessments. In the second, the criterion performance of ESP teachers is assessed using the Criterion Sampling Approach. The overall evaluation shows that the ESP distance-teaching programme does successfully train students to teach science and that their performance is equivalent to that of college-trained teachers.

The different evaluation techniques used in the study are reviewed and the results and findings of each are compared. No single evaluation technique provided an adequate assessment of the programme. The Criterion Sampling Approach, which has the advantage of using standardized situational tests, was found to be a reliable and a valid means of assessing teaching performance.

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Introduction

In curriculum development the need to identify the basic elements or components of the curriculum has long been recognized. Early texts on curriculum theory such as Herrick and Tylers' (1950) or Taba's (1962) stressed the importance of identifying the "key" "organizing" elements of the curriculum and many curriculum models have been developed which analyse the curriculum in terms of a number of key elements. Giles, McCutcheon and Zechiel (1942) for example, categorized the curriculum in terms of objectives, subject matter, method and organization, and evaluation. Kerr (1968) described it in terms of objectives, knowledge, learning experiences and evaluation, and Tyler (1949) and Merritt (1972) have also developed models which stress basic elements. In all these models one common central element is evaluation. Taylor (1967) referred to it as "a cardinal principle" and Kerr (1968) saw it as "an integral component" of curriculum development.

At present evalutation is becoming increasingly important in curriculum development, in part because of the trend in Europe and the USA towards public accountability in education, and growing disillusionment with education as a means of promoting economic growth (Husen et al 1978, Maybury 1978 and Curle 1973). Unfortunately, curriculum evaluation is itself beset with difficulties. There is an imbalance between theory and practice with empirical studies being "extremely rare" (Lewy 1977 UNESCO Handbook of Curriculum Evaluation).

Harlen(1976),Lewy (1977), Hawkridge (1978) and Hawkins (1981) have all noted the multiplicity of evaluation models and often the various authors and originators have used individual - even idiosyncratic - terminology.

For example, when Lewy (1977) referred to measurement of desired outcomes as an evaluation "approach", Eraut,Goad and Smith (1975) saw the same thing as an "evaluative function", Eggleston (1979) called it an evaluation "tactic" and McCabe (1979) referred to it as the "aim" of an evaluation. Other discrepancies exist throughout evaluation theory with the result that present theoretical models are not generally applicable (Harlen 1976) and each evaluator is obliged to develop a strategy suited to the particular evaluation as in the evaluations of the Nuffield A Level Biology Programme (Kelly 1972), the Science 5 - 13 Project (Harlen 1975) and the Humanities Curriculum Project (Mac Donald 1973); there is no generally applicable strategy.

In any event the purpose of the evaluation has to be identified and on this there is agreement. Stufflebeam (1971), Stake (1972), Parlett and Hamilton (1972) and Tawney (1976) all agree that evaluation should provide information that will

> "assist the decision maker in selecting among perceived alternatives"
> (Lewy 1977 p 13)

In the past decade there has been considerable curriculum development in distance teaching. This approach has been used for many different purposes including teaching children, upgrading public servants and training agricultural workers (See Young et al 1980). Distance teaching has had a considerable impact in education, particularly in teacher education. The approach has been adopted in many developing countries mainly because teacher training institutions have been unable to keep pace with the demands of their rapidly expanding education systems. In spite of its widespread adoption there has been no comprehensive evaluation of a distance-teaching programme for teacher education. Jenkins (1980) reports the evidence we have is mostly circumstantial and anecdotal,

> "circumstantial, in that the ministries of education which have supported schemes of teacher training at a distance have not, to my knowledge, expressed dissatisfation with the results, anecdotal, in that some trainees have said their teaching has changed and improved, and some observers have admired the performance of this or that teacher".

When programmes are evaluated it is usually done in terms of drop-out rates or percentage of students gaining certificates (Chale 1980, Kinyanjui 1974, 1977 and Kaye 1973) or in terms of the economic costs of training (Kinyanjui 1974 and Kaunda 1973). The justification we have for the use of distance teaching in teacher education is inadequate and

> "we need research that follows teachers through their training at a distance and compares their classroom performance with that of conventionally trained teachers" (Jenkins 1980).

There is a need, therefore, for a comprehensive evaluation of a distance teaching programme for teacher education which provides information for decision makers.

The Emergency Science Programme, a distance-teaching project for training science teachers in Guyana, was launched in April 1977 and the first trainees were awarded trained teacher's certificate in 1980. It has had a low drop-out rate and a high percentage of the student intake have gained teaching certificate. When the programme was designed in 1976 evaluation was incorporated into the curriculum model used in the original proposal submitted to the Ministry of Education Board of Examiners (See page 10 of Proposed Emergency Programme for the Upgrading of Junior Science Teachers in Appendix 4). In that document it was suggested that the summative evaluation,

> "might include a comparison of the teaching technique and science content of a sample of the students in the programme with that of a sample from the College of Education programme". (page 8).

This thesis provides a comprehensive evaluation of the Guyanese programme. As well as comparing the performance of a sample of the Emergency Science Programme (ESP) trained teachers with that of a sample of science teachers trained by the Lilian Dewar College of Education (LDC) it also includes an intrinsic evaluation of the curriculum materials, a contextual evaluation- which looked at the opinions of participants in the programme - and a Criterion Sampling evaluation of the criterion performance of the ESP teachers.

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Chapter One

The Role of Science Education in Developing Countries.

Economic and Social Development

Since the Second World War a key feature inherent in the policies of almost every government in the world has been the concept of development. For most leaders the term was synonomous with progress and progress was wealth. Development, therefore, was seen as an economic concept and as something which could be achieved by means of economic growth (Curle 1970, Baez 1976). The problem, however, was how to achieve this growth; how to develop the economy. But here too, the answer seemed obvious, as throughout the world leaders became convinced that the twin "miracle workers" of science and technology,

> "would soon abolish the remaining vestiges of disease, hunger and poverty ..." (Maybury 1975 p. 149).

This sentiment was especially appealing to politicians in developing countries who saw it as a quick solution to their problems (ibid). Science and technology were seen as being "all pervasive" (Whitehead 1976) and as being the agents for "transforming an industrially under-developed to a developed country" (Bhabba 1966). The first cloud on the horizon appeared, however, when the leaders realised that a country's ability to assimilate and exploit science and technology depended on the availability of scientific and technical personnel. "Effective production" needed scientists, technologists, technicians and engineers (Mutscheller 1961, Jones 1971). There was no shortage of manpower in the developing countries, but there was a severe shortage of skilled manpower (Springer 1969). The choice was either to train technologists and scientists in sufficient numbers or remain "stagnant" (Lauwery 1961). Since the shortage of trained personnel was "a critical limiting factor" to development priority was given in the late 1950's and early 60's in developing countries to producing scientists and technicians.

By the end of the 1960's when it became clear, however, that rapid development was not being achieved and that some "developing countries" were in fact retrogressing, the optimism and faith in economic development gave way to disillusionment (Curle 1970, Brocks 1971 and Murray 1979) and the concept of economic growth via scientific and technological development began to be seriously questioned (Baez 1976). The "shallowness" of many of the benefits derived from technological and industrial development were compared with their social and environmental consequences (Brocks 1971 and Jones 1971). On the one hand there was the pollution and depletion of natural resources, on the other even in socialist states, such as Zambia and Tanzania, there was the,

> "penchant for Mercedes Benz cars, air conditioned offices and houses with swimming pools" (Borrell 1981).

By the 1970's, therefore, the promise of science and technology was "becoming blurred" as politicians saw their full effects in accelerating and creating inequality (Murray 1979). Thus Nyerere the president of Tanzania, speaking about development in 1969, noted that,

> "Our emphasis on money and industries has made us concentrate on urban development. We recognize that we do not have enough money to bring the kind of development to each village which would benefit everybody. We also know that we cannot establish an industry in each village ... for these reasons we spend most of our money in the urban areas and our industries are established in the towns. Yet the greater part of this money that we spend in towns comes from loans. Whether it be used to build schools, hospitals, houses or factories, etc, it still has to be repaid ... yet ... it is the overseas sale of the peasants' produce which provides the foreign exchange for repayment. Those who do not get the benefit of the hospitals thus carry the major responsibility for paying for them". Nyerere 1969 p242.

Even when efforts were made to bring technoligical development to village and rural areas, however, these often simply accentuated the inequalities of the society. In India, for example, where emphasis was placed on the development of biogas plants, it was the rich farmers who acquired the plants and hence deprived the poor of the cowdung which they had formerly collected and used for cooking. As long as the technological advance was important enough, however, the governments accepted the fact that even at the lowest level, the people who were the most powerful were the ones who took the advantage (Ghandi 1981).

A second consequence of the emphasis on economic development was the change in social patterns that became evident in many developing countries in the late sixties. Primary and secondary school leavers from rural areas were drifting to towns and cities to look for employment; the small industrial sectors of the economies were unable to absorb them and many were turning to crime and black marketeering (Harbison 1969, Chigado 1980 and Curle 1973). Even many of the highly educated were having difficulty finding employment. For instance, in India in 1969 there were 20,000 unemployed engineers with degrees and diplomas (Tett 1974). In Greece there was overproduction of doctors (Eggleston 1980) and in Mexico there were high numbers of unemployed university graduates (Zubryn 1980). Politicians were faced, therefore, with the prospect of increasing numbers of,

> "highly educated, vocal, frustrated, and militant graduates with unrealistically high expectations" (Harbison 1969 p. 102).

Following the disillusionment with the concept of development through economic growth the 1970's saw a gradual realisation that development should not be measured in the strictly quantitative terms of Gross National Product (GNP) but should be seen rather as something qualitative in nature. True development it was now felt should be the development of people rather than merely the economy (Curle 1973, Tett 1974 and Brocks 1971). Thus Nyerere suggested that,

> "The development of a country is brought about by people, not by money. Money, and the wealth it represents, is the result and not the basis of development" (Nyerere1969 p. 243).

Curle (1970) made the point that in underdeveloped societies it is quite literally the society which is underdeveloped and not merely the economy. He suggested that the aim of development should be to help a society to achieve certain basic qualities rather than simply reaching a fixed degree of affluence and suggested that such qualities as security - for example, a low level of violence and safeguards from abuses of landlords, employers and officialdom; sufficiency - for example, a fair standard of material provision; satisfaction - so that sufficiency can be obtained without an excessive physical or cultural cost; and stimulus - so that the social order will permit and encourage the individual to grow to his full potential.

To achieve this form of development, it was suggested that the emphasis should be placed on involving the entire population in the process. "Success" in development, it was argued, depended upon the majority of the population possessing the right attitude of mind for accepting changes and benefit from technological advances (Savoury 1972). In almost every developing country, however, most of the population lived in rural areas and would continue to do so for many years to come (Jones 1971, Moshler 1971). Not only did most people live in rural areas but this was the sector which was most important to the economies of the developing or Less Developed Countries (LCDs) as they were sometimes called.

The main source of foreign exchange in LDC LCDs to pay for imported manufactured products came from farming. For example, Jones (1971) reported that agriculture contributed 30% of the Gross Domestic Product (GDP) of LCDs and provided 40% of their exports. In Malawi, 90% of the 4.5 million population lived in rural areas and their agricultural produce provided 75% of the nation's exports (Moss 1974). Lewis (1966) has suggested that the "single factor" which was the most common cause of low economic growth in developing countries was the absence of "a vigorous agricultural policy" and Cloverdale (1972) has argued that if developing countries are ever to,

> "pull their whole economy and society up by the bootstraps, it is in the rural sector where the development process must be accelerated".

Evidence that rural development can play a dramatic role in development comes from reports such as Curle's (1970) which reported that in Asia 75% of the male population were required to work in agriculture in order to provide the population with 2,500 calories per person per day. Using modern technological means of farming 15% of the population in the USA could supply the population there with 10,000 calories per person per day.

By the mid 1970's, therefore, the emphasis for development had changed from the concept of progress being achieved through economic development based on scientific and technological industrialization to the wider idea of developing the society, the majority of whose members lived in rural areas.

While the strategy for development had changed dramatically, the method to achieve it still remained basically the same. Although the twin miracle workers of science and technology had failed to produce the required level of economic growth, they were now hailed as the "most potent forces" for changing values and cultural patterns (O'Hearn 1976). Both social and economic development were viewed as being "dependent on the application of science" (Lewis 1972) and politicians and scientists argued that science and technology would change the "quality of life" in developing countries (Crawford 1976, Rawlins 1976). They would help to eliminate the constraints which tradition and superstition had place on development (UNESCO 1974). Only through them, it was argued, could developing countries "hope to narrow the gap" between the rich and poor nations of the world (Sandiford 1976).

The Role of Education in Development

Whatever the goal or the strategy for development, education was looked upon as a "major instrument" in the process. Just as science and technology were viewed as miracle workers, so too was education seen as having almost "magical properties" (Curle 1973, Porter 1969) and as being a "panacea" for all the problems of development (Tett 1974). Education was the "steel framework" and the "engine" for development (Lewis 1970, Curle 1973). When development was seen in terms of economic growth the main role of education was to provide the trained manpower needed for technology and industry, the scientists, engineers, technicians and technologists. (Mustaphar 1974, Mutschelle 1961 and Jones 1971).

This "manpower approach" was advocated by Harbison and Myers (1964) and was well summarized by Yaacob (1975), a former education minister in Malaysia when he proposed that,

> "To promote the development of industries in the country we need a large number of trained people in general fields of science and technology. One of the main aims of education is to produce trained people, and to increase the number of trained people, the government would have to increase the number of secondary science schools" (Yaacob 1975).

This manpower approach gained widespread acceptance and still plays a major part in the educational planning of most developed as well as developing countries. Thus, in 1980 when the US government became "increasingly disturbed" by reports that the United States faced "severe manpower shortage" in key areas of science and technology, President Carter ordered an inquiry to see how science education could be improved at school and university level (Cookson 1980).

There is considerable evidence that education does in fact assist economic growth. As Blaug (1970) has pointed out, there is a universal association between education and earnings, since in all the economies of which we have knowledge, people with more education, on average, have higher incomes than people with less education. For instance, Jencks (1980), on looking at the situation in the USA, found that although intelligence had "surprisingly little" effect on an individual's economic success, educational qualifications did - with a bachelor's degree, for example, adding an average 30 to 40 per cent to a man's lifetime earnings. Bowman and Anderson (1968) investigated how GNP per head varied in 83 countries and found that a literacy rate of 40% seemed to be a pre-requisite for income to exceed 300 US dollars equivalent per head and a 90% literacy rate was necessary for income of 500 US dollars equivalent per head. After a review of historical evidence, Anderson (1965) also concluded that a literacy rate of 40% was the general threshold for economic development. Peaslee (1967) has reported that in the past one hundred years no country has ever achieved siginificant economic growth without first enrolling 10% of the total population in primary schools and Kaiser (1966) has noted that at similar levels of GNP per head, the more children there are at school in a country, the higher the rate of growth of GNP will be during the following decade. Denison in a study of the USA concluded that for the period 1930-1960 the diffusion of education in the USA accounted for 23% of the annual growth rate (Blaug 1970). The evidence is persuasive, therefore, that education can assist with the process of development, at least in economic terms.

It is surprising to read, therefore, that by the early seventies major aid agencies, such as the World Development Bank and the Ford Foundation were questioning their "earlier optimism" about the contribution of education to development (Husen et al 1978, Maybury 1975). The 1950s and '60s had apparently,

> "shattered their optimism as, in country after country, hopes for development have failed to materialize despite large investments in education" (ibid).

The late '60s and early '70s were periods of "sombre stocking" for both aid agencies and governments in developing countries (Curle 1973). Their whole concept of development via economic growth had foundered, not least, because of the failure of the education systems to produce the skilled manpower needed for development. Many began to realize that although economic growth may be impossible without education, by itself education does not create economic growth (Jones 1971). Instead of the technicians, technologists and skilled workers, there were vast numbers of unemployed and unemployable primary and secondary school leavers in many developing countries, including India, Pakistan, Korea, Phillipines, Kenya and Zambia (Blaug 1970, Borrell 1981 and Cavanagh 1972). The education systems had somehow failed to fulfil their role. Skills and energy which could have been used for rural development were being wasted in the over-populated suburbs of the towns and cities. Instead of the technicians that the politicians had sought there were large numbers of young unemployed drifting to the cities in search of white collar employment. Even the "successful" products of the education system, the university graduates and secondary leavers, who did obtain jobs were often of limited use for development. Having left their homes in rural areas to attend secondary schools in towns, or universities in main cities, they had become alienated from their own culture and formed intellectual elites in the cities, elites which copied the language, culture and often the dress of the former colonial masters (Curle 1973, Husen 1979, Nyrere 1969 and Lewis 1972). Isolated from their rural backgrounds, they developed "caste" systems with membership based on academic qualification; a university degree carried with it membership of the highest caste (Curle 1973).

The question, therefore, was why, or how, had education failed to serve the needs of the community? Most educationalists and politicians in developing countries blame the failure on the fact that the education systems still closely resembled those of the former colonial administrations. While the newly independent countries may have wanted technicians and skilled workers their education systems had been designed by colonial governments to produce white collar workers, such as clerks and subordinate officers, to staff the colonial administration (Curle 1973). Politicians were trying to change society by using education systems designed to maintain the status quo (O'Jon 1979). Since the colonial administrations had wanted clerks and white collar workers, the curricula in the schools had been largely based on classical and academic learning and since the workers were to serve and work with colonial officers, the content was based on the values and culture of the colonial state. Thus, during the colonial administration of British Guiana (now Guyana), the East Indian, Negro and Amerindian children of the colony were taught what even a British inspector considered was "ludicrously grotesque" content, such as,

> "the religious difficulties of Queen Elizabeth (the first) or ... the cockney humour of Dicken's Christmas Carol" (Williams 1927).

Education systems have continued to produce educated elitists with curricula geared to colonial examination systems such as the Cambridge, Oxford and London GCE Boards. Even in village primary schools in developing countries the pupils receive an education that does little to prepare them for life in a village (Tett 1974) since the teachers themselves are products of the colonial education system and thus inculcated in the culture and values of the colonial state. Safer (1981) has reported that even at the present time, teachers in the US controlled Marianna Islands in the Pacific require their pupils to memorize the names of all the US State Capitals but neglect to teach them the names of local island groups.

Eighteen years after Guyana became independent (and fifty years after Williams had complained about the irrelevance of the curriculum) the author, after flying almost 200 miles to visit a remote school in the rain forest of Guyana, watched an East Indian headteacher - with a Masters degree from an English university - instructing his class to recite time after time the poem "The Lake Isle of Innisfree". The next afternoon the same headteacher suspended the timetable for the entire school so that he could talk to the pupils about "Socrates birthday".

Colonial education systems sought to produce a small well trained elite to help run the administration. In Zambia, for instance, at independence in 1964, out of the total population (4.5 million in 1976) there were only 100 university graduates and 1,200 people with Cambridge Overseas School Certificate. But even these people were unlikely ever to rise to senior positions in a colonial administration for these were reserved for expatriate staff. By "closing the doors" to the most promising of the local people colonial governments, such as Britain,

> "forced the best brains of her colonials into two occupations: law and medicine". (Murray 1979).

Law and medicine, therefore, became the status goals for all local people, the highest mark of achievement in a developing society; a status which was further enhanced by the many lawyers and doctors who became political leaders in developing countries - like Nehru of India, Castro of Cuba, Banda of Malawi, Obote of Uganda and Burnham of Guyana. The result was that even after independence and whatever the needs of the society, people still felt that for the individual the highest rewards would be attained by becoming either a doctor or a lawyer. Recruitment to these professions soared. Recruitment to the lower levels in these professions, for example, nursing and midwifery, however, remained low. In East Pakistan (now Bangladesh), for example, in the mid seventies, out of a population of 46 million people, there were only 119 trained nurses and a mere ten additional nurses were being trained each year (Curle 1973). Similarly in India, while there was one doctor for every 6,300 people, there was only one nurse for every 43,000. This meant that, unlike England, which had for example a ratio of three nurses to every doctor, in India there was a ratio of three doctors to every nurse (ibid).

In developing countries the main aim of those who could succeed in the education system was still focused on joining the elite; to do this one needed a degree, even if the degree came from one of the "assembly lines for the mass production of graduates" of "incredibly low quality" (Parthasarathi 1967). Thus in India, for example, new universities continue to be set up at the rate of one every three months and colleges are being affiliated at the rate of one every two days (Abraham 1980) while in Turkey in 1981 400,000 people sat the entrance examinations for 40,000 university places. The result is that in many developing countries there are large numbers of highly educated unemployed in fields such as in law in medicine and in the arts, while at the same time there are severe shortages of skilled technicians and technologists (Blaug 1970, Curle 1973, Zubryn 1980 and Wilce 1980).

As disillusionment set in with the concept of development as being economic growth and as greater emphasis was given to the idea of developing society rather than the economy, the role of education was questioned and politicians and educationalists proposed that it should concentrate on getting people to live creatively and work together (Curle 1973) rather than it being a series of stepping stones in which all pupils at primary schools follow an academic curriculum suitable for the few who will proceed to secondary school and hence to a curriculum designed to suit an even smaller group of university entrants. It was now proposed that primary and secondary school programmes should be complete in themselves and should emphasise the knowledge, skills and attitudes which were appropriate to the needs of pupils (Jones 1971, Curle 1973). Thus Nyerere proposed,

> "We should not determine the type of things children are taught in primary schools by the things a doctor, engineer, teacher, economist or administrator needs to know. Most of our pupils will never be any of these things. We should determine the type of things taught in the primary school by the things which the boy or girl ought to know - that is, the skills he ought to acquire and the values he ought to cherish if he, or she, is to live happily and well in a socialist and predominantly rural society and contribute to the improvement of life there".
>
> Nyerere1969 p. 282.

By the early seventies development was seen in terms of improving the quality of life for the majority. Since the majority of people lived in rural areas it was argued that education could best help development by preparing and encouraging pupils to live and work in rural areas. In many countries attempts were made to reorientate education systems so that they would be more suitable for rural majorities (Moss 1974, Nyerere 1969 and Mingo 1976). The emphasis of education in many countries has shifted, therefore, from training a scientific and technological elite for industrial development towards preparing a rural majority for subsistence and agricultural development.

Many people have expressed doubts, however, that education will be any more successful in this role than it was in producing technicians and technologists. Cookey (1969), for example, warned of "the long history of failure" of attempts to establish an agricultural bias in African education. Blaug (1970) spoke of agriculture science being a "bone of contention" among educationalists for almost fifty years and Young (1980) has noted how "attempt after attempt" to introduce agriculture into the school curriculum has failed. Foster (1966), in an historical review, examined education and social change in Ghana and found that proposals to increase the provision of agricultural and technical education had formed an essential element in every major document relating to education in the Gold Coast (now Ghana) from as long ago as 1847 right up to the granting of independence in 1957. Agriculture and technology are no more accepted in the school curriculum in Ghana than they are in the other parts of Africa even after a century of effort by the colonial government to establish them. One can question why then schools in Ghana still retain their academic bias and in the light of the historical failure of agricultural education, have the independent governments in developing countries any greater chance of success than the colonial administrations?

Foster (1966) suggested that agriculture education had failed because the agriculture sector of the economy held out few prospects for school leavers. The opportunities for employment were in the modern sector of the economy and here, no matter what the educational proposals might have suggested, the real demand was for clerical and commercial skills. The "graduates" of the academic schools, therefore, always had better employment prospects than those from technical and agricultural schools. Blaug (1970) suggested that parents and school children were not being irrational in their demands for academic education since they had correctly appraised the actual job opportunities. The teaching of the three R's, he argued "paradoxically enough" did provide a vocational education in the best sense of the word, since it allowed for entry into the most prestigious and best paid occupations in the economy.

In 1970 Blaug reported that the picture in Ghana had changed very little since independence with employment in the public sector at that time growing faster than employment in the rest of the economy, and a recent manpower study in Guyana (Anderson et al 1979) has revealed much the same pattern.

Over the past ten years the fastest growing sector of the Guyanese economy has been the public sector, so that at the present rate of growth, by 1982, clerical and saleworkers will become the biggest single group in the economy, accounting for nearly 21% of total employment and exceeding in size both the agriculture and production groups (ibid).

According to Blaug simply giving agricultural and technical education a high priority will not generate economic development. The idea that it could, he suggested comes from "totally exaggerated expectations" of what schools by themselves can be expected to contribute to economic development. Infusing some agricultural bias into the school curriculum, he accepted, may do some good but reorientating education towards agriculture would not, he argued, keep African school leavers in the countryside and could not eliminate urban unemployment. This, he suggests, could only be done by making the countryside a better place to live and work in.

The Role of Science Education in Development

The primary purpose of education in developing countries has been to produce the skilled manpower needed for economic growth and science education was required to play an essential role in training this manpower. Science at school level was seen as "providing the input" to higher education and the training institutions and so held "the key" to the output of scientific and technological personnel (Ponnamperuma 1975). Inadequate school science would hold back the development of scientific manpower (Maybury 1975). In many developing countries priority was given to the teaching of science and mathematics, with the clear objective of "harnessing potential manpower" (Chin 1972). Science was taught, therefore, in order to produce scientists and highly qualified technologists. At the 1961 conference of the Organization For Economic Cooperation and Development (OECD) on Policy For School Science, Lauwery (1961) took care to draw a distinction between teaching science" and "teaching about science". Science, he suggested, should be taught to those who would be the "producers" of science, those who would earn their living in scientific or industrial laboratories. For the "others", the "consumers" of science, the "ordinary" citizens who would earn their living by commerce, or by the professions, or by "relatively unskilled machine minding", he recommended that they should learn "about science",

> "a general understanding of modern processes of producing and distributing material goods" (ibid p. 58).

These people's lives, he suggested, could be "enriched by humble and distant participation in scientific progress". It was not necessary for them to be "skilled manipulators" of equipment, such as chemical balances, however, "more modest achievements" would suffice.

The role set for science education in many developing countries was to train the elite of scientific "producers". It is not surprising, therefore, that science became a narrow academic study, concentrating on factual knowledge, and with content which was often irrelevant to the everyday life of the pupils. For example, in a study of biology teaching in Israel, Jungwirth (1972) found that the principle aim of science and the pursuit of science was "fact collecting". Maybury (1975) reported that science teachers in Lebanon looked on the science curriculum as being merely a body of knowledge to be memorized. Davey (1972) has reported on the emphasis on content in science teaching in Malaysia, and Savoury (1972) has noted that in Africa, even primary school science is taught primarily as knowledge to be learned.

Knowledge is all important because school science is seen as being the "groundwork" for further study. The role of primary science is to prepare pupils to study secondary science and secondary science is designed to prepare them for university (Ewer 1969). The syllabus must be completed and the content covered. In the process "luxuries" such as practical work are often neglected, either because the teachers are unsure of the apparatus or because they have "no time" to do it (Elgood 1967, Williams and Pullen 1971 and Maybury 1975). Educators may deplore the content bias and the lack of practical work but if the teachers fail to pay proper attention to examination results, then - as happened in Guyana in 1979 - their ministry of education may conduct meetings to "make" them ,

> "more aware of the declining trend in GCE O Level science results".
> (Ministry of Education, Guyana, 1978).

Frequently the content which the teachers are required by the examination syallabus to cover is totally irrelevant to the everyday needs of the pupils. Elgood (1967) has written of visiting an African school and "suffering" a lesson on vegetative propagation which was "illustrated" with "pickled" onions, potatoes and crocus corns and included a theoretical discussion on the grafting of roses. At the same time as the discussion was taking place, Elgood reports he,

> "gazed out the window at several varieties of citrus, all grafted, in the school grounds".

In the late seventies the author visited over one hundred schools in Guyana. In only one was there a poster of a local plant, the hibiscus, but even in tiny one-roomed primary schools along the banks of the tropical rivers there were large neatly drawn posters of "The Buttercup" with the "Androcium" and the "Gynaecuim" carefully labelled. At the university level, Kalmus (1967) has written of the application to a United Nations aid agency from a university in a newly independent country for twenty electron microscopes - to be used for "virus research". There was, he reports, only one trained virologist in the country and nobody who could maintain the instruments.

The failure of science education to produce the numbers of trained scientists and technicians needed in developing countries has been blamed on the inadequacy of the teachers (Jones 1971, Curle 1973 and Odhiambo 1972). If sufficient numbers of trained teachers were available, it was argued, then the present problems in science education would be overcome. While this might well ease the difficulties, it would not necessarily resolve one of the major problems, namely the irrelevant and unsuitable nature of the school science curricula, unless their training was also changed.

Even when teachers are highly qualified and well trained, the curriculum still presents them with major difficulties. For instance, in a study of seven schools involved in the Biological Sciences Curriculum Study (BSCS) Adaptation Project in Israel, Jungwirth (1969) found that even though all the teachers were highly qualified "hand-picked volunteers", the attainment of their pupils was still "disappointing" and instead of the BSCS materials forming a one year programme of study - as originally intended - "local conditions necessitated" that it should be a two-year course. Williams and Pullen (1971) have written of their experiences when conducting a short course to adapt Indian teachers to Nuffield Biology materials. All of the forty-five teachers involved had university degrees, thirty-five also had B.Ed degrees and eleven had M.Sc degrees. Yet even this group of highly qualified science teachers reported that they had "no time" for practical work with their pupils.

Even for qualified teachers in developing countries, there is a problem with the science curricula being used in the schools. This problem stems largely from the fact that the curricula are mainly adaptations of programmes originally designed for use in the American and British school systems adaptations of programmes such as the BSCS programme or the Nuffield Physics, Chemistry or Biology projects. The BSCS programme, alone, has been adapted for use in fifty-five countries in Africa, Asia and South America (Baez 1976, Morikawa 1969 and Gardiner 1969). The difficulty is that these programmes were produced to fulfil specific functions and to suit the particular circumstances of the countries where they were first developed, that is, the USA and Britain. They were never intended for use in developing countries.

In the early sixties, there were five major science and mathematics curriculum projects in the USA. They were sometimes referred to as the first generation projects and were:

The Physical Science Study Committee (PSSC),

The School Mathematics Study Group (SMSG),

The Chemical Bond Approach (CBAP),

The Chemical Education Material Study (CHEMS), and

The Biological Sciences Curriculum Study (BSCS).

All five shared a number of characteristics, particulary in the way they were developed. Prior to the 1960's, school science programmes and text books had in the main, been devised and written by school teachers, with the help perhaps of a professor of science or science education. The first generation projects of the sixties broke with this tradition, however. They were led by scientists rather than by teachers or educators. Outstanding scientists, such as Professor Zacharies of the Massachusetts Institute of Technology, played predominant roles in deciding on both the content and the approaches to be used. The programmes were content oriented and the scientists began by deciding what new subject matter should be included in school science and what should be deleted. For the scientists one of the major goals was to restore the "primacy of subject matter" in the educational process (Baez 1976). The projects were also discipline centred and sought to present science as a system of inquiry rather than a stable body of knowledge. To help achieve this the programmes stressed major conceptual schemes and basic concepts in science. Research scientists played an important role in deciding what these concepts should be (ibid). In all five projects great emphasis was placed on having students deal with phenomena directly through practical laboratory experiences.

The fact that scientists played such a fundamental role in devising the first generation projects had important consequences both for the projects and for science education itself. Scientists brought two important benefits to the programmes: firstly, their knowledge of modern content, and secondly, an element of prestige, which helped both to enhance the acceptance of the projects and to gain financial support for them. There was an important disadvantage, however, with having scientists occupy such important positions in the projects. Since they had no experience of the actual day to day situation in schools, the materials the scientists produced were often unsuited for schools. Thus, although the materials were intended to cater for average pupils they were too difficult for the majority of pupils and suited only for a small elite of top students. In some cases, Baez suggests, the materials were too difficult even for the teachers to handle (ibid).

There was a "global hunger", however, for the new curricula and they were being advocated by the American scientists "with almost missionary zeal" (ibid). Before the problems with them had been discovered the materials were already being used in developing countries. They were introduced into Brazil, for instance, in 1962 and by 1965 140,000 copies of the texts had been produced there (Maybury 1975). By 1962 BSCS materials were being adapted in the Phillipines and by 1964 in Israel (Maybury 1975 and Jungwirth 1969). One of the reasons for the swift adoption of the US materials was the fact that they had been produced by scientists. Not only did this add to their prestige but it made them more attractive to fellow scientists in other countries, scientists who had important positions in their own countries' decision making processes (Maybury 1975). During the sixties the inadequacies of the first generation projects were beginning to be recognized. PSSC, for example, was seen by teachers in the US as being too difficult for the average student and was used in only four per cent of the senior classes. Alternative programmes began to be developed, which offered more flexibility to the teachers. In most of these new projects there was also close collaboration between scientists, educators and teachers (Baez 1976). But by this time many developing countries had committed themselves to the first generation projects. They had made substantial investments in materials, equipment and text books, and so had little choice but to continue using them. The prestige of the American scientists also made it difficult for teachers and educators in "less developed" countries to question the value of the materials. Nevertheless, by the late sixties and early seventies their value was beginning to be questioned in countries such as Turkey, Israel and the Phillipines (Maybury 1975, Jungwirth 1969 and Maddock 1981).

In some cases US and UK science curricula have simply been adopted by developing countries and the equipment and text books have been bought and introduced directly into the schools, though in many other cases the "overseas" materials have been adapted or modified to suit local conditions. The view, however, was that the modifications should not be too drastic. Mayer (1967) expressed the opinion of many of those concerned in the modification process when he wrote in the BSCS Newsletter that,

> "chemical reactions are the same in North America as in Australia, and the principle of the lever is the same in India as in Italy".

Getting local people to modify the materials was felt to give them a "pride of involvement" and thus encourage them to use the materials (Baez 1976). Those modifications were often superficial and consisted of little more than changing place names or substituting local examples of plants and animals, for example, mangoes for apples, Lagos for London (Wilson 1981, Maddock 1981). Details of content were localized but the aims, objectives and teaching methods, "emerged unscathed from the process" (Wilson 1981).

Just how limited the adaptation process can be is illustrated by the West Indian Science Curriculum (WISC). In 1968 the West Indian Science Curriculum Improvement Project (WISCIP) was initiated at the St. Augustine Campus (Trinidad) of the University of the West Indies. The project was set up to develop a science curriculum for the new junior secondary schools then being built in Trinidad. The project adapted the Scottish Integrated Science Project materials but retained the stated aims of the Scottish programme (Adey 1976). In 1970 the Ministry of Education in Barbados, through the work of a local science curriculum committee, produced a revised version of the

WISCIP programme for use in Barbados. This revised programme became known as WISCIP/B and was itself adopted by the Caribbean Regional Science Project as the basis for a programme it was developing for junior and secondary schools throughout the English-speaking Caribbean. CRSP piloted materials in eighty schools throughout the region and after an evaluation produced a modified version of WISCIP/B. After further school trials this revised version became the published West Indian Science Curriculum (Adey 1976). During the entire process, however, the aims remained unchanged. Even when the West Indian materials were later used as a basis for an African project - the Swaziland Integrated Science Programme - the same list of aims written for the Scottish Integrated Science Project persisted (Wilson 1981).

While there may be some excuse for the different curriculum teams using the same aims, there can be no excuse for them reproducing mistakes in the original materials. An error present in the original Scottish project persisted throughout the adaptations. On page 15 of the Scottish text, Science For the '70s (Mee, Boyd and Ritchie 1973) a pupil is shown looking at a series of ring magnets. The bottom ring of the series is shown as being suspended in mid-air. This cannot occur when the apparatus is set up as shown and one wonders, therefore, if the experiment itself was tested when the adaptations were being developed.

The Changing Role of Science Education

In the 1970's education systems in developing countries tried to adapt themselves to fit the new role devised for them, namely to provide an education suited to the majority of the population rather than to prepare an administrative and technical elite, one which was relevant to the needs and culture of their own society and not just to the nation's economic growth. In keeping with this, science education has tried to change its role. Instead of using copies or modifications of projects designed for elite science students in the USA or UK, educationalists in developing countries wished to develop local science programmes which would be relevant to the needs, interests and culture of the majority of people in their own society (Odhiambo 1972, Moss 1974, Rawlins 1976 and Gilbert 1978).

Cavanagh (1972) suggests that for developing countries the role of science education is four fold. Firstly, it should promote a basic level of scientific literacy amongst the whole population. It should also acquaint its students with science knowledge important for coping with the local environment, for example, in health, sanitation and agriculture methods. Thirdly, it should prepare the pupils for citizenship by making them,

> "scientifically knowledgable to the point where they can contribute toward the well-being of the community" (ibid).

Finally, science programmes should develop pupils' critical thinking abilities so that they will be more open minded and able to sift available information before drawing conclusions. Lewis (1972) has also written of the need for pupils in developing countries to have sufficient knowledge of science to be able to realize how it impinges on daily life and to appreciate its political and ethical implications. He stresses, however, the vocational role of science education in preparing both the majority of the population and the few who will eventually take up science based careers. For both groups it is important, he suggests, to develop a "spirit of inquiry" and a scientific attitude to life. In a similar vein, O'Hearn has proposed that scientific literacy should not be considered only as an ability to read and communicate about science, but also as a willingness and eagerness to do so. For the politicians, such as those at the Conference of African Ministers (UNESCO 1974), scientific literacy entails making the general public aware of scientific and technological problems. Rawlins (1976), in a speech to Caribbean science educators, summarized the key aspects of this politicians' view of science education when he proposed,

> "We must help children to develop enquiring and creative minds. And the science of the classroom cannot be removed from what is real and meaningful in our society. It must relate from the earliest stages to local situations - and our problems - in agriculture, fisheries, building construction, roads, water power etc".

Such a curriculum would be aimed at the majority of pupils, be designed to promote scientific literacy and critical thinking ability, be based on local relevant situations, and it is hoped would help to solve local scientific and technological problems. These are the key features of the role science education is now being asked to play in developing countries. But, the majority of people in developing countries live in rural areas so, if science education is to be relevant to their local situation and is to help solve their problems, it needs to have a rural and agricultural bias.

There is still the problem, however, that local people frequently do not want school science to be relevant to local conditions. When Gilbert (1978) was working on the primary science curriculum in Rhodesia (now Zimbabwe) in attempting to make the work relevant to local conditions he introduced activities which required the pupils, for example, to investigate the properties of sand and cement when mixed in different proportions and treated in different ways and to investigate which variety of tomatoes grew best in the school grounds. After a promising start the schools began to make excuses for not carrying out these activities. When he investigated Gilbert found that the local parents regarded it,

> "as quite immoral to waste the childrens' time during formal nature study lessons in making bricks (as they thought) and in pursuing intensive horticulture (as they thought)" (ibid).

Similarly, the teachers were unhappy with the idea of teaching "building" and "agriculture" because they felt that it,

> "smacked of training for second-class menial careers" (ibid).

It does seem important, therefore, to make school science both relevant and acceptable to local communities. One way to help ensure this would be to consult people and seek their views and indeed this approach has recently been tried by Tan (1976). In a survey of biological knowledge useful in everyday life in Malaysia, he questioned over five hundred people, including school pupils, teachers and members of the public. In this way he identified six areas of biology which people felt were relevant to their everyday life and which over 95% of those questioned felt should be taught in schools.

Teacher Shortage

The need to devise suitable and relevant curricula is undoubtedly of great importance for developing countries, but new curricula can only have impact if they are implemented and for this to happen teachers are required who are both competent in themselves and have been trained to handle the new materials. Many developing countries, however, have been unable to meet the demand for trained teachers. As their education systems expand and enrolments rocket upwards, many have resorted to recruiting untrained and poorly qualified personnel with the result that a large proportion of "teachers" in developing countries have neither the training nor the qualifications needed for their job. In India, for example, two-thirds of primary and nine-tenths of middle school teachers are unqualified. To be qualified for primary teaching in India, only a secondary school certificate and a "one-year" training diploma is needed, yet the majority of those teaching in primary schools do not have them. In fact, half of all primary teachers have only a middle school education and in middle schools most teachers have only a secondary school certificate (Jain 1977). In Zimbabwe, three-quarters of the present teaching force is untrained, with most teachers having only four years secondary education (Marlow 1980). In one school he visited, Marlow reports that for the 875 pupils in the school there were two trained and seventeen untrained teachers. Acute shortages of trained teachers are also reported in Botswana (Husen 1979), Burma (Ministry of Education, Burma 1979), Colombia (Pena and Chiappe 1977), Egypt (Wilce 1980), Jamaica (Murray 1979), Nigeria (Wali and Lovegrove 1978), Pakistan (Khan 1974) and Sierra Leone (Sawyerr 1975). In 1969 the Economic Commission For Africa (1969) reported that in the "vast majority" of African countries the"bulk" of teaching staff consisted of people who did not have the prerequisite training for their jobs. Since then most African countries have expanded their education systems without a corresponding increase in the number of teacher training places. Many educators with experience in Africa, now see the shortage of trained staff as one of the biggest problems facing education in the continent (see for example, Robson 1972, Savory 1972, Fayiga 1972, Odhiambo 1972 and Young 1980).

Causes of Shortage

Following the rapid expansion of education in developing countries, traditional training methods have been unable to cope with the increased demand for teachers. The recent situation in Nigeria illustrates the problem faced by colleges. In 1978 there were 130,000 primary teachers in the country. To meet the demands of the expanding system, however, an additional 105,000 teachers were called for, for 1980 and a further 55,000 were needed for 1982 (Wali and Lovegrove 1978). In two years, therefore, the training system was asked to almost double the entire population of primary teachers. Traditional training methods are not designed to cope with this scale of expansion.

A second reason for the shortage is that there are problems of recruitment. Many young people are reluctant to join teaching, preferring when possible to join the professions or public services (Nyrere 1969). Since independence the status of teaching in many developing countries has dropped (Fayiga 1972) and there are high wastage-attrition rates, as teachers leave to join the public, welfare and broadcasting services (Kwabena 1979, Lancaster 1978 and Brophy and Dalgety 1980). One reason for the drop in status is the low financial return offered for teaching. In Egypt in 1980, primary teachers earned less than the equivalent of £20 a month (Wilce 1980). In Zimbabwe, in the same year, teachers earned only £3 more than the minimum national wage of £49 a month (Marlow 1980). In Guyana, university graduates recruited to the local mining industry start at £200 a month and receive housing and car allowances in addition, while graduate teachers receive £112 per month and no allowances. The top point in the graduate teaching scale is £172 a month.

Research in both the developed and the developing countries has shown that recruitment of teachers is highly susceptible to how salaries relate with those of other comparable alternative occupations. Zabalga (1980), for example, concluded that for the UK a 10% increase in wages relative to earnings in other white-collar occupations would result in a 24% increase in the population of male graduates entering teaching. Ozunba (1972) found that the two most important factors in job satisfaction for Nigerian graduate teachers were salary and opportunities for advancement, and Dame (1972) found that teachers' job satisfaction in Ghana was significantly - and negatively - linked with job alternatives.

Two key factors in the shortage of teachers in developing countries, therefore, are (a) the low status accorded to the profession and (b) the inability of the teacher training colleges to supply the numbers of trained teachers needed.

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Chapter Two

The Supply of Science Teachers in Developing Countries

Alternatives to Training Colleges

Over the past fifteen years the role of training colleges in developing countries has been questioned. It has been suggested that they are too costly, and are inappropriate to the needs of the education systems in developing countries (Porter 1969, Springer 1969, Espie 1969 and Husen 1979). Husen, for example, has suggested that training colleges are,

> "not viable in the developing countries because of financial restraints and the soaring enrolment in primary school" (ibid p. 141)

while Springer (1969) has questioned the "usefulness" of prolonged periods of residential training. After a visit to the Kenya Science Teachers College, Espie (1969) wondered whether the "very excellence" of the buildings and equipment at the college would not create problems and make it difficult for the teachers to go out and teach in the far "less luxurious" conditions in the schools. The "isolation" of colleges from the world of schools and villages has also been criticized by Porter (1969) and by Murray (1979). Murray reports that in Jamaica,

> "some of the 'best' products of the colleges became exaggeratedly mannered in speech and deportment and cut curious figures among the rural folk".

Teacher training colleges can also be difficult to staff. In his 1968 report on staffing requirements for education in Africa, Hanson noted that,

> "the problems of staffing teachers' colleges were even more critical than those for secondary schools" (Hanson 1968),

and in 1975 Sawyerr reported that in the teachers' colleges in Sierra Leone there were science educators who had no professional qualifications. Teacher training colleges, therefore, are seen to be expensive to set up, difficult to staff and often producing teachers who are culturally isolated from the communities in which they teach.

Alternative Strategies For Teacher Education

In an effort to overcome their teacher shortage many developing countries have re-examined their conventional patterns of teacher education and sought to supplement them by introducing alternative methods of teacher training. A number of different strategies have been used; one characteristic they share, however, is their use of in-service training methods.

Sandwich programmes have been developed in a number of countries. These involve students undergoing lengthy periods of training (generally six to ten weeks) during vacations and then teaching in schools during term. Thus, the training forms a "sandwich" before and after the period of teaching. Often the trainees are supervised by their lecturers or tutors during the teaching period of the training course. This type of programme is used in Malawi, Nigeria and Brazil (Hawes and Ozigi 1975, Krasilchik 1980). In 1972 the Institute of Education at the Ahmadu Bello University in northern Nigeria initiated their sandwich programme for untrained graduate teachers. This programme has three phases. The first consists of ten weeks of professional preparation in the university and is followed by phase two, one year's full-time teaching in school. In the third phase the students return to the university for a further ten weeks of study (Hawes and Ozigi 1975). A sandwich programme - the Licenciatura Parcelada - was also used to train science teachers in Brazil and has seven stages:

Stage	Period	Place
1.	January to February	university
2.	March to June	school
3	July	university
4.	August to November	school
5	January to February	university
6	March to June	school
7	July	university

(Krasilchik 1980)

Each stage of this programme consisted of 800 hours work. During the odd stages, the teachers attended university for content lessons and during the even stages they worked in schools under the supervision of the university staff, attending regional sessions on teaching methods at the weekends.

A strategy different from the sandwich approach is used for training primary teachers in Guyana. In the In-service Teacher Training Programme (ITTP of 1976) of the Ministry of Education in Guyana, teachers attend lectures and tutorial sessions after normal school hours which take place at the College in Georgetown, the capital, and at secondary schools in two of the other large towns. During the day the teachers are visited in their own schools by tutors of the in-service programme.

A third approach, and one which has been used in over forty countries, relies on distance-teaching methods for training teachers.

Distance-Teaching and Teacher Education

Distance-teaching has many advantages in teacher education. For college-based training, teachers have to be removed from their schools. This exacerbates the critical problem of teacher shortage, for stand-ins, when available, are less qualified than the people they are replacing. With a distance-teaching method of training, teachers remain at their posts in school and replacements are not needed. Initial building costs for colleges are prohibitive especially if large numbers of teachers are required urgently. Hanson (1969) has reported on the difficulties of recruiting staff for teachers' colleges. Distance-teaching programmes need a much smaller number of full-time staff than college programmes since they can use people who are already employed in universities and colleges to write materials and to assist with vacation workshops. In this way the best qualified and most experienced educators in a country can be involved in distance teaching programmes.

Similarly, while it is difficult for overseas specialists to participate for two or three years of a college programme, it is comparatively easy to obtain their participation for short periods of time at summer institutes and vacation workshops and these can be incorporated into distance-teaching schemes. With care, distance-teaching schemes can be made to rely upon existing buildings, equipment and manpower and can be very economic. According to Lyle (1967) the UNRWA/UNESCO Institute of Education programme trained Palestinian teachers by correspondence (1964-66) at a cost of 341 US dollars per student year, while similar college-based training cost 820 US dollars per student year. Kaunda (1973) found that correspondence courses run by the University of Zambia trained teachers for half the cost of full-time college trained teachers. Training teachers by distance-teaching methods is less expensive than training them through college-based programmes.

Teacher training colleges are expensive to set up and difficult to staff. There can also be delays in completing college buildings such that it may take five years or more before their first trainees are available for teaching (Brophy and Dalgety 1980). Distance-teaching programmes, however, do not necessarily need new buildings, they require minimal new staff and the teachers are immediately available to schools (though initially they are untrained). Since it is egalitarian rather than elitist in nature, distance-teaching is expedient for most countries. Large numbers of teachers can be trained at any one time, and the programme brought to the teachers where they live: there need be no discrimination against those living in remote and rural areas. In Guyana, for instance, through distance-teaching, qualified science teachers became available in regions which previously had been dependent upon either unqualified or expatriate teachers (ibid). Curle (1973) suggests that creating alternative routes to advanced education will also help break down the elitism which has arisen in many new countries from the limited number of places available in universities and colleges.

Training teachers in situ helps to overcome problems encountered when trainees from rural areas are brought to towns or cities for college-based training. Often these rural students have difficulty settling into their courses and many of those who do settle do not want to return to their own areas after qualifying. Just such a problem has occurred in the USSR: of those graduating from teacher training institutes in 1979, 38% refused to take up posts as teachers, particularly when these were in village schools (Binyon 1980).

The fact that an in-service programme exists, with its correspondence materials and perhaps its radio and television programmes being distributed throughout a country can also bring benefits to education systems in general, and, even to the society itself. Kabwasa and Kaunda (1973) report that the radio programmes broadcast for the 8,335 students of a Kenyan distance-teaching project were listened to by half a million adults, and Moss (1974) estimated that 46% of all university tutors in England had used Open University materials in the conventional university programmes.

From the student teachers point of view it is a major advantage of distance-teaching that they can become qualified without having to interrupt their earnings. Many adults, especially those who are married, need to remain in their own town or village and it is important that they are not obliged to take up residence in, or near to, a college in order to be trained. Distance-teaching methods allow the trainees a considerable degree of autonomy in developing their study habits and in setting the pace of their study. Both features are particularly advantageous in developing countries, for many of the male teachers also farm and a large proportion of the female teachers have young children. Teachers living in rural areas seldom have access to libraries, and distance-teaching offers the further advantage that the structured correspondence units supplied to trainees will in themselves be a valuable source of reference material, both for their training and for their teaching. Unlike college trained teachers, they do not have to return books when their training programme is completed.

The distance-teaching approach to teacher education is not a recent innovation. As long ago as 1870 there were advertisements in the School Master - the journal of the National Union of Teachers - offering postal tuition for teachers' examinations (Elliott 1978) and a correspondence school offering courses for teachers was established by the Department of Education in New Zealand in 1922 (Ewing 1966). Distance-teaching is now widely used in teacher education.

Patterns of Distance-Teaching

Distance-teaching has been used in over sixty teacher education projects throughout the world. These programmes take many different forms and have served a variety of purposes within teacher education. Some have been used solely to increase the teacher's academic knowledge. One, the Kenyan Junior Certificate Programme which began in 1967, provides a secondary education for teachers who have only a primary school education (Kinyanjui 1974). Another, the General Secondary Course, set up in 1965 by the Malawi Correspondence College provided secondary education for many uncertificated primary teachers (Ewing 1966). Where teachers have already achieved a satisfactory level of academic attainment, distance-teaching has been used to provide professional knowledge and training. Graduates in Australia may obtain postgraduate teaching certificates through the correspondence courses of one of a number of universities (ibid and Smith 1978), and correspondence courses on teaching methods have been provided by the University of the West Indies for teachers on various Caribbean islands (Ewing 1966). On the other hand, there are some distance-teaching programmes in which both academic and professional knowledge are supplied, either as part of an initial training scheme or as an aid to the understanding and teaching of a new subject or topic area. This is the way modern mathematics has been introduced into schools in Mauritius (Kinyanjui 1974) and science into basic schools in Chile (Martin 1980). Teacher training courses which provide all the academic and professional knowledge and training needed to obtain certification have also been developed using distance-teaching techniques. Some of the better known programmes of this type are the UNRWA/UNESCO Institute of Education Project for Palestinian teachers, which has been in operation in the Arab refugee camps in Lebanon, Gaza, Jordan and Syria since 1964 (Kinyanjui 1974) and the Francistown Teacher Training Project which, between 1968 and 1973, trained over 80% of the unqualified primary school teachers in Botswana (ibid, and Kabwasa and Kaunda 1973).

As well as serving different purposes, the programmes for teacher education have employed a variety of distance-teaching approaches. Some, such as the schemes in Burma, Dahomey and the West Indies (Ministry of Education, Burma 1979, Kabwasa and Kaunda 1973 and Ewing 1966) have relied upon written correspondence linked with media materials. The National Teacher's Institute in Kaduna, Nigeria, uses written materials and audio cassettes (Wali and Lovegrove 1978) while the Television University of China, as its name implies, uses television broadcasts and correspondence materials (McCormick 1979). A third approach, which, like the first, does not use media at all, relies upon supplementing the correspondence materials with face-to-face tutorial sessions and is found in Jamaica (Murray 1979) and Zambia (Kabwasa and Kaunda 1973). From 1968 to 1979 it was also used for the Proyecto de Perfeccionamiento en Servico (PPS) by the Ministry of Education in Chile (Martin 1980). But each of these three approaches is less common than the one in which all three means of communication, namely correspondence, media and face-to-face meetings are employed. This three way approach, best known through its use in "Open" university schemes, has also been used specifically for teacher education in Kenya, Ivory Coast, Algeria, Botswana, Guyana, Uganda, Nigeria, Sri Lanka and Swaziland (see Young et al 1980, Brophy and Dalgety 1980, Kabwasa and Kaunda 1973 and Kinyanjui 1974).

Distance-teaching schemes have been designed to serve a number of purposes and have employed a range of methods. There is such a variety that it is difficult to establish the relative merits of each. A classification of distance-teaching patterns, both past and present, used for teacher education would help and such a classification is presented in Table 2.1. It is a grid or matrix, in which each teacher education programme is classified into a column according to its main purposes, and into a row according to its methods of communication with participants. A survey of distance-teaching programmes for teacher education shows that all of them can be classified into this four by four grid.

There are four groupings with regard to purposes, namely:

1. academic content alone,
2. pedagogy alone,
3. a limited amount of both content and pedagogy (limited in that a complete training programme for certification is not offered), and
4. a complete training programme of both content and pedagogy (offering certification to those who complete the work successfully).

In much the same fashion these programmes can be separated into four groups with regard to the method, or methods, employed by each, namely:

(a) correspondence materials alone,

(b) correspondence and media,

(c) correspondence and face-to-face, and

(d) the three way method (of correspondence, media and face-to-face).

All sixteen distance-teaching patterns identified by this four by four matrix have been used in teacher education. The programmes in Table 2.1 include distance-teaching schemes designed specifically for the training of teachers and also schemes intended for a wider audience, but in which teachers are known to make up 30% or more of the student body. The sixty-four projects shown in Table 2.1 are listed and classified in appendix 4.

The classification shows a number of trends in distance-teaching. For example, most complete training programmes (column 4 in Table 2.1) have been designed for primary school teachers. The classification also highlights the fact that few current projects rely solely on written correspondence materials (row a). Many of the distance-teaching projects which have encountered

TABLE 2.1 A Classification of the Distance Teaching Projects for Teacher Education

	Academic Alone (1)	Pedagogy Alone (2)	Limited Academic with Pedagogy (3)	Complete Academic with Pedagogy (4)
Correspondence Alone (a)	British Honduras Congo Zambia (1)	Malaysia Australia (1) West Indies	Australia (5) W. Germany (2) South Pacific	Algeria New Zealand (2) Dahomey Chad Burma Perù Nigeria (2)
Correspondence and Media (b)	Malawi China	Australia (2) Zambia	Mauritus	Nigeria (3)
Correspondence and Face-to-face (c)	Zambia (2) Ghana	New Zealand	Chile St Lucia Togo	Dominica Nigeria (4) Jamaica
Correspondence and Face-to-face and Media (d)	Sri Lanka (1) Kenya (1) UK (1)	UK (2) Nigeria (1) W.Germany (1) Australia (3) Australia (4) Costa Rica Pakistan Sri Lanka (2)	Philippines UK (3) Niger Ivory Coast Spain Tanzania (1) Israel Mexico	Botswana Kenya (2) Sri Lanka (3) Lebanon Iran Venezuela Nigeria (5) Uganda Mali Guyana Colombia Lesotho Swaziland Tanzania (2)

difficulties tried to rely on correspondence alone. The University of Brazzaville programme, for example, suffered a high drop-out rate (cell 1a). The programmes of the Institut Pedagogique National in Dahomey (cell 4a) encountered administrative problems and the Malaysian project (cell 2a) was judged by the Ministry of Education to be unsatisfactory and was terminated. Other projects that were of the correspondence alone type have been modified; the original Ministry of Education in Burma project (cell 4a) now includes the use of audio cassettes and so becomes a 4b programme, the Diploma in Education course in the South Pacific, initially a 3a scheme, has become a 3b and the CNEG programme in Algeria (cell 4a) now includes both media and face-to-face sessions (cell 4d). In each case the modifications lead to the programme being reclassified lower in the table rather than across; the purposes remain constant but the means to achieve them - the rows - changed.

The matrix and the appendix highlight the fact that there have been relatively few attempts to use distance-teaching to train science teachers and yet it is in science education that there occurs one of the greatest shortages of trained teachers. (See Robson, 1972, Lewis 1972 and Odhiambo 1972 for instance.) not in Bibliog

Since the problem is so widespread it is surprising that distance-teaching has not been used more often. A number of programmes, such as the British Honduras (now Belize) project included some basic science amongst the teaching content, but, to date, only eight projects have been designed specifically for science education. (A ninth project is expected to begin shortly in Cross River State in Nigeria (UNESCO) 1981).

Distance-Teaching Projects for Science Teachers

Of the eight projects only the National Diploma programme of the Sri Lanka Institute of Distance Education (SLIDE) is concerned solely with providing academic content. This programme was set up in June 1976 specifically to help overcome an acute shortage of science and mathematics teachers and aims to upgrade trained primary school teachers so that they will be able to teach science and mathematics in secondary schools (Perera 1978).

Two of the projects are designed for postgraduate students. The Western Australia Institute of Technology offer a distance-teaching programme which leads to a postgraduate diploma and/or masters degree in science education (Dekkers 1974) and the Correspondence and Open Studies Unit of the University of Lagos offers a postgraduate diploma in science education (University of Lagos 1976).

Two projects were designed to train teachers to use new curricula materials. The Deutsches Institut Fur Fernstudien of the University of Tubingen uses distance-teaching techniques to provide in-service training courses for physics, chemistry and biology teachers (Fernstudien Im Medienverbund 1978) and from 1968 to 1979, the Proyect de Perfeccionamient en Servico in Chile used correspondence materials linked with face-to-face teaching sessions in basic schools (Escuelas Basicas) Martin (1980).

Of the three remaining projects, two are produced as part of the activities of local open university systems. The Free University of Iran in 1978 began a programme to prepare science and mathematics teachers to degree level (Free University of Iran 1978) and the National Open University of Venezuela provides courses leading to education degrees with majors in physics and mathematics (Project 1979). These two courses were provided, therefore, as part of the distance-teaching programmes already being supplied by large "open" university systems.

To date, only one distance-teaching project has been set up solely to provide a complete training programme for science teachers. This is the Emergency Science Programme (ESP) of the Ministry of Education in Guyana. The author was the first coordinator of this ESP programme.

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Chapter Three

Science Education in Guyana

Geographical Location

Guyana is an independent socialist republic on the north-east coast of South America. It lies between 2 and 8 degrees north of the Equator, with Venezuela to its north and west, Brazil to the south and Surinam to the east. It has a mainland territory of 83,000 square miles, most of which is covered by dense tropical forest or sparse savannah grassland. Three large rivers, the Essequibo, the Demerara and the Berbice cut across the territory. There is a small population (approximately three-quarters of a million people in the 1970's) and over 90% of them live along a narrow coastal strip. Most of the land along this strip is below sea level and has been empoldered in the Dutch fashion. To cope with the problem of flooding during the rainy season many of the houses are built on stilts and large drainage channels and canals have been dug along most of the roads and streets. Most of the population live in rural areas: there is just one city, which is the capital, Georgetown. This is situated on the mouth of the Demerara river and has a population of less than 200,000. Because of its drainage canals and the trees and flowers planted along its main streets, Georgetown has been likened to the Venice of the New World and is sometimes called the Garden City. In the mid 1950's, however, the entire coastal strip was also referred to as,

"a tropical Gorbals, an enormous slum" (Simms 1953).

Historical Development

In a Papal Bull of 1494 Guiana was identified as all the lands that lay between the Orinoco and Amazon rivers and was granted to Spain. The Spanish, however, preferred to concentrate on their other New World territories. Following the publication of Sir Walter Raleigh's book, "The Discovery of the Large, Rich and Beautiful Empire of Guiana", successive groups of

Englishmen tried to establish colonies along the coast but were unsuccessful. The first successful settlement was made by the Dutch in 1616 away from the coast and up the Essequibo River. Initially the Dutch were mainly interested in trade and through the Dutch West India Company established an extensive trading network with the local Amerindian population for cotton, dyes and letter wood. As the settlements became more permanent, however, the Dutch established plantations to grow cotton, tobacco and sugar. During the 18th century there was a fall in the prices for cotton and tobacco, due to the competition from North America and so there was a gradual shift in Guiana towards the production of sugar. This was also a period of great political uncertainty. The colony was captured by the British in 1781, taken from them by the French in 1782 and then returned to the Dutch at the Treaty of Versailles in 1783. In 1796 a British expeditionary force from Barbados captured the colony again, but after a few years' rule it was once more returned to the Dutch through the Treaty of Amiens in 1802, only to be retaken by the British in 1803. Guiana was finally ceded to Britain in 1814 and remained a British colony until independence in 1966.

During the eighteen and nineteenth centuries the economy of the colony depended primarily on sugar production and this in turn was based on slavery. In 1826, for example, out of a total population of 100,836 about 90% were slaves who had been taken from West Africa. Of the remainder, 3.5% were white and 7.5% were either free coloured or free blacks. The abolition of slavery by the British parliament in 1834 caused widespread concern amongst the white planters. After their release from slavery, few of the former slaves wished to continue serving on the plantations for the wages being offered by the planters. Many hoped for an improvement in conditions and chose in the meantime to take up small-hold farming. Rather than raise wages to attract the former slaves the planters decided to import indentured labourers to work on the plantations. During the period 1835 to 1917, therefore, over 340,000 indentured labourers or contract immigrants were imported into the colony. Most of these people (70%) were of East Indian origin. The others came from the Madeira, Azore and Cape Verde Islands (9%), China (4%) and from Africa and other parts of the West Indies (17%) (Bacchus 1980).

It is important to note, however, that the East Indian population had been brought into Guiana by the white planters, specifically to replace black workers. When the colony was granted independence in 1966, over one hundred years later, Guianese society was still,

"polarized in political partisanship based on race" (Anderson pl, 1979) and even to the present day strong political tensions based on racial lines persist.

Britain ruled Guiana as a colony until the mid 1960's. There was a local legislature which had developed powers for limited local government but this was dominated by representatives of the local white and coloured (mixed) population. Universal adult sufferage was not introduced until 1947: only after this was there political consciousness amongst the masses (Bacchus 1980). The first major political party to appear from this new consciousness was the Peoples' Progressive Party (P.P.P.). It united the East Indian and African populations in the single aim of getting rid of the colonial system. It was led, however, by Dr. Cheddi Jagan an avowed Marxist. When the first election with universal adult sufferage was held in 1953, the P.P.P. party won eighteen of the twenty-four seats. The party took office in April 1953 under a modified form of Ministerial government, but after six months it was suspended by the British Government in order to prevent "Communist subversion" and a "dangerous crisis" in public order and economic affairs (Government of Great Britain 1953). This suspension set up internal conflicts in the P.P.P. party and the leadership split along racial lines, with the deputy leader, Forbes-Burnham leaving to form a new political party, later named the Peoples' National Congress (PNC). In the elections held in 1957 and in 1961, however, the PPP party won a large majority of the seats and held office until 1964. The country still had only internal self-government and both the British and

US governments were strongly opposed to the socialist policies of the PPP party. When the PNC party called a general strike this was financed openly by a number of US based labour organizations such as the American Institute of Free Labor Development (AIFLD) and the International Confederation of Free Trade Unions (ICFTU). Allegedly the strike was also financed secretly by the US Central Intelligence Agency (CIA) (Bacchus 1980). The general strike lasted eighty days and there was widespread economic and civil disturbance. As a result the British Government amended the constitution and changed the electoral system to bring in a system of proportional representation. Elections under the new constitution were held in December 1964. The PPP won the largest percentage of the vote (45.8%) but the PNC, who took 40.5%, were able to form a coalition government with the small conservative United Force party. The former British Attorney General Sam Silken has alleged that the PNC was brought to power, therefore,

"largely through American fear of Dr. Jagan's brand of Marxism" (Silken 1980). Under the new government Guiana was granted full independence in May 1966 and changed its name to the Amerindian spelling of Guyana.

Guyana Today

The PNC party under Forbes-Burnham has been in power since 1966 and the PPP, still under Dr. Jagan, has remained in opposition. One unforeseen development, however, was the socialist philosophy adopted by the PNC. Although it was seen by the British and the US governments as a counter to the Marxism of the PPP, the ruling PNC has adopted Marxism-Leninism as its ideological guide. The government has nationalized over 80% of the economy and in 1970 Guyana became a Socialist Co-operative Republic.

Guyana is in the unusual position of having a Marxist-Leninist government divided from a Marxist-Leninist opposition. The two parties have very different viewpoints, however, with the PNC regarding the opposition as merely "book socialists" who try to fit the Guyanese experience into a "preconceived framework", whereas they, while cherishing the principles of "international solidarity" still maintain "an independent view" (Chandsingh 1979).

The PNC draws its support mainly for the Afro-Guyanese sector of the population and the PPP from the Indo-Guyanese sector, and there is considerable bitterness between the two parties. After the death, in an explosion, of Dr. Walter Rodney, the leader of a new anti-government party, Silken (1980) wrote of Guyana being,

"a powder-keg verging upon a police state"

and a local Jesuit priest (Parrot 1981) writing in a missionary journal, has written of the,

"steady erosion of the democratic processes".

Whatever the criticism of their commitment to Marxist ideology, there is no doubt that the government has attempted to implement a number of socialist policies, and one of which was the right of every citizen to free education, and another was their nationalization of large sections of the economy.

The Economic Situation

Guyana's economy, like that of many third world countries, depends upon the production of primary commodities via mining and agriculture. The three key sources of wealth for the country lie in bauxite, sugar and rice. During the past decade, the performance of these three sectors of the economy has been disappointing. In a 1979 report for the Second World Bank Project in Guyana, Anderson (1979) noted that,

> "The long run performance of the agricultural section in particular is most disturbing with both 'sugar' and 'rice' showing virtually zero growth in real terms" (p. 35).

He also reported that there was "cause for concern" over the contraction of the mining industry, noting that there was over the 1960-1970 period a growth rate of 8% per annum, and over the 1970-1975 period a contraction of just over 2% per annum. The relative decline in these vital sectors of the economy along with the unprecedented rise in energy costs during the 1970's has placed considerable economic strain on the country. The newspaper, the Caribbean Contact (1981) reported the unemployment rate to be between 35% and 38% of the national labour force and that instead of the 5% economic growth planned for 1980 there was, in fact, an 8% "negative growth" with the country failing by at least 20%, to meet the production targets in all three key sectors of bauxite, sugar and rice.

One way in which the government has attempted to meet the economic crisis is by import substitution. To encourage this they have banned or restricted the importation of many goods and foodstuffs. The shortage of power and the regular electrical power cuts are constant sources of irritation to people in Guyana. They have led to much dissatisfaction and encouraged a high rate of emigration. But the emigration itself has contributed to the poor performance of the economy. Thus Anderson (1979) in his National Manpower Survey concluded that,

> "The impact of emigration on the dilution of overall labour force quality was found to be a significant barrier to raising productivity" (p. 19).

Education in Guyana

In the nineteenth century British Guiana was the classical colonial setting for colonists. A small group of whites controlled the entire colony. Slave (or later, indentured) labour produced the sugar for export to Europe. The only indigenous people, the Amerindians, had retreated into the forest and savannah, rarely emerging except to claim a bounty for returning escaped slaves. The planters prohibited any attempt by missionaries to educate the black population, for as the editor of the local paper at the time wrote,

> "While we have no desire to treat Africans with undue rigour ... we cannot be ignorant (of the fact) that our power over them can exist only so long as we are more highly educated and enlightened. We are few, they are many, and if their moral qualities or education be allowed to equal ours, it follows that the power of government or the right of government which is the same thing, will be determined by the amount of physical force" (Quoted in Daly 1966 p. 135).

In 1876, however, the British Government introduced compulsory elementary education for children between the ages of 5 and 12. One unusual aspect of the law was contained in Crdinance 14 which forbade the sugar estates from employing children of statutory school age unless they could produce a "certificate of proficiency" in reading, writing and elementary arithmetic or unless the children could attend an "efficient" school for two and a half hours a day (O'Jon 1979). Right from its introduction, therefore, education in Guyana was linked with certification.

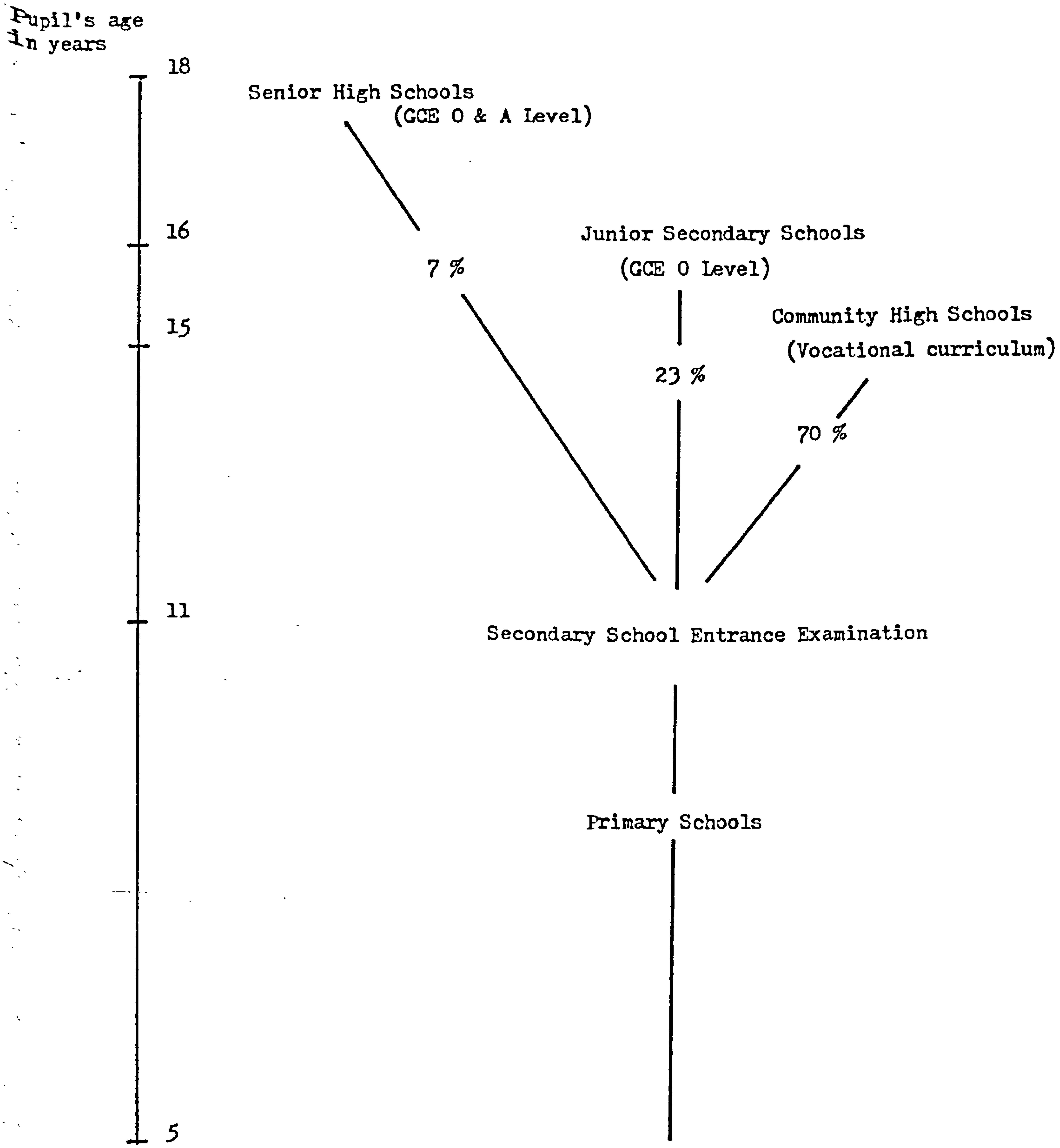
During the nineteenth century the East Indians were not assimilated into the colonial society and the colony consisted of three groups - the whites with English values, the coloured community which aspired to "white" status and the negro who were hoping to "move up" in society. All three groups accepted English standards and saw acceptance of these as being the gateway to social advancement. Education was the means to achieve the standards - education based on English values. Any attempt to make the curriculum either vocational in nature or relevant to local needs was resisted as being an attempt to suppress social mobility (O'Jon 1979). The importance of certification and the need for the curriculum to be related to "overseas" values are still fundamental issues in Guyana today, and are not issues that are unique to Guyana.

Following internal self-government in 1961, and independence in 1966, there was a rapid expansion of the education system with enrolment in secondary schools, for example, rising from 14,721 in 1964 to 21,248 in 1968, and to 30,967 in 1973. The new seccndary schools built during this time, however, had less academic status than the traditional "senior" high schools which had existed from pre-independence days but even with their introduction still only a minority of pupils could enter secondary school.

At eleven years of age the school population in Guyana is divided into three parts (see Fig.31 below). Using the results of the national Secondary Schools Entrance Examination (SSEE), the "top" 7% of pupils are selected for

Figure 3.1

The School System in Guyana



the elite senior high schools. The next 20 to 25% are selected for the junior secondaries and finally the "bottom" 70% are assigned either to all-age primary schools or to community high schools. Technically no-one "fails" the examination but the community high schools (CHS) are designed for "average" and "below average ability" pupils and they do not follow academic programmes such as the General Certificate of Education. The goal for most parents in Guyana is to get their children into one of the senior high schools. One reason for this can be seen from the results of the GCE examinations for schools in Guyana. Thus in 1972, while 83% of the candidates from the five elite senior high schools passed in English Language, only 18% of those from junior secondaries passed. A similar pattern exists in almost all subjects, for example, in science subjects 63% of the elite school candidates passed compared with only 22% from the junior secondaries (Bacchus 1980). Up to 1976 many primary and secondary schools were independent, fee-paying institutions controlled mainly by religious bodies such as the Christian churches. In September 1976, however, all schools were taken over by the government and since then the Ministry of Education has been striving to implement the government's principle that,

> "Every citizen will the right to free education,nursery to university as well as at non-formal places where opportunities are provided for education and training" (PNC 1978).

The government looks upon education as being "pivotal" for success in their "transition to socialism" (Chandsingh 1979). Thus the national slogan for 1976 was,

> "Education makes a nation".

The school curriculum is seen, therefore, as,

> "a means of promoting national development, as a means of innovation and transformation, as a means of promoting competencies to meet the changing needs of society" (ibid p. 28).

Positive efforts have been made by the Ministry of Education to implement the government's socialist and egalitarian policies: there are no school or university fees, text books are provided free to pupils and pupils are to be provided with free school uniforms. The economic situation, however, has considerably hindered the Ministry's efforts.

The Situation in Schools

Primary Schools

Primary schools are overcrowded. The furniture, equipment and sanitary facilities are described by the district education officers as being "grossly inadequate" (Minutes 1978) and over 50% of teachers are untrained and poorly qualified (Planning Unit 1975). In many schools the children are taught simply through repetition and rote learning methods. Some idea of the atmosphere in Guyanese primary schools is conveyed in the reports of the observvational studies carried out by the Curriculum Development Unit of the Ministry. The extract below gives a physical description of a primary school in Georgetown,

> "School is located in rather large yard. Structure is set well in from street and occupies only a small portion of property. Classes visited are in bottom of two story building. One large unpartitioned space had between eight and ten classes. Groups averaged 35 to 50 students with one teacher to a group ... Furnishings included a chair for the teachers ... a chalk board of sorts ... and benches for about 95% of the pupils ... A small number of children were without seats. They stood for most of the time but on occasions sat on the floor ..."

The observer goes on to describe the general chaos inside the building with teachers appearing "amazingly calm (almost detached) in spite of the general noise level". From the author's own experience the extract provides an accurate reflection of conditions in many Guyanese primary schools. They are overcrowded and have inadequate facilities and poorly qualified teaching staff.

Community High Schools

One major development within the education system in Guyana was the launching, in the mid-seventies, of the community high school programme (CHS). Prior to 1974, children who were unable to obtain a place in either the senior high or junior secondary schools remained in their primary schools, where they were placed in the all-age department of the school. In 1974 the Ministry of Education opened two pilot schools which were designated as community high schools; a further twenty-six such schools were opened between 1976 and 1978 (Cox 1979). These schools were,

> "designed to cater for the development of the potential existing in all those children who at the age of 11+ years were not allocated to any of the traditional secondary schools which provide primarily an academic programme for 'white collar' workers" (Mingo 1977).

The aim of the community high school programme is to produce "a better quality of citizen" and to train students "for life rather than for examinations" (Curriculum Guide 1976). Community high schools bear some relationship to the secondary modern schools developed in England in the 1950's though the programme has also been heavily influenced by more recent curriculum development in Tanzania (Hinzen and Hundsdorfer 1979). Their primary purpose is to launch their pupils on a programme of continuing or lifelong education. The knowledge and skills taught in these schools are those which are relevant to the pupil's future needs in his community. The programme aims to provide young people with organizing skills for employment and self-employment in accordance with their abilities and interests and the observed needs of the particular community. The major thrust of the CHS Programme, therefore, is towards the acquisition of the relevant life skills needed to live and work in the Guyanese community.

In common with all other programmes of the Ministry of Education and in spite of its obvious significance for the government's declared aims, the CHS programme has been affected by shortages of materials and personnel. The programme is seeking to provide secondary education for approximately 70% of children in the eleven to fifteen age group. Until 1976 these children had received only primary education. The provision of secondary education requires a vast amount of expenditure: buildings must be converted or constructed, materials and equipment purchased and large numbers of specialist teachers trained. There is an emphasis in the CHS programme on agriculture and technology, and as part of this emphasis a major component of the school curriculum is the study of science. Unfortunately, even before the first CHS school was opened (in 1974) there was already a severe shortage of science teachers in Guyana.

Senior High Schools

There are eight senior high schools: five in Georgetown, two in the other urban areas (Linden and New Amsterdam) and one residential rural school in Essequibo. All schools are now co-educational but prior to 1976, there were two traditionally "good" schools for boys - the government Queens College and the Roman Catholic St. Stanislaus, and three "good" girls' schools - Bishops, St. Josephs and St. Roses. Successful students from the top government schools could look forward to a career in law, or medicine, or government administration. Successful students from the Roman Catholic schools traditionally entered business. Writing about senior high schools in the Caribbean, Adey reports that,

> "The atmosphere in High Schools in unashamedly academic. Morale is high since teachers are aware that they have the most able pupils, the support of parents, good equipment and a long standing tradition of external examination successes" (ibid p. 107 , 1979).

This was the situation in the Guyanese senior high schools until 1976. Since then, however, the economic recession has meant that the schools have been unable to replace materials and equipment and since teaching appointments are now made via the Teacher's Service Commission (TSC) the schools have also found it more difficult to obtain the teachers they wish to have. These schools continue to serve the top ability band of pupils, however, and are still considered by both parents and government as providing the best education for pupils.

Junior Secondary Schools

Conditions in junior secondary schools are much more difficult than in the senior highs. Chandsingh (1979) the present Minister of Higher Education in a 1979 speech on education, noted that,

> "Inadequate accommodation poses a problem in many schools together with furnishings, facilities and teachers - particularly the inadequacy of trained teachers in science and industrial arts" (p. 27).

The junior secondaries also have the problem that they are expected to provide their pupils with an academic curriculum leading to London GCE O Level certification. The most able pupils, however, have been "creamed-off" for the senior high schools and the teachers know of the junior secondaries history of low examination pass rates. The teachers, therefore, do not have high expectations for their pupils' examination or employment prospects and as Adey (1979) reports, both teachers and pupils have a "tendency to feel second-rate".

The major problems facing the education system in Guyana at present are: overcrowded classrooms, inadequate accommodation, shortage of equipment, and serious shortages of trained teachers - particularly in specialist subject areas such as in science and in technical studies.

Science Education

In Guyana science education is asked to perform a dual role. In the first instance it is seen as providing the input into higher education and hence as holding the "key" to the output of scientific and technological personnel (Ponamperuma 1976). There is also an awareness, however, that science teaching must help to develop "a sound science background" throughout the population (Impey 1975). Perry (1977) has characterized this in terms of the short term and long term goals. The immediate and most apparent goal, he suggests, is for science education to meet the present and foreseeable national manpower needs. The urgency of these needs he argues will "to a large measure dictate our endeavours to improve science education" in the immediate future. Short term economic benefits, he argues, should not be allowed, however, to prevent,

> "the implantation of science in the cultural, social and economic life of the nation".

To emphasize scientific training for vocational purposes he feels is "dangerous" because it will divert attention from the more crucial political and social implications. In the long term, both economic and social development, he suggests, will require a,

> "climate of popular understanding and acceptance of science and technology".

Although these two diverse goals of science education are recognized by educationalists they have not been reconciled within the school curriculum. At school level, science is still seen almost totally in terms of its vocational manpower role.

School Science Curricula

Science in Primary Schools

Science is an integral part of the curriculum in primary schools and since 1979 science-based questions have been included in the 11+ Secondary Schools Examination. There are no specialist science teachers in primary schools and ordinary class teachers are expected to teach the subject as part of their normal duties. Over 53% of primary teachers, however, are untrained and even the trained teachers have little, if any, science background. In many schools, therefore, the science lesson is reduced to a period in which the children learn a number of facts about animals and plants, facts which they then have to repeat in an examination (Impey 1975). A new programme is at present being developed. Pilot work started on the Primary Science Education Programme (PSEG) in 1975 and from 1977 onwards the programme has been gradually introduced into the schools (PSEG 1977). This programme places much less emphasis on factual knowledge than the "Scope and Sequence" programme which it is replacing. PSEG is seeking instead to develop pupils' values and attitudes towards science while at the same time fostering their ability to "think clearly" and develop skills for finding and processing information (ibid). In-service training sessions are run by the Ministry of Education to help primary teachers to understand and cope with the new materials.

Community High School Science

The community high school science programme has caused some concern in the Ministry of Education (Monize 1978). There is a severe shortage of teachers to teach it. In 1978, for example, of the 35 people teaching science in community high schools, only 11 had received teacher training: the other 24 (69%) were untrained with only GCE O level qualifications. Few community high schools have laboratory facilities. The Materials and Facilities Sub-Committee (1977) of the Science Education Committee, after reviewing conditions in community high schools, reported that laboratory facilities were "inadequate". The curriculum that is being used is merely a temporary one until further development work can be undertaken (Monize 1977). This temporary programme is based on the Secondary Department's Science Programme (SDSP) which was originally developed at the University of Guyana for use in the upper forms of the all-age schools (Impey 1973). Since the pupils from these forms now constitute the population of the CHS schools the programme was considered by the Ministry to be appropriate. The CHS programme, however, is a four year course and SDSP was devised to last for only three years. A second problem is that the CHS curriculum is meant to be strongly vocational in nature, while SDSP, however, was devised as a general science course and does not stress vocational aspects of science. In an attempt to make the SDSP programme more suitable for CHS schools, the Science Unit of the Ministry of Education prepared a one year science programme to be used at the end of SDSP. This "Year Four" programme is strongly vocationally oriented with the main aim being to provide the pupils with "concretised science experiences" which will help them to,

"realize the relevance of science to society". (Monize 1977).

Senior High and Junior Secondary Science

The West Indian Science Curriculum (WISC) is followed by all pupils in forms one to three of both the senior high and junior secondary schools. As described in Chapter One, the WISC programme was developed from the Scottish Integrated Science Project. It was piloted throughout the Caribbean with a number of the pilot schools being in Guyana. In a recent Ph.D. study on the cognitive development of children following WISC, Adey (1979) reported that most of the WISC programme was beyond the range of the target population. He recommended that,

> "An immediate effort should be made to modify the existing West Indian Science Curriculum to make it more appropriate for use with average and below average ability pupils" (p. 180).

Even for the slightly higher than average ability pupils in the junior secondary schools in Guyana, the WISC programme is difficult. From 1976 to 1979 it was part of the author's duties to monitor the implementation of WISC in Guyana and in an evaluation study undertaken in conjunction with the local science education officer a number of problems were identified (Brophy and Dalgety 1981). Classrooms were overcrowded, having an average 40 pupils in each class; most pupils had three to four periods of science each week but on average only 1.5 of these were taken in a laboratory. There was a serious shortage of trained teachers and few schools had the equipment needed to teach the programme. Using the WISC Pupil's Worksheets the authors identified fifteen items which were essential for carrying out the practical activities of the programme. Only three of the thirty-nine schools involved in the survey had all the items of equipment, nineteen had less than nine of the items. For example, only 10 (26%) of the schools had bicarbonate indicator, yet the Teacher's Guide reported that this chemical "plays a vital role throughout the unit" and could not be replaced by other chemicals such as lime water.

Similarly, Millon's reagent was not available in 23 (59%) of the schools. The teachers reported that many of the concepts in the programme were too difficult, particularly the mathematical concepts in year one. These involved the concepts of density, pulse rates and graphs. They also criticized the heavy reliance in the programme on equipment that was unavailable in Guyanese schools. WISC was designed as a laboratory-based pupil-centred programme. Because of overcrowding, lack of equipment and shortage of trained teachers, in many schools in Guyana the programme has become a,

> "teacher-centred, text-book oriented course with the minor benefit that it used local examples" (ibid).

In their fourth and fifth year at senior high school or junior secondary school, pupils in Guyana follow the separate science syllabuses of the London Overseas General Certificate of Education Board. For these programmes there is also a lack of equipment and shortage of teachers. The courses are generally text-book oriented (UNESCO 1963) with teachers presenting the pupils with prescribed factual knowledge (Impey 1973). GCE pass rates are low (see Table 3.1 below). Over the six year period 1973 to 1978, there was a 28% pass rate in Biology, a 40% pass rate in Chemistry and a 35% pass rate in Physics.

Table 3.1

G.C.E. O Level Results for Guyana 1973 - 1978 (June)

Year	Biology		Chemistry		Physics	
	entered	% pass	entered	% pass	entered	% pass
1973	4063	25	1087	45	1124	32
1974	3270	34	1019	51	1108	40
1975	3383	34	1204	45	1194	39
1976	3563	36	1488	39	1407	39
1977	4067	21	1792	32	1569	28
1978	4317	23	1757	36	1779	32

Besides shortage of equipment and teachers the GCE O level pass rates are also affected by the examination entry policies of many head teachers. Year after year schools enter hundreds of candidates for science subjects although the staff are aware that only a handful of the pupils will be able to achieve "pass" grades (Master 1978). The Science Unit of the Ministry have tried to persuade head teachers to use more stringent criteria in selecting pupils for GCE entry but have met with very little success (ibid, Minutes 1977, and Science Education in Guyana 1979).

GCE O level results for Guyana for the 1973 to 1978 period show a negative correlation between the percentage of pupils passing a GCE science subject and the number entering for the subject. For Biology there is a correlation of $r = -.92$ and for Chemistry $r = -.95$. In both cases the relationship is significant at the 5% level. For Physics the relationship is also negative ($r = -.54$), the result, however, is not significant at the 5% level.

Using the technique outlined by Dudley (1977) graphs were drawn to show the regression line between the number of pupils entering and the percentage passing GCE in each of the three science subjects. These are shown in Appendix 1. From the information in the graphs we can suggest that, under present conditions, to maintain a pass rate of over 30% in Biology the Ministry should limit the numbers entering for GCE Biology to below 3,700. Similarly, if facilities, equipment and teaching staff can not be improved then the Ministry can best maintain a pass rate of 35% or more in Chemistry by limiting the number of pupils entered for O level Chemistry to 1780.

In an effort to overcome some of the problems encountered with the GCE programme, the Ministry of Education is co-operating with the Caribbean Examinations Council (CXC) in the development of a locally (Caribbean) based examinations system. Amongst the first syllabuses developed was the CXC Integrated Science Project. This was launched as a pilot project in 1977 in a number of schools throughout the Caribbean region including some in Guyana. Eventually it is hoped to replace all London GCE O level examinations with locally developed examinations. There have been difficulties, however, in getting parents and pupils to accept the status of the local examinations. This, along with the reluctance of "single subject" science teachers to teach integrated science, has caused some problems in the pilot study (Brophy 1980). In-service and vacation workshops for teachers, followed by parent-teacher meetings have helped, however, to reduce the problems.

Pupils who achieve a high standard in either GCE O level or CXC may be accepted onto the GCE A level courses of the senior high schools. Advanced level sciences are taught in all the senior highs, although even in these schools there are shortages of qualified teachers. In 1977, for example, the only person who could be recruited to teach A level Biology at the senior high school in Essequibo was an eighteen-year old who had failed the examination the previous year. The problem is not so severe for the other areas but in a number of schools the teaching of A level science has in the past few years depended upon the availability of expatriate staff. Relatively few students are accepted onto the A level programmes, an average of 86 per year for Biology, 116 for Chemistry and 129 for Physics. Pass rates for A level are higher than for O level, with each year an average of 40 (46%) students passing Biology and 60 to 70 (50% to 55%) passing in each of the other two subjects.

The main problems facing science education in Guyana are overcrowded classrooms, lack of facilities, materials and equipment and in some cases inappropriate teaching programmes. The one problem which is consistently encountered at all levels, however, is the shortage of qualified teachers.

Supply of Science Teachers

There is a general shortage of trained teachers in secondary schools in Guyana. The Digest of Educational Statistics (1974) presents figures on qualifications of teachers in secondary schools. Only 42% of all secondary teachers had received teacher training and 44% were untrained non-graduates, that is, they had only GCE O or A level qualifications.

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Table 3.2

Qualifications of Teachers in Secondary Schools in Guyana 1974

	Trained Grads.	Untrained Grads.	Trained Non-grads.	Untrained Non-grads.	Total Trained
All teachers	192 (17%)	158 (14%)	278 (25%)	491 (44%)	470 (42%)
Science Teachers	21 (11%)	32 (17%)	40 (21%)	94 (50%)	61 (33%)

In the same year (1974) the Faculty of Education at the University of Guyana carried out a survey of the qualifications of science teachers in the same secondary schools. These results are also presented in Table 3.2. Comparing the two sets of data, we find that amongst secondary teachers generally 58% are untrained but for science teachers the figure is 67%. 50% of the science teachers had only O or A level qualifications as compared with 41% of the non-science teachers. In 1974 while there was a general shortage of teachers, the problem was most acute therefore in science education. Surveys carried out in 1977 and 1978 by the author showed that the situation had deteriorated from 1974 (see Table 3.3 below).

Table 3.3

Qualifications of Science Teachers in Guyana 1974, '77 and '78

	1974	1977	1978
Number of schools	40	50	53
Trained graduates	21	20	21
Untrained graduates	32	77	50
Trained non-graduates	40	25	33
Untrained, with GCE A level	58	71	38
Untrained, with GCE O level	36	91	138
Total	187	284	280
Percentage untrained	67	84	81

(Brophy and Dalgety 1980)

In 1977, for example, the percentage of untrained science teachers rose to 84%, and was 81% in 1978. Of the people teaching science in 1978, 63% had only GCE qualifications.

As well as there being a shortage of science teachers there was also the problem of the high rate of teacher turnover. From the original 1977 and 1978 survey data the turnover of science teachers was calculated for 32 secondary schools. In the 32 schools there was a turnover of 52% of science teachers. The 1977 survey was carried out in January, while the 1978 survey was taken in May. The figure represents the turnover, therefore, for a sixteen month period, but one in which there was only one long vacation (i.e. the traditional time for teacher loss). The data suggests that for a twelve month period there would be a 39% turnover of science teachers. The highest turnover rate was found amongst the untrained O and A level staff, the lowest rate was for the group of trained graduates. In a separate survey, the author gathered data from head teachers on the reasons science teachers gave for leaving their posts during the academic year 1977-78. Information was collected on 57 teachers. Twenty-one (37%) had reported that they were leaving either to attend university or training college or to take up another teaching appointment. Eight of the teachers (14%) had said that they were leaving to work in industry but the largest number, 28 (49%) reported that they were leaving teaching in order to emigrate. Emigration is causing a substantial dilution of the science teaching force, as it is, according to Anderson (1979), for skilled manpower generally in Guyana. During the past decade there have been repeated calls for a positive effort to be made to overcome the science teacher shortage. The Science Teachers' Association (STAG) 1973) reported to the Ministry that the shortage,

> "militates strongly against any significant overall improvement in our school science teaching".

In a memorandum to the National Science Research Council, Millar (1976) noted that the lack of qualified scientific and technical personnel was the "bottleneck" to Guyana's rapid industrialization and that this manpower shortage was in itself due to a shortage of qualified science teachers.

Prior to 1977 there were three routes by which science teachers could receive training. Science graduates took a one year part-time programme for the Diploma in Education at the University of Guyana. Trained teachers with a science background took the four year part-time programme of the bachelor of Education degree, and untrained teachers took the three year full-time programme of the Lilian Dewar College of Education. The output from the three routes is summarized in Table 3.4 below.

Table 3.4

Number of Science Teachers Graduating From Institutions in Guyana 1971-79

Year	College of Education	University	
		B.Ed.	Dip.Ed.
1971	6	-	2
1972	0	-	6
1973	0	-	1
1974	0	-	9
1975	5	-	9
1976	2	-	5
1977	6	-	3
1978	13	2	3
1979	18	2	9
Total	50	4	47

(Brophy and Dalgety 1980)

These low figures, however, do not actually represent inputs into the secondary school system. For example, the two B.Ed. graduates in 1978 were trained teachers, and of the three Diploma in Education graduates, two were lecturers at the university.

The 1970's had been a period of intensive curriculum development in science. In 1976 the West Indian Science Curriculum (WISC) had been introduced into the secondary schools, and the Secondary Departments' Science Programme (SDSP) into the community high schools. In 1977 a pilot study of the Caribbean Examinations Council (CXC) Integrated Science Project was also launched though for only a few schools. The majority of schools, however, were short of the materials and equipment needed to teach these curricula and depended upon untrained teachers - often school leavers waiting to enter college or university. As might be expected, therefore, frequent difficulties were encountered in implementing these new science curricula (Brophy 1980, Brophy and Dalgety 1981 and Farley 1980).

Coupled with the introduction of the new curricula a number of events occurred which both highlighted the urgent need to launch a programme to help alleviate the shortage of science teachers and also provided the opportunity for this to be done.

1. Reports from UNESCO and from Commonwealth Secretariat consultants were published showing that there were severe shortages of scientific and technological personnel in Guyana. Ponnamperuma (1975), a consultant from the Commonwealth Fund for Technical Co-operation, advised that,

   "Science at school level provides the input to higher education and training institutions and hence in fact holds the key to the output of scientific and technological personnel",

   and Whitehead (1976), the UNESCO consultant warned that,

   "The science and technical output of the educated system will not increase until more teachers with appropriate qualifications are available".

2. With the abolition of private education in September 1976 the Ministry of Education found that, while some of the schools which had been taken over had high standards and good facilities, many had been merely commercial "profit-making" institutions with poor facilities and staffed predominantly by unqualified teachers. Science had a very low priority in such schools. In one Georgetown school, for example, the physics laboratory was being used as a bicycle shed, while in a New Amsterdam

secondary school the GCE O level Biology class was being taught by an untrained teacher who, at that time, had not sat the O level himself.

3. Prior to 1976 the Science Unit of the Ministry of Education had been staffed by two officers. In September of that year this was increased to four officers, one of whom was appointed through the UK Ministry of Overseas Development specifically to supervise science teacher education.

4. The takeover of private education had resulted in additional funds being made available for the improvement of science teaching. Unfortunately, the funds could not be used to purchase equipment from abroad so that an in-service teacher training programme was one of the few ways in which such funds could be spent beneficially.

By December 1976 the Science Unit recommended to the Science Education Committee of the Ministry of Education that an emergency programme for training science teachers should be launched as soon as possible. The recommendation was accepted by the committee but no decision was made at that time as to what form the new programme should take.

Emergence of The Emergency Science Programme

At first the solution to the teacher shortage problem seemed to require simply an increase in the numbers of students being trained at the secondary college of education, but this was impractical. Not enough students were being attracted to the existing training programme to fill places already available. The college was housed in a very old building and did not have adequate laboratory facilities even for its current intake and perhaps most important of all, the college was in the capital while the most severe shortages were in the rural areas.

Two main constraints on the proposed new programme, therefore, were:

(a) that it should be able to train science teachers where they were needed, namely in their own urban, rural and interior schools and,

(b) the teachers must be able to continue teaching while being trained.

There are few training strategies which allow for both these constraints. The two which have been tried successfully elsewhere are:

(a) in-service "sandwich" programmes, and

(b) in-service distance-teaching programmes.

There are a number of disadvantages with sandwich programmes. It is expensive to bring students to a central college or training institution and pay for their upkeep for lengthy vacation workshops. Many teachers are unable to be away from their families for lengthy periods, particularly if they are mothers with young children or if they supplement their salaries by farming or small holding , as many male teachers do in Guyana. Sandwich programmes require relatively large numbers of personnel during their relatively long training sessions. For instance, the sandwich programme of Ahmado Bello University in Nigeria employed twenty-seven staff to train forty-five students during their 1973 vacation course (Hawes and Ozigi 1975). The programme proposed for Guyana would depend upon the assistance of personnel from the University of Guyana but the University's own B.Ed. programme was conducted during the long vacation and so the university personnel would be able to give only minimal assistance at that time. Taking into account the various problems that would be faced by either a college-based or a sandwich programme, the Science Education Programme Committee of the Ministry decided that the proposed Emergency Science Programme (ESP) should adopt a training strategy based on distance-teaching methods.

In March 1977 a formal proposal to launch the programme was put to the Board of Examiners of the Ministry of Education. They accepted it and gave permission for the programme to begin. In April 1977 ESP accepted its first intake of forty-six students. ESP seeks to provide its students with content in science, education, mathematics, English and geography and with a course of educational training. The structure of the ESP programme is discussed in detail in Chapter 5: it is a three year in-service course and, as described in Chapter 2, uses a 4d distance-teaching approach involving correspondence units, media materials, face-to-face tutorial sessions and vacation workshops.

To date there have been three intakes of students. Twenty-nine, from the first (1977) intake have successfully completed the programme and were awarded trained teachers certificates by the Board of Examiners in 1980. A further twenty students - some from the 1977 intake but mostly from the 1978 intake - are due to complete their training in 1981. A third intake began the programme in April 1981. It is expected that over 80% of the combined 1977 and 1978 intakes will gain teaching certificates by the end of 1981. ESP, therefore, will have increased substantially the number of trained science teachers in Guyana, indeed doubling the number teaching science in 1977. In the four years since it began (1977 - 1981) the ESP programme will have produced the same number of trained science teachers as did the College of Education in the nine year period 1971 to 1979.

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Chapter Four

The Evaluation Strategy

One of the problems in evaluating a curriculum development such as the Emergency Science Programme is choosing a technique or strategy from amongst the many models that have been proposed. Indeed, Hawkins (1981), Lewey (1977) and Harlen (1976) have all reported that there is a "multiplicity" and "proliferation " of evaluation models. Lewey suggests, however, that although there is this multiplicity of models, three approaches have become dominant in the field of evaluation. These he notes as,

(a) The Achievement of Desired Outcome Approach,

(b) The Merit of Entity Approach, and

(c) The Decision-oriented Approach.

(a) In the Achievement of Desired Outcomes Approach the evaluator is interested in the extent to which students are developing in the desired way and so this Approach entails the assessment of the degree to which the stated goals of objectives of a programme are congruent with what is achieved. This Approach is sometimes referred to, therefore, as a "Congruence Evaluation" (Stufflebeam 1971, Lefere 1981).

(b) The Merit of Entity Approach defines evaluation as the "examination" of a programme as a given entity. Scriven (1967) has criticized Outcome or "Goal-based" evaluation as implicity accepting "tunnel-vision" since it only allows for the evaluation of "intended" outcomes. He suggests that the evaluator's job should be,

> "to look out for the effects the experimenter (or producer) did not expect or notice" (Scriven 1977),

and proposed that curricula should be evaluated in terms of the "actual" rather than intended effects (Scriven 1971, 1972). Stake (1969) has also emphasised the need for evaluation to look at the overall effect of a programme and he noted the importance of recording the merits and shortcomings as seen by "persons from divergent viewpoints".

(c) A Decision-making Approach to evaluation assumes that evaluation is worthwhile only if its results affect future actions. Evaluation is seen, therefore, as being,

> "the process of delineating, obtaining and providing useful information for judging decision alternatives" (Stufflebeam 1971).

Alkin (1970) refers to evaluation as being a process of ascertaining the "decision areas of concern" and Stake (1972) has suggested that the "first duty" of an evaluator is to offer the "client" a "comprehensive portrayal" of the programme.

As well as discussing different approaches, Lewey has specified the different criteria which can be used in these approaches and the different techniques which can be used to collect data. He has also identified a number of roles which an evaluation study can play. Thirty different evaluation models have been identified (Hawkridge 1978). As Harlen (1976) reports, however, present models "lack general applicability" and frequently do not fit evaluations of materials or situations which are different from those for which they were developed. The result is that most evaluation studies do not fully subscribe to any single evaluation theory or model (Lewey 1977).

The evaluation of ESP did not rigidly follow any single theory or model but utilized elements from a variety of sources. In developing the evaluation strategy, special attention was paid to the need to maintain as Dave (1980) suggests "a proper balance" between quick and qualitative reviews and more quantitative and sophisticated procedures. The main aim was that the strategy should use what Stake (1967) has called a "panoramic viewfinder" rather than a microscope, since a narrow "microscopic" approach could provide accurate and reliable measurements of the "irrelevant". One way of obtaining a panoramic view of a project is for the evaluation to use a "Pluralistic" strategy in which a variety of disciplines and techniques - both qualitative and quantitative - are employed (McCabe 1979). Thus while each source may provide only partial evidence about the programme, the combination will provide an accurate and reliable perspective.

The ESP Evaluation Strategy

In providing a description of an evaluation one of the most commonly used procedures is to categorize the evaluation as being either formative or summative in nature (Scriven 1967). Often, however, it is difficult to designate an evaluation as being either wholly formative or summative. Harlen (1975), for example, reports that,

> "Formative evaluation often produces information useful in a summative context, whilst the summative evaluation of the products of one curriculum project could be the first step in the formative evaluation of the next wave of curriculum development in that field" (p. 14).

Hawkins (1981) comments that since evaluation studies are frequently concerned with one "iteration" of an educational programme, what will be a summative evaluation of one iteration will be formative for those following it. The evaluation of ESP was neither wholly summative nor wholly formative the programme has been completed by one intake of students, and another intake is continuing. The evaluation, therefore, was summative with regard to the first intake but formative with regard to later students.

Of the three "Approaches" listed by Lewey, the ESP evaluation came closest to an Achievement of Desired Outcomes Approach. In order, however, to obtain a more comprehensive view of the "Entity" of the programme, contexual and intrinsic elements were built into the evaluation strategy. The ESP programme was evaluated in relation to its "Outcomes" and in terms of the way it met or "fitted" desired standards (Lewey 1977). Data was collected using a number of different measures of student performance and also by asking the opinion of experts and consumers. The evaluation of ESP, therefore, had two main roles. It sought:

1. to identify flaws in the programme so that these could be modified,

2. to provided information about the ESP programme itself, which would be of use to decision-makers in Guyana and other third world countries, as to the merits, advantages and limitations of the distance-teaching approach used by ESP for training science teachers.

West (1975) has recommended that a full summative evaluation should include intrinsic, contextual and performance evaluations. In the ESP evaluation close attention was paid to the way that West has suggested that such an approach can be implemented. He was concerned, however, with proposing a model for school-based evaluation: the ESP evaluation was concerned with a distance-teaching in-service teacher education programme and so the way the strategy was implemented was different from that suggested by West. The strategy used, however, involved the same three elements, namely:

(a) An Intrinsic Evaluation,

(b) A Contextual Evaluation, and

(c) A Performance Evaluation.

Intrinsic Evaluation

Various techniques for carrying out the intrinsic evaluation of curriculum projects have been described by Steadman (1976), Eraut et al (1975) and West (1975). As used in the evaluation of the Inter-university Biology Teaching Project, the Sixth Form Mathematics Project and the Nuffield Advanced Biological Science Project, intrinsic evaluation centres on the general appraisal of curriculum plans and materials (Eraut 1976, Steadman 1976). The method is concerned essentially with examining the project in terms of its stated objectives. In some forms of intrinsic evaluation an analysis is made of the extent to which the materials are likely to promote the programme's aims and objectives. Up to the mid-seventies it was usual to give the materials to a group of experienced educators to assess how closely they matched the aims and objectives of the programme, but since then it has become more common to structure the analysis. The content analysis method described by

Eraut et al (1975) and West (1975) has been used for the evaluation of ESP. This analysis was based on the technique designed by Easley et al (1974) specifically for analysing science curriculum materials.

In addition to the content analysis a second method of intrinsic evaluation was employed. Consumer reports which ESP teachers had written about the first eight correspondence units were analysed using a "keyword" technique similar to that suggested by Cannon (Steadman 1976). Both content analysis and consumer reports were used, therefore, in the intrinsic evaluation of ESP. These are described in detail in Chapter 5 and summarized in Diagram 4.1 below.

The Contextual Evaluation

It is recognized that there is a risk in intrinsic evaluation of confining the study to just stated aims and objectives while the curriculum might have effects in a wider context. Indeed, contextual evaluation has been advocated by Simmons (1977), Eisner (1977), Parlett and Hamilton (1977), West (1975) and Dave (1980), with West describing its purpose as identifying the "actual" effects of the innovation. The technique by which the information is gained is by interview, especially of the participants. Parlett and Hamilton (1977) suggests it is crucial to discover the views of participants. The contextual evaluation of ESP, therefore, involved collecting the views of participants and this was done mainly by interviews and by group discussions. There were, however, many levels of participation, and all levels were interviewed in order to gain a full contextual evaluation. Members of each of the following levels were interviewed:

1. Senior officials of the Ministry of Education,
2. Personnel from the Science Unit of the Ministry,
3. ESP Course Writers,
4. ESP Local Tutors, and
5. ESP Students.

Moreover, since Stake (1967) recommended that the evaluator should report opinions not only of those in favour of the project but also of those who were not, interviews were conducted with individuals in these categories at level 1 above and at level 5. To this end interviews were conducted with Ministry personnel who were against ESP and those who were for the programme, and with successful and unsuccessful students. The full details of the contextual evaluation of ESP are described in Chapter 6, and an outline of the techniques used is given in Diagram 4.1 below.

Performance Evaluation

Performance or outcome evaluation is concerned with assessing the extent to which the intended outcomes of a programme are achieved, and the level of interference from unintended outcomes. This can be done by assessing the performance of those who have completed the programme, for example, by their teaching performance grades or final examination marks. However, there are two methods of performance evaluation, norm-referenced and criterion-referenced and both were used in the performance evaluation of ESP.

Norm-referenced Evaluation

The ESP programme was designed specifically to train teachers to teach science in secondary and community high schools in Guyana. It was introduced to supplement the output of science teachers from the Lilian Dewar College of Education. Science teachers trained via the College and the ESP programmes are awarded equivalent teaching certificates by the Board of Examiners of the Ministry of Education and are expected to teach the same science programme in the same types of school. For this reason the performance of teachers trained via ESP was compared with the performance of those trained via the college programme. The performance of the 29 ESP teachers who qualified for teaching certificates in 1980 was compared with that of the 22 who qualified from the College in the same year. The performance of the two sets of teachers was compared from as many different perspectives as possible. This included supervisors' assessments of teaching performance, head teachers' opinions, teachers' self-assessments and pupils' opinions. Their performance was compared, therefore, using assessments made by those involved in their training, those directly responsible for their job performance, their own opinion of their teaching ability and their pupils' perception of it.

In order to qualify for teaching certificates both groups of students had been observed teaching and their teaching ability assessed by the same panel of Ministry supervisors. The official teaching grades awarded by these supervisors formed the basis of the comparison of the teaching performance of the two sets of teachers. In addition, a self-image questionnaire was designed specifically for this performance evaluation. In it the teachers were asked to rate their teaching performance on 36 skills which Guyanese science educators had rated as being important for science teaching in Guyana. This questionnaire was sent to all the teachers in both the ESP and College groups.

There are over 60 secondary and almost 30 community high schools in Guyana. There were, however, only six schools in which both an ESP and a Lilian Dewar College (LDC) science teacher taught. Interviews were conducted with the head teachers in each of these six schools, and a comparison made of the head's opinions of the individual ESP and LDC teachers. Also pupils' opinions were collected from these same six schools. Pupils, as far as possible from equivalent classes - one taught by the ESP teacher and the other by the college teacher - were asked to write paragraphs describing the way they were taught science. The pupils' perceptions of ESP and college trained teachers were then compared. Information for norm-referenced evaluation was collected, therefore, from a number of different sources. The norm-referenced aspect of the evaluation is described in detail in Chapter 8 and outlined in summary form in Diagram 4.1.

The Criterion-referenced Evaluation

Comparing the performances of the ESP teachers with those of college trained teachers meant that these would be evaluated relative to one another, and as such this is inadequate unless it can also be shown that the teaching is in itself adequate or satisfactory. For a complete evaluation of the Emergency Science Programme it was important, therefore, to determine if ESP teachers could perform satisfactorily the role for which they were trained. It was this aspect of the performance evaluation which was criterion-referenced. It sought to evaluate the performance of the ESP teachers on a number of skills which Guyanese science educators rated as being important for science teaching in Guyana.

The technique used was the Criterion Sampling Approach (CSA), an approach to criterion-referenced evaluation first proposed by McClelland (1973) and O'Leary (1973) and more recently developed by Shavelson (1974, UIE 1978, 1979) who is at present Co-ordinator of a UNESCO Institute For Education Meta-evaluation project which is testing the suitability of the Criterion Sampling Approach for evaluating non-formal education programmes. The criterion-referenced evaluation of ESP used a Criterion Sampling Approach and was one of three case studies which formed the basis of the UNESCO Institute's meta-evaluation. The report of the ESP case study, submitted to the UNESCO Institute in June 1981, is included here in Appendix 3.

For a CSA evaluation the teaching performance of a sample of the ESP teachers was evaluated using a number of situational performance tests. The skills assessed during these tests were themselves a sample of those considered by Guyanese science educators to be the most important for science teaching in Guyana. The tests were designed to assess the teacher's ability on tasks which were representative of those they would normally be required to perform in their everyday teaching situation. The Criterion Sampling evaluation is reported in full in Chapter 9 and summarized in Diagram 4.1.

The strategy used to evaluate the ESP programme, therefore, included intrinsic, and contextual, and performance evaluations. The performance of ESP teachers was assessed using data collected from Ministry supervisors, head teachers, pupils, from the teachers themselves and from situational performance tests. Views of participants involved at all levels of the programme were collected and analysed. The evaluation of ESP, therefore, presented an opportunity of a comprehensive evaluation of a science education programme involving a range of strategies, criteria and techniques.

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Diagram 4.1

Evaluation Strategy for ESP

METHODS	COLLECTION TECHNIQUE	DATA COLLECTED FROM	SAMPLE
Intrinsic	Content analysis	Written course materials	All correspondence units
	Free response written comments	ESP students	All 1977 intake
Contextual	Interviews and group discussions	Ministry officials Visiting supervisors Local tutors, Course Writers and Students	Theoretical sample
Performance	Norm-referenced		
	Classroom ratings	Ministry Supervisors	All ESP/College teachers
	Interviews	Head teachers	Six schools
	Questionaires	ESP and College teachers	All ESP/College teachers
	Written opinions	School pupils	Six schools
	Criterion-referenced		
	Situational tests	ESP teachers	Sample of 16

Chapter Five

The Intrinsic Evaluation

Section 1

1.1 The Teaching and Learning Mode of ESP

From Chapter Four we see that this intrinsic evaluation is concerned essentially with establishing the aims and objectives of the ESP programme and judging the extent to which these are likely to be met, by analysing the course materials and by reviewing the structure and resources of the programme.

ESP uses a multi-media approach; correspondence materials are specifically written for the programme and are supplemented by face-to-face teaching sessions and by audio-visual media materials. The programme is designed for the many untrained O and A level people who are already teaching science in Guyanese secondary schools and offers them a three-year in-service course of teacher training consisting of written correspondence units, audio-visual materials, tutorial sessions, vacation workshops, teaching supervision and workstudy. If they complete the programme successfully the students are awarded the Trained Teacher's Certificate of the Ministry of Education and this is equivalent to that awarded to successful students from the secondary college of education. ESP includes content knowledge in science, in English, in mathematics and in geography and also educational theory and practice. During their three years of training students receive 1,720 hours of instruction and carry out 2,000 hours of classroom teaching.

Correspondence Materials

Over the three-year training period, students receive eighteen correspondence units, six each year. Each unit is designed to provide learning materials for six weeks of "home study" and includes reading material, a written assignment and practical work (which may be carried out at home, in the teacher's own school or at one of the face-to-face tutorial sessions). Eleven authors were involved in writing these correspondence materials, all them specialists in their own fields. Detailed information about the units is given in Table 5.1 page 84.

Face-to-face Teaching

The face-to-face teaching component of the programme uses four different approaches, namely; weekly tutorial sessions, vacation workshops, supervised teaching and workstudy.

Tutorial Sessions

When the ESP programme began (in 1977) local tutorial centres were set up in the most fully equipped secondary school in each of five regions, (See map on page 92a) with an experienced graduate science teacher in charge of each centre. The tutorial sessions last three hours and are held every Saturday during school terms. At these sessions students carry out supervised laboratory practicals related to the correspondence materials and use equipment and facilities which may be unavailable in their own schools. They receive face-to-face tuition including group work and micro-teaching and they use the centres to obtain resource materials such as books, magazines and audio-visual materials.

Vacation Workshops

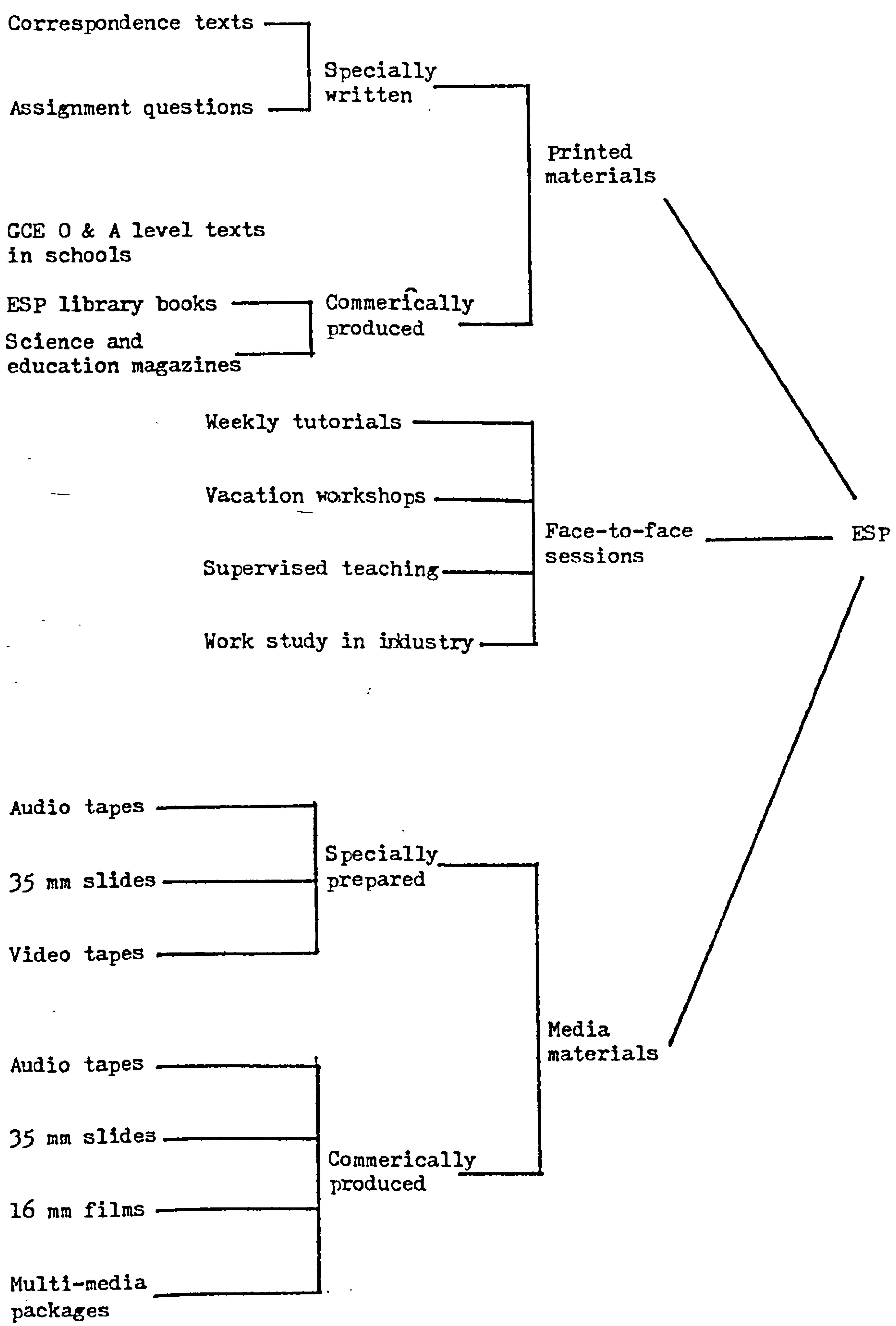
The three-week vacation courses are held in Georgetown and form an integral part of the training programme. A student would attend two such vacation courses in the three years of ESP. At the workshops work is closely related to the correspondence materials but emphasis is placed on practical and group work. Course writers and local tutors are involved in the planning and teaching of these workshops.

Supervised Teaching

Throughout the three-year training period regular and frequent visits are made by the officers of the Ministry of Education to the schools in which trainees are teaching. During such visits the student is observed teaching

Fig 5.1

Structure of the Emergency Science Programme (ESP)



a lesson in his normal environment and the (officer) supervisors, who are all trained and experienced science teachers, advise and guide him on the professional aspects of teaching. During these sessions, and during their other visits to the schools, the supervisors also act as field-workers for the programme, disseminating information to the students and head teachers, collecting feedback on the correspondence units and the weekly tutorials and trying to solve any school-based problems related to the programme.

Workstudy

A key feature of the science curricula now being implemented in the schools in Guyana is the emphasis placed on the relevance of science to the local environment. Since ESP teachers are being trained in their communities they are expected to develop an understanding of the need for school science to be relevant to that community and of how this relevance can be incorporated into the science curricula. In an attempt to help the students gain such understanding they are required to undertake one period of "workstudy" or work experience, in which they are attached for a two-week period during an August vacation, to a local industrial or medical laboratory. In 1979, for example, students were attached to the Government Analyst Department, the Meteorology Office, hospital and private food company laboratories. Reports on the students' work are prepared by the head of each laboratory. This component of the programme has proved to be very popular with the students and all the laboratories involved have commented favourably on the work of the students.

Audio-visual Materials

There is no television service in Guyana and the Course Team felt that radio broadcasts would be unrealistically expensive for a programme which had an initial intake of forty-two students. Supporting audio-visual and resource materials, therefore, are supplied to the students through the local tutorial centres. At the centres the students have access to small libraries of education and science books, tapes, slides, 16mm films, multi-media packages and a selection of science magazines and journals. The books, tapes, slides and multi-media packages were obtained mainly as gifts from the UK Ministry of Overseas Development (now the Overseas Development Association) and the magazines and journals from the local J. F. Kennedy (US Aid) Library. Each centre is supplied with a cassette tape recorder and a number of blank recording tapes for use in micro-teaching and group work. Pre-recorded tapes and slides linked with a number of the units are produced by the Ministry and sent to the centres. The 16mm films are supplied from the Ministry's Audio-visual Unit's library, and projectors are also available from the same source.

In the early stages of the programme the feasibility of obtaining some video-recording equipment for use at the local centres was examined but three major problems were encountered, namely;

1. the prohibitive cost,
2. the technicians were unavailable to run and maintain the equipment, and
3. the national electricity service was in the process of converting electricity transmission from a sixty to a fifty Hertz system.

The Audio-visual Unit of the Ministry does have some video equipment, however, and this has been used at the ESP vacation workshops. For instance, recordings were made of students teaching in their schools and these were used for micro-teaching sessions.

1.2 Course Content

The course content for the ESP programme was set out in the original proposal submitted to the Board of Examiners. (See Appendix Four). This proposed that the programme should include eighteen correspondence units, three foundation units - one each of mathematics, English and geography - eight units of science and six of education.

Foundation Courses

Students are required to complete one foundation course during each of their three years of training. The geography course was prepared by members of the course team and was based largely on Section B of the Caribbean Examinations Council (CXC) Integrated Science Programme. This section of the programme deals mainly with aspects of physical geography which are of particular relevance in integrated science, for instance the solar system and the structure of the earth. The content of the mathematics and English foundation courses was left largely to the authors of the individual units. In both cases, leading authorities in Guyana were each commissioned to prepare their own syllabus and unit. Thus Mr. Chunnilall, a senior lecturer in mathematics at the University of Guyana and a former mathematics teacher at Queen's College, prepared the mathematics units and Basil Armstrong, a senior education officer in the Ministry of Education and a former principal of the national Cooperatives College was responsible for preparing the English unit.

Science Content

The science content of ESP was set by the Science Education Committee of the Ministry of Education and closely followed by the syllabus of the CXC Integrated Science Programme. For ESP, however, the students were required to cover the content to a higher level of understanding than that required for the CXC school programme. The science content was listed under five headings, each of which had a number of sub-sections.

Section A Building Blocks of Matter

(1) Atomic Structure

(2) Bonding and Stoichiometry

(3) Cellular Structure and Function

(4) Correspondence between Structure and Function.

Section B The Universe

(1) Galaxies, the Solar System, Space Travel

(2) The Earth and its Atmosphere.

Section C Energy

(1) Energy in Chemical Bonds

(2) Electricity and Magnetism

(3) Wave Motion and the Electromagnetic Spectrum

(4) Thermodynamics.

Section D Life and the Environment

(1) Life Processes

(2) Continuity of Life

(3) Ecology.

Section E Resources of the Environment

(1) Resources from which Commodities are Obtained

(2) Resources Produced from Mixing and Blending

(3) Heavy Chemical Industries

(4) Agro-Industries.

Each of the sub-sections was then set out in further detail. Thus, sub-section A,1 was given as,

> "Atomic structure including electron levels, atomic orbitals, relative atomic mass, atomic number, isotopes, the atomic nucleus, molecules, natural and artificial radio-activity, half-life, the use of radio-isotopes, (the dangers involved and the precautions to be taken). Periodic relationships among elements (including atomic and ionization energies; properties of selected families, viz Group la, Group Vll)".

Education Content

The content for the education section of the ESP programme was devised with the help of tutors from the local In-Service Teacher Training Programme (ITTP) and from the local primary and secondary colleges of education. A preliminary list of content, drawn up by the ESP Course Coordinator was presented for discussion at each of a series of meetings with the principals and education tutors of the two colleges and of the in-service programme. In the light of their suggestions and comments a final draft was prepared and sent to the Board of Examiners of the Ministry of Education for approval.

1.3 Internal and External Assessment

(a) Internal Assessment of Students

The performance of the ESP students is assessed both internally and externally. Internal assessment is based on the end of year examinations, observations of teaching performance and tutor assessment. At the end of each year each student is required to sit examinations in science, in education and in one of the three foundation subjects. Thus at the end of the first year the examinations are in science, education and English and at the end of the second year they are in science, education and geography. In order to proceed to the next year of training the students must obtain a pass grade in all three subjects each year. If a student fails he or she may resit any or all of the examinations and those are held before the beginning of the new academic year - to ensure that successful students may continue without further delay. It was intended that the end of year grades would be awarded by combining the student's examination with the continuous assessment marks obtained for course work. However, this was found to be impractical because the course work was marked by the local tutors and there was a wide variation in the marks they awarded. The tutor grades awarded for the first correspondence course work assignments were moderated by the Course Coordinator but this was a lengthy and time consuming process. The time needed for the students' scripts to be posted to the coordinator, moderated by him and then returned to the tutors meant an additional delay of two or three weeks in the return of the scripts to the students. Byrne (1979) and Edwards (1979) have both reported on the unreliability of grades awarded by tutors in the Open University programme in the United Kingdom and Jarvis (1978) has commented that,

> "one of the disadvantages of correspondence tuition is the necessary time lag between students expressing their ideas on paper and their receiving a response to them. This means that the tutor must try to return work to students as soon after he receives it as possible, but this strategy, in turn raises problems of standardization".

Halmburg (1979) has also acknowledged the delay in feedback from tutors as being "an evident weakness" in distance-teaching and suggests that,

> "students seem to accept and profit from comments and corrections given within seven to ten days after an assignment has been completed, but are usually dissatisfied if the delay is of longer duration".

In the ESP programme if the tutor-marked assignemnts are to form part of the end of year assessment, they must be moderated, and for moderation to be carried out entails a delay in returning the scripts and comments to the students. The ESP Course Team felt that the assignments were more important as teaching than as evaluation exercises and so it was decided that assignment grades would not be incorporated into the end of year grading scheme but would be taken into account only in the case of students who had failed the examination. In this way a student's high assignment grades can compensate for an examination score which is slightly below the pass mark. No student, however, can be failed solely because of a low unmoderated assignment grade.

Informal assessment of the students' performance is carried out by the tutors at the weekly tutorial and vacation workshop sessions and by the supervisors during their school visits. Besides awarding grades for assignments, local tutors report verbally on the performance of individual students to the course coordinator and present written reports to him on attendance at the tutorial sessions. Visiting school supervisors observe the students teaching and report on each lesson that they observe. Although no formal grade is awarded for a student's teaching performance, the reports indicate the supervisor's view of the lesson and his description of the student's abilities. Copies of the supervisors' reports and records of their visits are kept in the students' personnel files.

The internal assessment of the students consists, therefore, of written examinations, tutor-marked assignments, lesson observations, vacational tutors' ratings and local tutors' reports. Most weight is given, however, to the examination results and the supervisors' reports.

(b) External Assessment of Students

Teaching certificates are awarded by the Board of Examiners on the results of the final examinations and final teaching assessment. The papers for the final examinations are set by the Course Team but the Board of Examiners ensures that the papers are of the required standard for certification and present an adequate coverage of the syllabus. The students' marks, the Chief Examiner's report and a sample of the scripts are sent to the Board for moderation. If a student does not achieve a pass grade in each examination his assignment work can be taken into account and his local tutor will be asked to prepare a written report on his progress. If the student's performance is still judged to be unsatisfactory the Board will then require that he sits a supplementary examination and his performance on this forms the basis of the final decision.

In the final term of the student's third year of training the Board arranges for his teaching performance to be assessed by at least two examiners appointed by the Board. The examiners for each candidate meet, award a grade and prepare a written report using the Board's Assessment Procedure Sheet. The grades awarded by the examiners are then moderated by the Board and the final teaching grade awarded. Each student must obtain a pass in both the final examinations and teaching assessment before being awarded the Trained Teacher's Certificate. The process used for the ESP programme is the same as that used for students at the two colleges of education and on the ITTP Programme, and so all teaching certificates awarded by the Board of Examiners are considered to be equivalent for salary and promotion purposes by the Ministry of Education.

(c) Formative Assessment of the ESP Programme

On-going formative assessment of the ESP programme is carried out using reports from students, tutors and examiners. Initially the students were asked to complete questionaires on the suitability and difficulty of each correspondence unit and on each day's session at the vacation workshops. While the data from the questionaires provided the course organisers and correspondence authors with quantitative information, for instance on how difficult or how interesting the students had found the various sections of the work, it did not help them to understand the difficulties encountered nor how to avoid or overcome them. After one term, therefore, the structured questionaires were discontinued and replaced by a request for students to prepare short written reports on the level of difficulty and the level of interest of the various topics both in the units and in the workshops and on how they felt any difficulties that they encountered could be overcome. These reports, on the workshops and on the previous year's correspondence units, were discussed at the final session of a vacation workshop and a report of students' recommendations prepared for the Course Team.

Local tutors meet with the Course Coordinator and correspondence writers to discuss the individual correspondence units. These meetings take place before the units are sent to the students. They are intended primarily as briefing sessions for the tutors but during the meetings the tutors are asked to report on any difficulties encountered in the previous units and invited to make suggestions for the improvement of the materials. Shortly after each unit is received by the students the tutors are contacted by telephone and asked to report on any further difficulties or problems encountered with the new materials. For example, occasionally the tutors find it difficult to obtain some of the plant or animal materials specified for biology experiments. The Course Coordinator is able to get in touch with the correspondence unit author and through him supply the tutors with additional information on how to obtain the material. Thus when the author of one unit referred to a plant as Canadian Pondweed, one tutor did not know it by this name, but was able to obtain it when told its local name of Shrimp Grass.

At least two of the five tutorial centres are visited each week by the Course Coordinator and any difficulties encountered by the tutors or by the students either with the correspondence materials or with any other aspect of the programme are discussed. Recommendations from the students can then be put to the Course Team or, if this is more appropriate, to Ministry officials (for example, in matters relating to the re-imbursement of money for travelling expenses).

Examiners are asked to prepare reports on all end-of-year examinations. In their reports they are asked to write about the general standards of the students in the examination and about the standards of the responses in the different topic and content areas. These reports, along with the feedback from the students and tutors, are then used by the Course Team as the basis for making modifications to the programme. For example, if a particular content area has been reported as presenting exceptional difficulty for the students, then the Team could arrange for additional coverage of that topic to be included either in a subsequent correspondence unit or at a vacation workshop.

Section 2

Description of Course Materials

The ESP programme uses a three way approach to distance-teaching, incorporating written correspondence units, face-to-face tuition and media materials. The main learning component, however, is the printed correspondence materials. Tutorial sessions, vacation workshops and audio-visual materials are provided to supplement and reinforce the correspondence units, for example, by providing practical laboratory exercises using equipment which may not be available in the schools in which the students teach.

Over the three year period of training, students receive eighteen correspondence units (six per year). Originally it was proposed that the course should consist of eight units of science, six of education, one each of mathematics, English and geography and a students' research project. In practice, however, this became nine units of science, four and a half of education, one and half of mathematics, one each of English and geography, and the research project. The structure of the units is described in more detail in Table 5.1 below. With the exception of unit 16, the research project, each unit is designed to provide the students with learning materials for six weeks' "home" study.

Students are expected to work for an average of ten hours per week for six weeks on each unit of work. Reading materials, written assignments and practical investigations are included in the correspondence materials and these are to be undertaken by the students either at home, in their schools or at the tutorial centres.

As Table 5.1 demonstrates, eleven different authors were involved in writing the correspondence materials. Six of them were members of the ESP Course Team, including:

(1) Professor J. Niles, formerly Head of the Biology Department at the University of Guyana,

(2) C. Drayton, lecturer in Science Education,

(3) P. Shaw, lecturer in Technology at the University of Guyana, and

(4) C. Barker, Head of Science at the Richard Ishmael High School in Georgetown.

The other five authors were commissioned to write on particular areas for which they had expertise. They were:

(1) Cde. Chunilall, lecturer in mathematics,

(2) Cde. D. Chun, lecturer in Psychology at the University,

(3) A. Crasner, Research Specialist,

(4) J. Masters, Science Specialist, and

(5) B. Armstrong, Senior Education Officer,

all from the Ministry of Education. The large number of authors involved meant that there was a considerable variation in the style and presentation of the written materials, even though each author was given detailed guidelines on the content and style required for the units. However, the interpretation of these guidelines varied from author to author, and an indication

Table 5.1

The Correspondence Units of the Emergency Science Programme

Unit No.	Title	Author(s)	Number of Pages: Text	Number of Pages: Diagrams	Number of Pages: Total	Main Content Areas
1	Life and the Environment	C. O. Perry	107	11	118	Science process, Case studies on malaria and germ theory.
2	Science, Education and Society	M. Brophy	93	13	106	The Nature of Science, Functions of Education, Case study of CHS in Guyana.
3	Foundation Mathematics	Chunilall and C. Drayton	111	20	131	Number Systems, Scientific Notation graphs, ratio and proportion.
4	Energy Matter Relationships (one)	C. Drayton and C. Barker	80	12	92	Nature of Energy, Heat Energy, Structure and Nature of Matter, Metric Units in Science.
5	Foundation English	B. Armstrong and M. Brophy	70	3	73	Communication Skills, Guided Composition and Comprehension.
6	Educational Pyschology	D. Chun	157	16	173	Teaching Styles, Theories of Learning, Intelligence and Creativity.
7	Ecology	J. Niles and J. Masters	95	18	113	Ecosystems, Transfer of Energy, Soils, Practical Ecology for Schools.
8	Teaching Science	M. Brophy	83	2	85	Planning Science Lessons, Methods of Teaching Science, Safety in Science Teaching.

... cont.

Table 5.1 continued

Unit No.	Title	Author(s)	Number of Pages: Text	Number of Pages: Diagrams	Number of Pages: Total	Main Content Areas
9	Energy Matter Relationships (Two)	C. Drayton and C. Barker	151	20	171	Acids and Oxidation, Oxidation States, Electricity and Light Energy.
10	Metabolism	C. O. Perry	86	10	96	Characteristics of Life, Digestion, Transport, Respiration, Excretion, Homeostasis and coordination.
11	The Curriculum	M. Brophy	90	3	93	Defining the Curriculum, Curriculum Theory, Other Peoples' Curriculum, Curriculum Development in Guyana.
12	Geography For Science	C. Drayton	119	24	143	Geography and Space Science, The Earth-Moon System, Finding Your Way About the Earth, The Earth Itself.
13	Continuity of Life	C. O. Perry	104	17	121	Levels of Biological Organization, Genetic Continuity, Evolution.
14	(a) Revision Education (b) Further Mathematics	M. Brophy C. Drayton	8 42	0 11	8 53	An analysis of Supervisors' Reports on Students' Teaching. Introduction to Calculus, Vectors, Motion in a Circle.
15	Electricity and Magnetism	P. Shaw	41	19	60	Electric Fields and Charges, Capacitance, Permitivity, Direct Current Circuits.

... cont.

Table 5.1 continued

Unit No.	Title	Author(s)	Number of Pages			Main Content Areas
			Text	Diagrams	Total	
16	A Guide to Research and Project Work	A. Crasner	85	15	100	Why Do Projects? Planning a Project, Writing up a Project.
17	Energy Matter Relationships (Three)	C. Drayton and C. Barker	74	5	79	Gases, Vapours and Heat Energy Elasticity, Gravity and Radio-activity.
18	Energy Matter Relationships (Four)	C. Barker and C. Drayton	32	19	51	Applications of Chemical Processes, Raw Materials in the Chemical Industry.

of this variation is shown in Table 5.2 below.

Table 5.2

Statements of Objectives in the ESP Correspondence Units

Objectives stated in Specific Terms	Objectives stated but not in Specific Terms	Objectives not stated
Unit no. 2, 4, 8, 7b, 11, 12, 14a	Unit no. 1, 3, 5	Unit no. 6, 7a, 9, 10, 13, 14b, 15, 16, 17, 18

All of the authors incorporated structured activities and exercises into the correspondence texts. These included practical experiments, (such as that on germination in Unit 1) the interpretation of data, (such as the estimation of high and low tides in Unit 12) and the writing and production of new materials (such as Activity 11 in Unit 8 in which the students were asked to prepare a series of examination questions testing different cognitive levels of thinking). Units 2 and 6 included lengthy self-instructional learning programmes.

Section Three

Antecedent Conditions

3.1 Student's Age and Ability Level

There have been three intakes of students into the ESP Programme to date. The first was in April 1977 when forty-six students (thirty male and sixteen female) were accepted for training. Four of these students did not sign contracts with the Ministry of Education (agreeing to teach for three years after completing training) and were not permitted to continue on the Programme. A second intake began training in September 1978, when twenty-two students (fifteen male and seven female) were accepted for the Programme. Again, four did not sign their contracts and were not allowed to continue. A third intake of twenty students began the Programme in April 1981.

Table 5.3 (a)

O and A Level Qualifications of ESP Students

Year of intake	No.	2 A levels or more	6 O levels or more	4 or 5 Olevels	Less than 4 O levels
1977	46	3	30	12	1
1978	22	0	13	9	0

Table 5.3 (b)

Age of ESP Students (1977 Intake)

Tutorial Centre	Average Age	17-19 Years	20-22 Years	22-24 Years	25+
Georgetown	22	4	4	0	3
New Amsterdam	21	2	4	0	1
Corentyne High	22	1	4	3	2
West Demerara	20	5	2	3	1
North West	20	2	0	1	0
Interior	20	2	1	1	0
Total		16	15	8	7

Overall, 67.5% of the 1977/78 ESP students had six or more GCE O level passes (Grade A, B or C). With one exception, all students had four or more O level passes. (One student in the North West region was accepted on trial because of the especially acute shortage in that region). The 1978 intake had on average slightly lower GCE qualifications than in the 1977 intake. This may have been due to the fact that the second intake were deliberately chosen from amongst Community High School teachers and the teachers in these schools are normally less qualified than those in the more academically oriented secondary schools. Also, many of the best qualified had already been selected for the first intake.

A profile of the age range of the students in the 1977 intake is given in Table 5.3 (b). The average age of the students on entry to the programme was 21 years: the youngest being 17 and the oldest 31. Students from the interior regions were, on average, younger than those from the coastal regions.

3.2 Students' Backgrounds and Previous Experience

The ESP students taught in secondary and community high schools in all regions of Guyana except for the Rupinunni district, for there is only one secondary school in this vast district (St. Ignatius School, see map on page 312 and it already had a trained science teacher. Some of the ESP students taught in only junior forms, (pupils aged between eleven and fifteen) while others taught fourth and fifth form GCE classes. The students were of many different ethnic, religious and cultural backgrounds. The East Indians were mainly Hindu and Muslim and the Negroes and Amerindians were Christian.

As the ESP Programme was meant specifically to train science teachers, the students' science background was extremely important both in the initial selection process and in the design of the ESP curriculum. Since it was to be based on correspondence materials, the English language background of the students was also to be taken into account in selection. Table 4 below, sets out the GCE O level backgrounds of the students in English, mathematics and the sciences.

Over 80% of the students had GCE O level passes in English, mathematics and biology. Sixty-five per cent had a pass in chemistry and 66% in physics. There were, however, considerable variations between the GCE backgrounds of students from different areas. The most highly qualified were those from the Corentyne region, who had an average of seven O level passes; all students in the 1977 Corentyne intake had passes in English and chemistry, and 90% had passes in mathematics and biology. The students in the North

West region were the least qualified. Of the ESP teachers, only two had passes at GCE O level. However, with the exception of their expatriate ESP tutor, they had higher qualifications in science than any other teachers in their area.

Table 5.4

ESP Students' O Level Background in English, Mathematics and the Sciences

Region	Number of Students	Maths	GCE O Level Passes Phy	Chem	Bio	Eng
1977 Intake						
Georgetown	11	8	7	7	9	6
New Amsterdam	7	5	4	5	6	6
Corentyne	10	9	7	10	9	10
West Demerara	11	10	6	6	11	9
North West	3	2	0	0	2	2
Interior	4	4	4	3	4	4
1977 Total	46	38	28	31	41	37
1978 Intake						
Corentyne	11	11	11	6	7	9
Georgetown	11	9	6	7	10	10
1978 Total	22	20	17	1	17	19

In his study of the effect of teacher variables on pupil achievement in developing countries, Husen (1978) found that in six of the eight national studies he analysed the pupils' achievement was directly affected by the teacher's teaching experience. For an in-service teacher training programme such as ESP the student's previous teaching experience is extremely important, not only because it may help in selecting the most effective teachers for training but because it also serves as a useful indicator of the teacher's committment to remaining in teaching. Although there are between thirty and forty people with A level GCE passes recruited to teach science in Guyana every year, very few of them remain in teaching for more than one year. Most of these recruits enter teaching only because they have not received their A level results in time to be accepted for overseas universities and so they teach for one academic year, while waiting to obtain a university place abroad. Most other untrained science teachers have only O level qualifications and many of them are studying privately for A level examinations or are waiting for visas to enable them to study in Canada or the United States of America. In 1977 of the 162 people with O or A level qualifications who were teaching science in secondary schools, only twenty-five had been teaching for three years or more. Of these a few were able to study part-time for the BSc degree of the University of Guyana (this was a full-time course but some teachers had been able to arrange to attend on a part-time basis). Of the others, sixteen were accepted onto the ESP Programme. The remaining few experienced untrained non-graduate science teachers were not accepted because they had already indicated to their head teachers that they were planning to emigrate.

Table 5.5 presents the range of teaching experience of the ESP students. The ESP students had taught for an average of 2.4 years before beginning training; the least experienced had been teaching for three months, the most experienced for twelve years. There were differences in the average length of experience of the teachers from different regions. As well as being the best qualified, the Corentyne teachers were also the most experienced.

Table 5.5

Teaching Experience of ESP Students

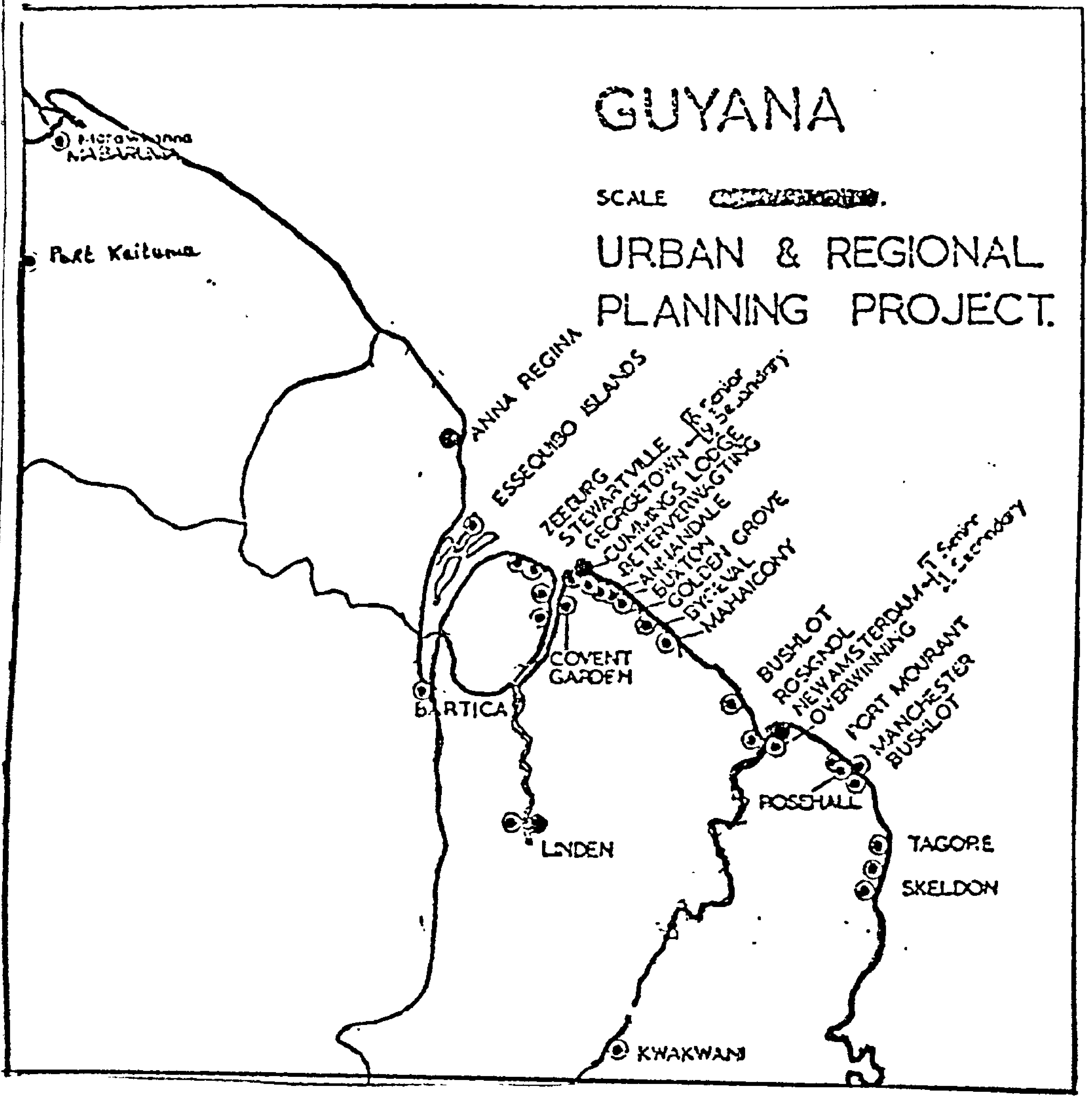
Region	Average teaching experience of group (in years)	0-1 year	1-3 years	3-5 years	5 years +
1977 Intake					
Georgetown	2.8	3	5	0	3
New Amsterdam	1.8	4	2	0	1
Corentyne	3.0	3	1	5	1
West Demerara	2.3	5	2	2	2
North West	2.5	1	1	0	1
Interior	1.7	2	1	1	0
Totals		18	12	8	8
1978 Intake					
Corentyne	2.0	0	7	3	1
Georgetown	1.8	1	3	3	0
Totals		1	14	6	1
Totals - 1977 and 1978		19	26	14	9

3.3 Organization of Teaching Groups

In April 1977 tutorial centres were established in secondary schools in five different regions. Schools were chosen as centres because of their accessibility for the students and because they already had the equipment and facilities need for science teaching. The five centres are marked on Map 2 along with the schools in which the ESP teachers teach (1977 and 1978 intakes).

Fig. 5.2

(a) Distribution of Secondary Schools in Guyana

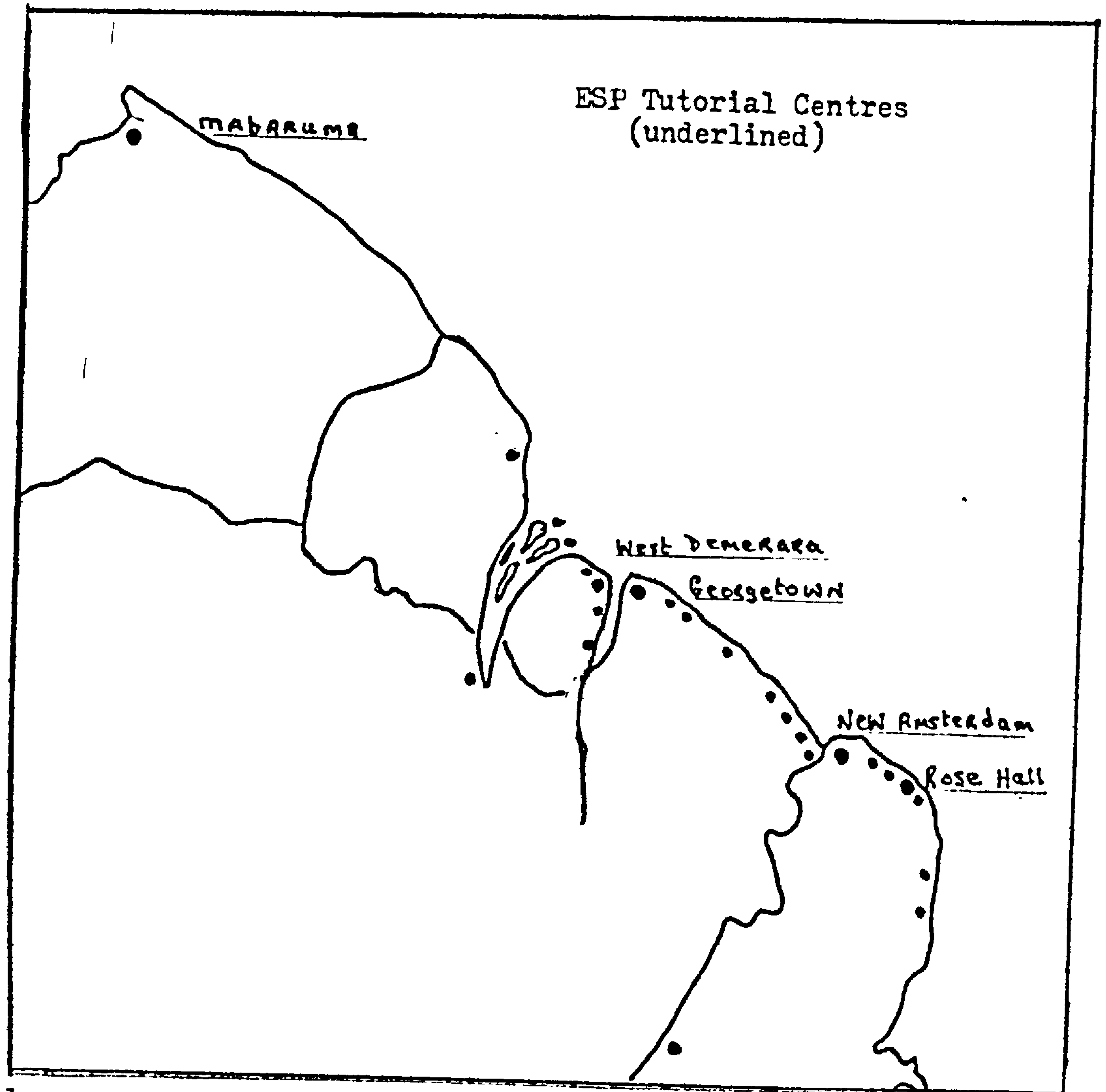


● senior high school

⊙ junior secondary or community high school

(one interior school not shown)

(b) Distribution of ESP Schools



scale

0 25 50 miles

• school with ESP teacher

The centre for Georgetown and East Coast Demerara is based at Queen's College, a senior high school in Georgetown which has good facilities for teaching O and A level sciences. For students from West Coast Berbice and New Amsterdam area the tutorial centre was based at the New Amsterdam Multilateral School. This, the senior high school for the region, had, along with Queen's College, the best facilities for science teaching of all schools in Guyana. There were no senior high schools in either the Corentyne or West Demerara regions so the tutorial centres for these regions were based at the schools which had the best science facilities, namely the Corentyne High School and the West Demerara Secondary School.

There are two secondary schools in the North West region and they are separated by many miles of jungle. The only means of travel available between the two points is either by aircraft or by small boat. As all three students from the region lived and taught within a few miles of the North West Government School at Mabaruma, the tutorial centre was based there rather than at the Port Kaituma Community High School, even though the Port Kaituma School had the better facilities.

Three students lived and taught in such remote areas that they could neither share a tutor nor be expected to travel to one of the other centres. The very fact that they were teaching in such remote areas, however, made them particularly suitable candidates for training through the distance-teaching rather than through the normal college-based programme.

In a study of correspondence students in remote areas, Sissons (1977) reports that for those not able to attend tutorials their greatest problems were the lack of contact with other students and the inability to get advice on specific problems encountered with the correspondence material. Individual arrangements were made to provide the three ESP students with such contact and advice. One who lived in Bartica, was allowed special study leave from his school to enable him to travel once a month to the Georgetown tutorial centre. It was not possible, however, to make the same arrangements for the other two students, partly because of the expenses involved and because of their domestic situations. Officers of the Ministry of Education visited the Essequibo region in connection with the other science programmes and so it was possible to arrange for the student at the Anna Regina School to have monthly visits. He was also encouraged to write and telephone to the Course Coordinator for help with any specific problems he encountered. This arrangement worked quite well. For the student at Kwakwani Community High School the arrangements were not as satisfactory. Kwakwani lies on the Upper Berbice River and is difficult to travel from the coast (see map). The rough overland route takes at least five hours, the river journey between eight and twelve hours and air transport is by private plane only.

It was planned that the student at Kwakwani would receive frequent visits from the officers of the Ministry of Science Unit. In the first year of the Programme this was possible because the officers were able to fly to the area in a private mining company plane. This plane, however, was grounded in late 1977 because of a shortage of spare parts and the air route was no longer available to the officers. The student herself was absent from her school for two three-month periods of maternity leave. However, as the Programme was based on correspondence methods, she was able to continue with her studies. The postal service to the area was inadequate. The only telephone communication was by radio link and this was extremely unreliable. The most effective means of helping the student, therefore, was for the visiting supervisors to make the 250 mile round trip by Landrover and launch. This was expensive and time consuming and could only be undertaken if there was other Ministry business in the area. So, for this student visits were irregular and infrequent.

1978 was a year of severe economic recession in Guyana and there was strong pressure on all government departments to make financial savings. As part of the savings made by the Science Unit there was some modification to the ESP tutorial system. Instead of the students meeting for three hours every week during term, as they had been doing, it was arranged that they would in future have three meetings every month and each of these would last four hours. This arrangement, while maintaining the number of student-tutor contact hours, reduced by one-quarter the students' travelling expenses. Another saving was achieved in September 1978 with the second intake of students. The New Amsterdam tutorial centre was closed and all Berbice students met at the Corentyne centre. Only one tutor was then needed for the 1977 intake of New Amsterdam and Corentyne students, and the second tutor was able to take responsibility for the 1978 intake. The twenty-two students in the 1978 intake were all accommodated at two tutorial centres, therefore - one at Bishop's High School in Georgetown and the other at the Corentyne Centre.

Work at the Tutorial Centres

The sessions at the tutorial centres supplement the correspondence materials in four main ways. Firstly, the students are able to carry out supervised laboratory investigations using equipment and facilities which are scarce or unavailable in their own schools. Secondly, they are able to use the ESP schools as resource centres for books, magazines, audio-visual materials, and, by arrangement, for science equipment. They are also able to receive face-to-face tuition, micro-teaching and group discussion lessons, and, finally, they can maintain contact with other students in the programme. Many of the correspondence units contain experiments and exercises specifically to be carried out by the students at the tutorial centres.

Tutors have a considerable degree of autonomy over how the tutorial sessions are run. They are encouraged to discover what the needs of the students are and as far as possible provide learning experiences to satisfy these needs. For instance, following requests from students many of the tutors provided courses on particular topics within the science syllabus such as the handling of equipment for chemistry experiments.

3.4 ESP Staffing

Four categories of teaching staff are involved in the ESP programme:

(a) Course writers who prepare the correspondence materials,

(b) tutors for the local centres,

(c) lecturers and tutors for the vacation workshops, and

(d) Ministry supervisors who visit the students to observe and help them improve their teaching technique.

All teaching staff work on a part-time basis and their work is coordinated by the Course Coordinator. The role of coordinator is pivotal, therefore, to the ESP programme. He (or she) is responsible for; commissioning, production and distribution of the course materials, organizing the local tutorial sessions and the vacation workshops and coordinating the supervisory school visits. The coordinator is also responsible for organizing and maintaining communications between the different categories of staff.

Course Writers

Course writers are required to write correspondence materials for the students. Each author is commissioned to provide within the unit, 42 hours of reading for the students, 30 hours of activities and 6 hours of assignment work. They are required to prepare the material on specified sections of the syllabus which have been approved by the Ministry of Education Board of Examiners. With the national shortage of qualified science specialists, the college and University programmes in Guyana have found it almost impossible to recruit and maintain an adequate staff in their science departments.

Since the ESP programme does not involve full-time staff nor full-time maintenance of students, it is possible to use the financial resources available to offer attractive rates for correspondence writing. Leading specialists are recruited as authors. This has included, for example, the Vice-President of the Caribbean Conservation Association and the Caribbean Education Consultant to the World Health Organization.

One difficulty with recruiting authors of such high calibre could be that they have no first hand knowledge of school situations or of the level of content suited to the students. Fortunately, nine of the eleven authors have had teaching experience at secondary school level and most of them are also lecturers at the vacation workshops and so have first hand experience of the students from which to judge the level of content. However, none of the authors had previous experience in preparing correspondence materials. For this reason each author when first preparing his unit, met with either the Course Coordinator or with the Course Team to discuss a suitable layout and structure for their work and each was also supplied with copies of UK Open University materials and other ESP correspondence units as well as with copies of relevant texts which were available to the students at their local centres. Each author was then commissioned to prepare his materials to cover a particular section of the syllabus.

Local Tutors

One of the most important, yet problematic roles in distance-teaching is that of the local tutor. Mills (1979) has written of the isolation and rejection felt by tutors in the TAFE distance-teaching network in Victoria, Australia. Perraton (1976) has expressed his concern over the expense and ineffectiveness of tutors in the Botswana Extension College Programme and Kirk (1976), Thorpe (1979), Belchem (1979) and Bradford (1979) have all reported on the difficulties encountered by the part-time tutors for the Open University Programme in the United Kingdom. Thus Kirk in her article "The Loneliness of the Long Distance Tutor" has commented on the "sad lack of contact" between local tutors and the full-time staff of the University, while Thorpe, a Research Fellow in the Regional Tutorial Services Section of the Open University, has noted that even in its tenth year of existence, there is still within the OU an "inadequate grasp" of the role of the part-time tutor. Bradford has suggested recently that except for Foundation Courses, tutorials, "may well disappear altogether" from the Open University system because of their cost and low take up. One reason for these difficulties is that there is little agreement over exactly what should be the role of local tutors. In their handbook to students, the Open University state that, "The Course tutor's job is to help you to understand and learn the course and its assignments" (OU 1975). On the other hand, Barker (1977) (who has produced distance-teaching packages for UNESCO) and Perraton (1974) (a former director of the Botswana Extension College) both suggest that the tutor's main function is to adapt the correspondence material to suit the local conditions and the individual needs of the students. Bates (1974), a UNESCO consultant on distance-teaching and a lecturer at the Open University, suggests yet a different function for tutors, namely that they should be the,

> "filter for identifying and separating weaknesses due to course materials, and weaknesses due to student shortcomings."

These views are all from staff who were centrally-based in distance-teaching and they emphasise the role of the tutor in terms of his relationship to the correspondence material. Local tutors, Kirk (1976) argues, see their role in an entirely different way, feeling that they should have a more active teaching function. For instance, by choosing local topics for study from within a general course framework, rather than being merely,

> "unquestioning purveyors of centrally produced materials".

In an attempt to clarify some of the ambiguities surrounding the tutor's role, Gibbs and Durbridge of the Open University Tuition and Counselling Research Group undertook a study of the actions and characteristics of OU local tutors who were considered by their staff tutors to be either notably successful or notably unsuccessful. From their results they suggest that tutoring success in the OU system depends to a large extent upon the tutor's personality, with the successful tutors being "warm, friendly, supportive and understanding" and having an "informal egalitarian style". The unsuccessful tutors, they found were characterised as being unfriendly, unapproachable, brusque, egocentric, insensitive and overcritical (1976a), (1976b).

When setting up the ESP Programme, the planners were therefore faced with the problem of deciding what should be the role of the tutor in a Guyanese programme. At an early stage, the decision was made to employ "local" as distinct from "correspondence" tutors. Correspondence tutors need never meet their students (Mills 1979) but may correspond with them through written communications or by telephone or audio tape. The local tutor, on the other hand, is expected to meet his students frequently and to provide them with at least some face-to-face tuition.

Holmberg (1979), the Professor of the Methodology of Distance Teaching at the Fernuniversitat in West Germany and an international authority on distance-teaching has suggested that face-to-face sessions have particular value in distance-teaching for:

(1) Aiding cognitive learning,

(2) Practicing psychomotor skills,

(3) Acquiring attitudes and habits,

(4) Understanding human behaviour, and

(5) Providing stimulation and inspiration from other students.

Mills (1979) following his report on distance-teaching projects in Victoria in Australia has commented that tutorials are "essential" for science and other practical subjects.

ESP tutorials were seen by the course planners in broadly similar terms to those suggested by Holmberg. The students would receive help in their understanding and comprehension of the correspondence materials with the tutors adapting the materials to suit the individual students and providing additional learning materials and experiences for the students, when needed, including additional practical laboratory investigations and exercises. The tutors would also be expected to act as counsellors by helping the students to develop their study habits and techniques and overcome any individual learning problems. The question for the planners, therefore, was what type of person could most effectively perform such a role?

Experienced teacher educators would perhaps have been best able to perform the functions of counselling and of fostering the students' group study techniques. Teacher educators would not, however, have the specialist content knowledge in the sciences needed for a science teacher training programme. The few science teacher educators that were in Guyana were all based in Georgetown and could not take on any additional regular teaching. The ESP course was to provide content in physics, chemistry, biology, mathematics, English and geography as well as in educational theory. No one person with a specialist knowledge of all these areas was available. If the tutor was required primarily for his specialist knowledge then clearly different tutors would be needed for the different content areas. Having different tutors assigned to the centres every six weeks, however, would not provide the continuity required for them to function as counsellors.

The solution arrived at was to recruit experienced well qualified science teachers as tutors. This decision accepted the limitation that the tutors would not have had any previous teacher training experience and, therefore, would not be familiar with some training techniques such as micro-teaching or simulation exercises. Neither could they be expected to have specialist understanding and knowledge of all the content areas of the programme. The benefits, however, were that they did have specialist knowledge of at least one, and probably two, of the science content areas and they would be able to supervise the practical laboratory activities and provide supportive material and lessons when needed. They could also combine the functions of student counsellor and course tutor and hence provide a sense of cohesion to the many different parts of the course.

Tutors who have been engaged have all been well qualified experienced science teachers, most have post graduate certificates of education and have taught GCE O level in at least one science subject. Two of the tutors have had masters degrees and a number of them are involved in the Phase One Pilot Stage of the Caribbean Examinations Council Integrated Science Project.

Workshop Teaching Staff

There are two categories of staff involved in the vacation workshops, "resident" tutors and "visiting" lecturers. The resident tutors are responsible for the day to day running of the workshops. They teach on a one-to-one basis during the practical sessions and assist with the group discussions. Each is also responsible for leading at least one session during the three week workshops. Resident tutors are either science teachers or Ministry supervisors and all of them are familiar with and known to the ESP students, (having been either local tutors, course writers or visiting supervisors).

The course content of the vacation workshop is closely related to the work of the correspondence units. The workshop programmes are drawn up by the Course Team and the visiting lecturers are then recruited to present specific sections of the work. Visiting lecturers are leading specialists in their fields. In-service training programmes such as ESP have a major advantage over college-based programmes in that they can obtain the services during the vacation periods of highly qualified local and overseas educators (Hawes and Ozigi 1975). The ESP programme is fortunate to have many highly qualified people from other institutions willing to serve as visiting lecturers.

School Supervisors

Ministry supervisors visit the ESP teachers in their classrooms and observe them teaching at least once each term. These supervisors play an essential role in the training programme, both as teachers and as field-workers. They observe the students teaching in their everyday situation, present them with a written report on their teaching and then discuss with them how they can improve their teaching style. During these observation sessions and during their other visits to the schools, the supervisors also act as field-workers, for instance by disseminating information about the programme and collecting feedback from head teachers and students. To standardize the procedures used by the supervisors during their visits to the students a rating scale, which was developed for use with science teachers in Guyana, is used as a basis for observation (Lalgie 1978).

3.5 Curricular Implications

The ESP programme caters for students of a number of different cultural and ethnic backgrounds. It includes students with a wide range of academic backgrounds and there is a considerable variation in the type of school they teach in. These factors all have important implications for the content and structure of the programme.

If the science content of the training programme is set to suit only those teachers who have already attained O level standard in all three of the science disciplines, almost 40% of the students would be placed at a serious disadvantage, since they do not have this standard. On the other hand, if the standard is set to suit this 40%, then the better qualified students would quickly become bored. In an effort to satisfy both groups of students, the early units of science are designed to present the content in an introductory manner but in a way which differed from the normal GCE O level approach, for example by being more conversational in tone and by following the historical development of the topic. Each section also includes a number of open ended exercises to allow the students to develop the topics further if they wish, and the local tutors are asked to provide laboratory experiments and exercises to suit the individual needs of the students. Completely independent learning multi-media courses in O level physics, chemistry and biology were obtained through the UK Ministry of Overseas Development and the students are encouraged to use them to help them overcome any shortcomings in their background knowledge.

A serious problem for the curriculum planners arose because the students for the programme were selected from teachers at two very different types of school, namely secondary and community high. As noted in Chapter Three, the secondary school science programme in Guyana is strongly academically oriented.

It leads to O level or CXC certification and is designed to suit pupils of higher than average academic ability. The community high school programme, on the other hand, is vocational in nature and is designed to suit pupils of average and below average ability. The ESP training programme has to provide its students with enough academic content to enable them to teach the O level sciences and also train them to be able to teach vocationally relevant science to community high school pupils.

There is a wide variation in the level of facilities and equipment in the different schools and this caused some modification to be made to the structure of the programme at the end of the first year (1977). It was originally planned that the students would carry out some of their practical work in their own school laboratories. In choosing the students, however, the school's need for teachers was taken into account rather than its facilities. Thus, when the teachers had been selected it was realized that some of them were teaching in schools which did not have functioning laboratories. A number of the others were in schools which, although they did have laboratories, had very little science equipment. Due to the shortage of facilities and equipment a number of the students reported that they were unable to complete in their own schools many of the practical activities in the first two science units. So, the subsequent units were modified so that less emphasis was placed on individual practical work in the students' own schools and more reliance placed on practical work at the tutorial sessions.

Religious and cultural values have had little apparent effect on the ESP curriculum. Guyanese society is westernized compared with most African and East Indian societies, and many of the values still fervently held by Muslims and Hindus in Asia have been discarded or modified in Guyana. East Indian women wear western dress. Few Hindu men are vegetarian and most Hindu and Muslim men drink alcohol. Alcoholism, in fact, is a major social problem amongst all ethnic groups in Guyana. Two aspects of the curriculum, however, which may have been either consciously or unconsciously affected by religious and social values were:

(a) the choice of animal organs and tissues for dissection,

All dissections were carried out on toads and fish. Thus, in the correspondence materials dealing with the heart and transportation of the blood, practical investigations were carried out on fish and Daphnia, but there was no dissection of a pig's or cow's heart,

(b) sexual reproduction,

It is noticeable that in unit 13 entitled "Continuity of Life", sexual reproduction is dealt with in terms of genetic reproduction. There is no discussion on human or even mammalian reproduction or reproductive organs.

Political loyalties in Guyana follow ethnic patterns. Most East Indians support the opposition Peoples Progressive Party (PPP) and most negroes the government Peoples National Congress (PNC) party. Care had to be taken in preparing certain sections of the ESP programme, for instance, unit 2 (Science, Education and Society) and unit 11 (The Curriculum) that the material offered a balanced account of the education system in Guyana.

As an integral part of the programme the students are expected to devote one working day each week to their studies; this necessitates them being released from one day's teaching. Many head teachers find it difficult to timetable for this and allow the students two half-day study periods instead of the one complete day. Each year, however, some head teachers have been reluctant to allow the students any time for study, and the visiting supervisors often have to negotiate with head teachers to arrange for the ESP teachers to obtain study time.

3.6 Financial and Resource Implications

In an estimated costing of the ESP programme made in February 1977 it was found that the greater the number of students accepted for training, the lower the cost per student. The total costs for each group would be G$ 57,306 for 90 students, GS 48,218 for 60 students and GS 42,159 for 40 students. If 90 students were accepted onto the programme in the first year, the cost of training each student would be GS 637. If the number was reduced to 60 the cost would be GS 804 per student and if only 40 students were accepted the cost was estimated at GS 1,054 per student. In deciding on student numbers the availability of teaching staff, however, had to be taken into account. The initial impetus for the programme was the need for trained science teachers, yet the number of students who could be trained depended to some extent on the existing availability of science teachers to act as tutors. There was also a shortage of personnel within the Ministry of Education to supervise the students in their schools. Taking both financial and manpower factors into account, the programme was planned to accommodate 40 students in the first year. An initial selection of 46 students was made to allow for a 12% drop out.

Section 4

Intrinsic Evaluation

West (1974) recommended that an intrinsic evaluation of a curriculum should examine its course materials in the light of the rationale and strategy of the course in order to establish,

> "the degree to which the course as written exhibits internal consistency between its objectives, content and methods".

He suggests that the best way of doing this is to use a quantitative technique of curriculum analysis, since this can provide valuable insights into the internal balance and structure of the course materials. A number of such techniques exist (Eraut et al 1975) but one, the Easley Technique (1974), has been designed specifically for analysing science curriculum materials and it is recommended by both West, and Goad (the co-author of the Sussex Scheme for the analysis of curriculum materials) ref. Goad (1980). It is the Easley Technique that has been used for this intrinsic evaluation of ESP but it is augmented by reports written by the students who used the materials.

Organization of Course Content

The Easley Technique for analysing the curriculum requires the evaluator to classify the course content using fixed, "discrete" and "assignable" units. The system chosen for the classification should be one which will allow the internal structure of the materials to be examined and will assist with assessing the extent to which the materials meet the aims and objectives of the course.

The objectives of the ESP programme (see Appendix 4) are summarized below. The programme aims to:

(1) provide its students with enough theoretical knowledge, practical knowledge and skills in science and in education, English, mathematics and geography to enable them to understand and teach CXC, WISC and SDSP (the community high school programme),

(2) foster in the students an awareness of the importance and relevance of science and technology for achieving the aims of a developing society.

The ESP course, therefore, has to provide the students with both theoretical and practical learning experiences to enable them to teach the science programmes used in the secondary schools in Guyana. These experiences can be presented in written materials either in a "text book" manner emphasising factual content or in a structural approach incorporating learning activities. Since the ESP teachers are being trained to teach science, their course materials also needed to include some knowledge of scientific methods and processes. The fact that the ESP planners included in the five objectives one specifically seeking to foster in the students an awareness of the importance and relevance of science and technology to society, suggests that this awareness should itself be reflected in the ESP course materials. Also, since the programme is correspondence-based and the students are able to meet with their tutors only once a week, it is important for the course to develop in the students an ability to evaluate their own understanding of the course materials.

The intrinsic evaluation addressed itself, therefore, to the question: to what extent did the course materials present the students with theoretical knowledge and practical knowledge and skills, and were these provided by using factual "text book" presentations or by using structured activities and practical exercises? To what extent were the students made aware of the importance of science and technology in society and was this importance reflected in the written course materials? To what extent were the students provided with opportunities to evaluate their understanding of the written materials?

The ESP written materials were analysed into five categories to see to what extent they provided the students with:

(a) academic content,

(b) structured student tasks,

(c) knowledge of scientific methods,

(d) information or activities stressing the importance of science and technology to society, and

(e) opportunities for testing their understanding of the materials.

The science units of the course were further analysed to see to what extent the tasks in the materials provided the students with opportunities to carry out practical investigations or exercises.

When using the Easley Technique the written content is sub-divided - partitioned-into "discrete", "assignable" units and each of these is then classified into one of the five categories being used in the analysis. Even if an assignable unit is serving two or more functions in the course materials, it must be ascribed to only one of the listed categories. The person undertaking the analysis must decide what is the main function of this "assignable unit" and ascribe it either to one category or the other. For example, in the ESP materials, the students may be presented with a "task" which will help them to "evaluate" their understanding of the materials, and the unit must be ascribed to either the task or the evaluation category. Taking into account the different writing styles of the various authors it was decided that the assignable unit should be the individual page. Each page of the ESP course materials was classified, therefore, into one of five main functional categories. The results obtained are given in Table 5.6 (Appendix 1) and are summarized in Fig. 5.4 below.

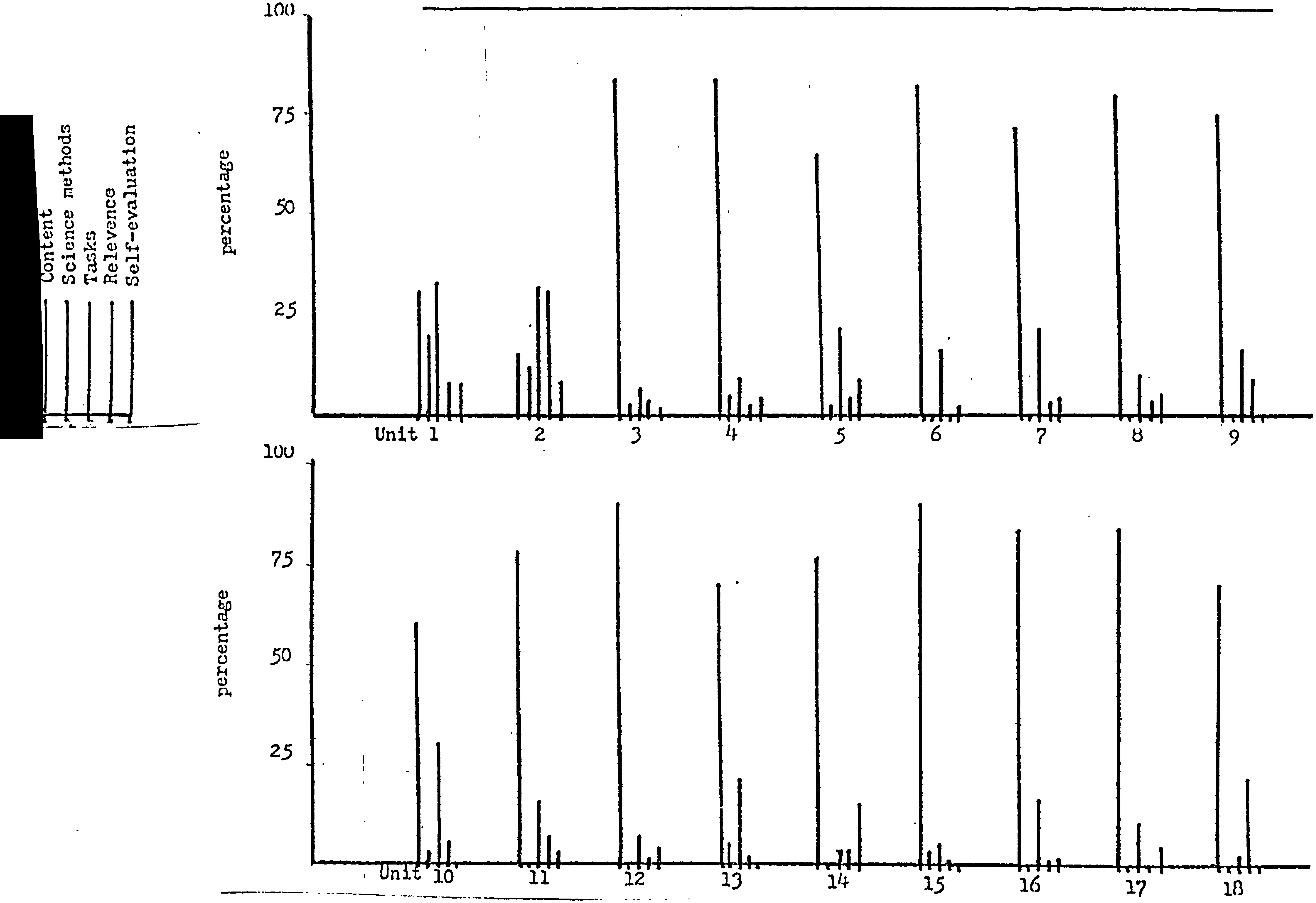
The Quantitative Analysis

It is evident from the quantitative analysis of the written materials that the correspondence materials for the ESP programme are heavily "content" oriented. In the eighteen units, 71% of the "assignable units" (pages) were concerned with a textbook like presentation of theoretical "academic content". The science units dealing with physics and chemistry are particularly content-based with, for example, unit 15 having 90% and unit 4 having 83% of their pages devoted to the presentation of content. The biology units rely less on the direct presentation of the content and included considerably more student tasks and self-evaluation exercises. All four biology units devoted a total of 25% or more of their pages to tasks and self-evaluation, while the physics/chemistry units devoted an average of only 12.5% of their pages to these activities.

In the booklet, "The Techniques of Writing Correspondence Courses", Perraton (1973) has suggested that if a correspondence text has a "variation in Texture" it will be more interesting for the students. Holmberg (1979) has reported that the structure of printed materials needed for distance-teaching study differs considerably from that needed for text books. The presentation in a text book he suggests can normally be supplemented by the exposition of a teacher. The distance-teaching material, however, must

Fig. 5.4

Profiles of the ESP Written Materials Based on the Quantitative Data in Table 6



guide and teach,

> "by giving complete explanations with elucidating examples, by providing exercises of various kinds and by constantly referring to what the student has already learnt to master".

Since the ESP programme is a distance-teaching course it is important that the printed materials should have the structure of correspondence materials rather than that of text books. One way of judging this for ESP would be to compare its structure with that of the correspondence texts of another distance-teaching course. Using the Easley technique and again choosing the individual page as the assignable unit, an analysis was made of the first two units of the Open University Foundation Science Course to find out what percentage of the pages in these units were devoted mainly to student tasks and self-evaluation activities. In unit 1 of the Open University course (Science; its origins, scales and limitations) 33% were concerned mainly with student tasks and self-evaluation activities and in unit 2 (Observations and Measurement) 25% or seventeen of the sixty-eight pages were devoted to tasks and self-evaluation.

Table 5.7

Pages Devoted to Tasks and Self-evaluation in

ESP and Open University Units

	No. of pages	No. of pages devoted to tasks/self-evaluation	% of pages devoted to tasks/self-evaluation
Open University Science Foundation Course			
Unit 1	64	21	33
Unit 2	68	17	25
ESP			
Science units	903	190	21
Education units	557	120	22
Foundation units	398	62	16
All ESP units	1858	372	20

In ESP 20% of the written materials were concerned primarily with student tasks and self-evaluation activities. This compares favourably with the two Open University correspondence texts. In some of the ESP units over 40% of the pages were activity-based: in six units, however, less than 15% of the pages were so based. These six units would have more in common with traditional text books than with correspondence texts and if Holmberg (1979) is correct, they may prove to be difficult and uninteresting for the students.

The ESP programme is meant to train people to teach the CXC, WISC and Community High School Science programme, which are all activity-based courses in which pupils are required to undertake practical laboratory investigations and exercises. If the ESP trained teachers are able to teach these programmes effectively, they must have themselves acquired the basic practical laboratory skills. The quantitative evaluation of the ESP written materials can provide information on how well the students are prepared for practical laboratory work.

Using the Easley technique, a further analysis of the written course materials of the Science units was made to see what amount of the tasks, set for the students, involved them in practical work. The result of this analysis is given in Table 5.8 below.

Table 5.8

Practical Work in ESP Science Units

Unit Number	1	4	7	9	10	13	15	17	18
Number of Pages Practical	38	2	24	28	25	20	0	8	1
Total Number of Pages	118	92	113	171	96	121	60	81	51
% of Course Unit Practical (to nearest integer)	32	2	21	16	26	17	0	10	2

In the nine Science units, 16% of the pages were concerned with student practical work. This ranges from a low of 0% in unit 15 to a high of 32% in unit 1. There is a major difference between the biology and physics/chemistry units, with the biology units on average devoting 24% of their pages to practical work and the physics/chemistry units devoting an average of only 6% of their pages. The low percentage of practical work in the physics/chemistry units is due in part to a decision taken by the ESP Course Team that because physics and chemistry equipment in many of the schools was scarce, practical work in these subjects would be carried out mainly at the tutorial sessions and weekly workshops. A further reason for this decision was that most of the local tutors have good backgrounds in chemistry and physics but have poorer backgrounds in biology. Thus, they can devise practical work in physics and chemistry themselves but need more guidance for the biology work.

The figure of 16% for the science course material is quite high therefore, particularly in view of the fact that;

(1) much of the time spent at the vacation workshops is devoted to practical work,

(2) the local tutors provide additional laboratory work, and

(3) the students undertake a three week period of workstudy in which they carry out practical experiments and exercises in industrial and hospital laboratories,

it would seem that the ESP teachers would have adequate practical laboratory experience to enable them to teach the secondary school science programmes which are in use in Guyana.

With more than 70% of the pages of the course units concerned with content and with less than 3% of the pages concerned with science methodology, it is clear that the ESP course relied very little on the process approach to science teaching but was "traditional" in that it was mainly content orientated. Considerable space was devoted to science methodology in the first two units of the course, with unit 1 having 19.5% and unit 2 having 12.3%

of their pages related to this. The students, therefore, could be expected to have some understanding of scientific methods and processes.

The ESP course planners felt so strongly about the importance of science teaching being relevant to the society in which it takes place that they included amongst the five objectives for the course one which specifically referred to the importance and relevance of science to society. If the course was to be concerned with stressing the social implications and applications of science we might reasonably expect that a high proportion of the pages in the written materials for the course would be concerned with this aspect of science. Lewis, in his 1980 presidential address to the Education Section of the British Association, has suggested that 10% of the science course should be concerned with the social aspects of science. It is surprising, therefore, to see from Table 5.6 that in the written units of the ESP course only 5.8% of the 1858 pages were devoted to the social aspects of science. As with the other categorization there was a wide variation between the units. Unit 15, for example, had only one page which was classified as stressing the relevance of the course material to society, while unit 2 devoted 33 of its pages (31.2%) to this.

There is some difficulty in classifying pages to the "relevance" category. The theme and title of unit 2 is "Science, Education and Society", and so almost the entire unit could be classified as being concerned with the relevance of science and education to society. Unit 7, the ecology unit, on the other hand was judged to have very few of its pages (2.6%) devoted to relevance. This may appear surprising. The problem is that in the context of a teacher training programme topics such as "Components and Functions of Ecosystems" and "Transfer of Energy and Materials Through an Ecosystem" and even the ecology surveys of a local area, have all been judged to belong to the content rather than the relevance category of the classification system. Only when the written material was concerned with ecological topics such as pesticides and deforestation were the pages assigned to the relevance category.

While acknowledging this difficulty it is still worth noting that in the ESP written materials very little emphasis was placed on making the topics immediately relevant to Guyanese society. Even in the units prepared by those authors who were members of the Course Team responsible for devising the course objectives, only 7.3% of the pages were concerned with the social aspects of science. One implication that can be taken from the quantitative analysis of the written materials, therefore, would be that while the Course Team authors were aware of the desire to make the science teaching relevant to society they were, in fact, able to do this to only a limited extent in their own teaching.

Student Reports on Written Materials

During the vacation workshops held in July and August 1978 the students of the 1977 intake were asked to write reports on how suitable the first eight units of the programme had been for them. At that point in time the students had completed these eight units and the assignments connected with them. They had also completed the end of Year 1 examinations based on the first six units, but they had not received their results for those examinations. The students were each given a blank sheet of paper and asked to write a paragraph about each unit. The reports were completed and returned anonymously by the students. Of the forty students then on the programme, thirty-three (82%) submitted reports.

These reports were analysed using a "key-word" technique. In this technique the reports are first read and a list of key words or phrases (Steadman 1976) that are frequently used is drawn up. Thus the words "satisfactory", "interesting", "difficult", and "disappointing"; used in many of the reports, were listed. During this first reading, words and terms which were to be accepted as simil.es for "key words" were also decided on. For example, the terms "well presented", "well put over" and "well written" were all accepted as being equivalent to the word "clear". Altogether nine key-word categories were identified. Each report was then read for a second time and if a key-word or its accepted simile occurred, this was recorded on a tally sheet. A record was made only of the first time a word occurred in a script and separate tallies were kept for each of the nine key-words. From the tallies a profile of the students' reports on the eight units was prepared, and this is presented in Table 5.9 in Appendix 1.

The units which the students reported as being the most satisfactory were numbers four and five, while the most interesting were numbers two and eight. The unit which was judged by the students to be most "unsatisfactory" and "most unclear" was unit three the mathematics unit. It was unit six, however, that was considered by the students to be the most difficult.

Looking at the raw data in this way helps us to see how the units compared with each other in the students' reports. For example, we can judge which units were the most and the least satisfactory for the students. It would also be valuable, however, if we could obtain pictures or descriptions of each unit as the students saw them and compare these with the profiles obtained via the quantitative analysis. One way of doing this is to use the results of the key-word analysis again but this time to accept that if a key-word occurs at or above a fixed frequency in the reports then that word can be used in the description of that unit. From a review of Table 5.9, and taking into account the fact that the scripts used were free response reports, it was decided that if 7 (21%) or more of the students used a key-word in their scripts then that word could be used in a "word-picture" description of the unit. The figure of 21% was chosen because it was the most discriminating, and by using it eight of the nine key-word categories (in Table 5.9) could be incorporated into the analysis. Using this acceptance level the following word pictures of the eight units were obtained.

From these word pictures we can see that some of the key-words appear together in a number of units. Units 1 and 5 share the same description, namely "satisfactory, clear, interesting, easy and long". Units 2 and 8 were

were judged to be "clear" and "interesting" but were not reported as being "satisfactory". (Only 3% of the students reported unit 2 and only 6% of them reported unit 8 as such.)

Unit 1	Satisfactory, clear, interesting, easy, long.
Unit 2	Clear, interesting.
Unit 3	Disappointing, unclear, difficult.
Unit 4	Satisfactory, interesting.
Unit 5	Satisfactory, clear, interesting, easy, long.
Unit 6	Interesting, difficult, long.
Unit 7	Satisfactory, intersting, difficult.
Unit 8	Clear, interesting.

Units 1, 2, 5 and 8 all share the description of being "clear" and "interesting". Units 1, 4, 5 and 7 were reported as being "satisfactory" and "interesting" and units 1 and 5 were "clear" and "satisfactory".

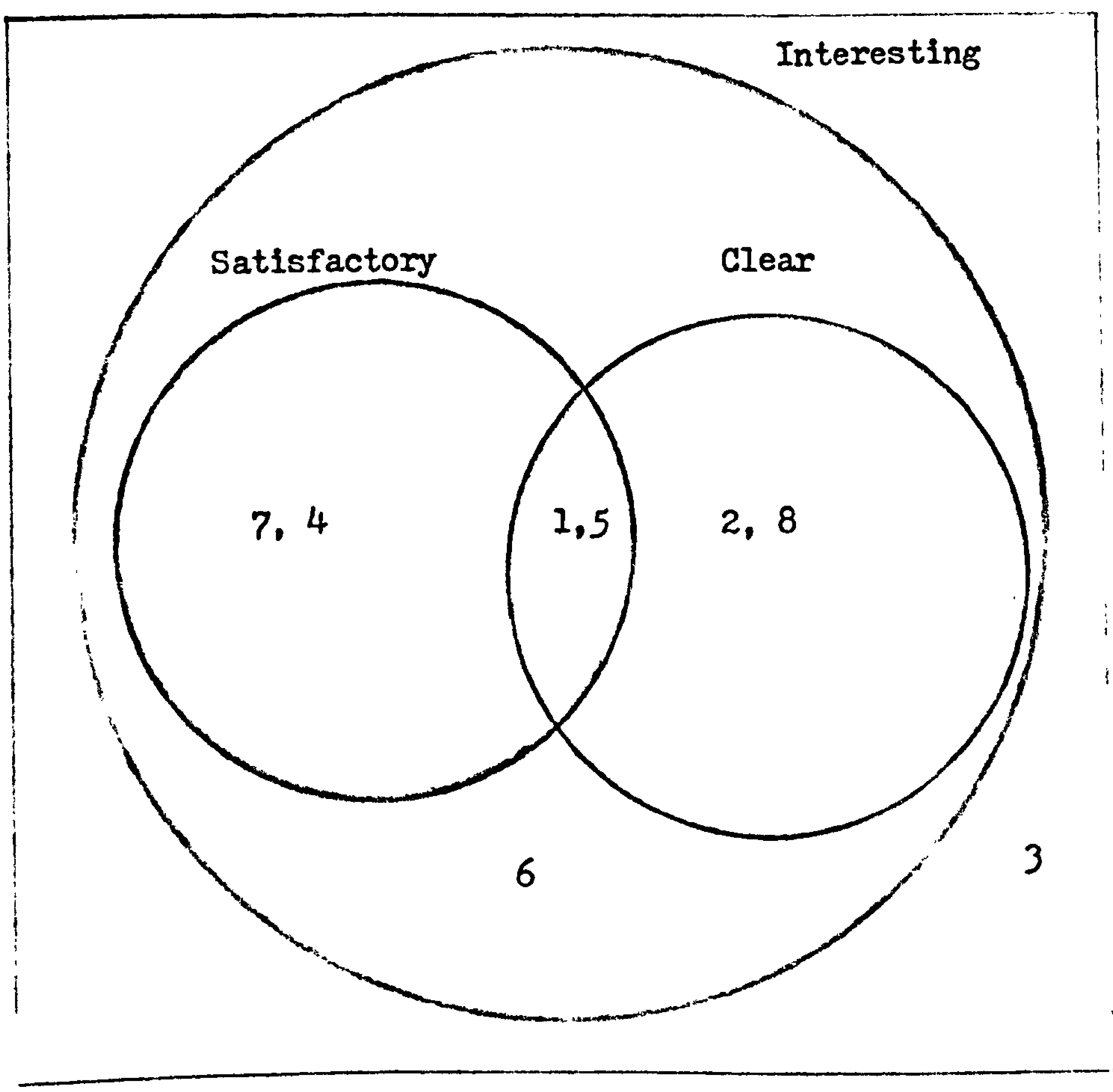
From the results it is evident that although all the units which were reported as being "clear" were also reported as being "interesting" not all the "interesting" units were seen by the students as being "clear". Similarly, while all the "satisfactory" units were judged to be "interesting" by the students not all the "interesting" ones were seen as "satisfactory". We can also observe that of the units described as being "satisfactory" not all were also described as being "clear", nor were all the "clear" units "satisfactory".

The results demonstrate, therefore, that for these first eight units to be either "clear" or "satisfactory" they had to be "interesting" for the students. However, units could be "interesting" and still be neither "clear" nor "satisfactory". It can also be concluded that the units could be "satisfactory" for the students without necessarily being "clear" and even though a unit may be "clear" for the students that did not necessarily mean that the students thought it was "satisfactory".

One way of representing these statements more simply is to depict them in a Venn diagram. Such a diagram for the three descriptions of "interesting", "satisfactory" and "clear" is given below (see figure 5a).

From the Venn diagram it can be seen that while units 1 and 5 were "clear", "interesting" and "satisfactory", units 2 and 8 were "clear" and "interesting" but did not reach the threshold level required for them to be described as "satisfactory". Units 4 and 7, however, were "satisfactory" and "interesting" but did not reach the level required to be described as "clear". Although unit 6 was reported as being "interesting" only two of the students reported that it was "clear". Unit 3, the students thought was neither "interesting" nor "clear" nor "satisfactory".

A Diagram of the relationship between the descriptors Satisfactory, Clear and Interesting in the Students' Reports of ESP Units 1 - 8



Comparing the Students' Reports with the Quantitative Analysis

Since the quantitative analysis of the written curriculum materials was carried out independently of the students' reports it would be of interest to know if there was a relationship between the students' descriptions of the units and the structures that were found to exist in the quantitative analysis. For example, it would be valuable to know if the units that the students found to be satisfactory had more self-evaluation exercises in them than the units judged to be unsatisfactory, or if the units with the highest percentage of content in them were seen by the students as being more, or less, difficult than the others. Such a comparison can be done for the first eight units of the course since the students' reports and the quantitative data are both available for these units. Using information from Tables 5.6 and 5.9, the eight units were ranked for each of the five functional categories used in the Easley quantitative analysis. Thus, the unit which had the greatest content percentage was ranked first and the unit with the second greatest content percentage was ranked second. The same eight units were then ranked for seven key-words used in the analysis of the students' reports. The word "unsatisfactory" was not included because it was only used in connection with two units (numbers 3 and 5).

Rankings for the twelve categories (five functional and seven descriptive) were then set out as in Table 5.10 in Appendix 1. Using Spearman's technique for ranked order data, the Rank Order Coefficient of Correlation between each of the five functional categories and each of the seven descriptive categories was calculated. The thirty-five correlations obtained are presented in Table 5.11 in Appendix 1. Only two of these thirty-five correlations were statistically significant at the 5% level. There were, however, thirteen other correlations which had values of 0.5 or more and a number of trends appeared to be consistent throughout the results.

High correlations were found between the percentage of the pages in the units devoted to self-evaluation and the students' responses on clarity

(P = .82 significant at 5% level) and on ease (P = .77). The percentage of self-evaluation activities were negatively correlated with the students' rankings of the difficulty of the units (P = -.82 significant at 5% level). We can summarize these results by saying that the greater the percentage of self-evaluation activities in a unit the clearer, the easier and the less difficult the students said that they found that unit to be.

There were high positive correlation between the percentage of content and the students' rankings of the units being unclear and difficult. At the same time there were high negative correlations between the percentage of content and the students' rankings on interest and clarity. This can be summarized by saying that the greater the percentage of content in the units the more difficult (.57), the less interesting (-.68) and the less clear (-.62) the students found the units to be.

Section 5

Summary and Implications of Intrinsic Evaluation

The intrinsic evaluation of ESP made a detailed study of the curriculum materials used for the programme. The written correspondence units were first of all analysed using a content analysis technique and the students' reports about the first eight units were analysed using a key-word technique. From the evaluation a number of factors about the programme have been identified.

(1) The ESP programme has considerably fewer study hours devoted to educational theory than was originally planned by the course organisers.

(2) Although the objectives of ESP emphasise the importance of science and technology to society the small amount of study time devoted to this in the correspondence units indicates that it did not have a high priority for the course writers.

(3) A higher priority was given by the writers, however, to the place of practical laboratory work in the programme, with 18% of the pages in the correspondence units being devoted to this.

(4) In unstructured and anonymous reports on the first eight correspondence units, only one unit (unit 3) was reported by a substantial number of students (21%) as being unsatisfactory: 42% of the students also reported that this unit was unclear and 24% wrote that they had found it difficult.

(5) A significant positive correlation was found between the percentage of pages in a unit devoted to self-evaluation and the number of students who wrote about the unit as being clear. There was a significant negative correlation between the percentage of pages of self-evaluation and the number of students reporting that the unit was difficult.

Implications

The intrinsic evaluation has shown that teachers trained via the ESP programme have less educational content than was originally proposed. The curriculum materials have given a high priority to academic content and to practical work but have placed little importance on the relevance of science and technology to society. It will be of interest, therefore, to see if the students' performances in these different areas reflect the relative importance given to them in the correspondence materials.

One important implication for the ESP programme arises from the students' comments on the mathematics unit (unit 3). From the students' point of view, the unit was unsatisfactory, unclear and difficult. Unit 3 was included in the ESP programme in order to ensure that the students had enough mathematical background to enable them to understand and teach science up to CXC level. If unit 3 was unsatisfactory, unclear and difficult for the students one might well ask if the teachers do have the necessary background. The Course

Team was aware of the problem with unit 3 quite early in the course, however, and the mathematics section of unit 14 was increased to include an additional twenty-six hours of study in order to help the teachers overcome specific difficulties encountered in unit 3.

The significant relationships between self-evaluation exercises and students' reports on difficulty and clarity highlight the importance of incorporating self-evaluation exercises into the correspondence units. A number of the units, for example numbers 10, 13 and 15, have no self-evaluation exercises in them. In the light of the results, it is essential, therefore, that for future students an effort be made to modify these units, by for example, providing supplementary materials containing self-evaluation exercises.

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Chapter Six

The Context Evaluation

A performance evaluation assesses a curriculum innovation in terms of its impact on pupils or students, for example, the extent to which their performance of certain criteria has improved. A context evaluation, on the other hand, looks at the wider implications of the innovation, by posing questions such as, has the innovation had any effects on the teachers' teaching behaviour or style? Has it influenced the overall curriculum of the school? West (1975) claims that a context evaluation is "essential" for a full summative evaluation of a curriculum innovation and suggests that it should,

> "assess the effects of implementation of the course in terms of staff loads, resource allocations and curricula organization in schools; and estimate the effect on the curriculum proposals of the varying conditions under which it has been implemented"
> (ibid p. 24)

The principles suggested by West were followed though they were adapted to suit the ESP programme. A number of different approaches were used. To get as comprehensive a view as possible of how the programme has affected and influenced science education in Guyana, interviews were conducted with personnel at all levels within the Ministry of Education and within the ESP programme itself. Discussions were held with groups of ESP teachers, questionaires used in the formative evaluation were reviewed and analysed, as were notes, minutes of meetings and letters in which ESP was discussed.

Individual interviews were conducted with senior personnel of the Ministry of Education, including the Chief Education Officer, the Deputy Chief Education Officer and the Chief Planning Officer. They were also conducted with people who worked on the ESP programme, science officers, course writers, local tutors, head teachers, the course coordinator and with successful and unsuccessful students. A number of people who were not directly involved in ESP but who could perceive its effects were also interviewd, for example, the Principal of the Lilian Dewar College of Education and the Appointments Officer at the Teacher's Service Commission.

Goran (1977) has suggested that structured interviews are more productive than unstructured interviews because they provide many responses to particular questions and thus enable assessments to be made of the consensus which exists amongst those interviewed. With this in mind, loosely structured interviews were conducted for the ESP evaluation. Participants in the programme were each asked the same four questions and then were invited to make general comments and observations about the ESP programme. The four questions asked of each person interviewed were:

(a) How successful do you think ESP has been?

(b) To what extent has it met the objectives set for it?

(c) What do you feel are the strengths of the ESP programme and what are its weaknesses?

(d) How could the programme be improved?

Views of Ministry Personnel

All nine Ministry officials interviewed felt that the ESP programme was successful and, in a letter to the author, the Secretary to the Board of Examiners, reported that the Board felt that the course had been "very carefully conceived" and in a "practical way" had met the needs of teachers in the system. He noted that the programme's,

"implementation also came in for considerable praise (from the Board)". Ministry personnel who visited schools reported that a number of head teachers had commented favourably on the subject knowledge of the ESP teachers, and one officer who ran workshops for teachers in community high schools noted that the ESP teachers at these workshops appeared to be "more proficient" in practical work than the college-trained teachers. However, the main benefits of ESP as reported by the Ministry personnel were:

1. The in-service nature of the programme meant that there had been an immediate effect upon the schools. Instead of having to wait for two or three years before acquiring science teachers, the schools had been able to use the ESP trainees in the classroom right from the start of the programme.

2. A number of the officers spoke of the beneficial effect the programme had upon the attitudes of Ministry personnel. One officer commented that because of the success of ESP it was now possible to contemplate the development of a similar programme to upgrade or update the knowledge of trained teachers. A second officer reported that because of the way ESP involved Ministry personnel in visiting trainees in schools, there was now a closer relationship between Ministry personnel and teachers. Thus there was now a group of teachers in the system who could be used in the implementation of new programmes. This officer felt that there was "no barrier" between the ESP teachers and Ministry personnel and when visiting ESP teachers in school,
"You didn't feel you needed to stand on ceremony".
According to this officer, the success of ESP also meant that Ministry personnel were "more disposed" towards tackling other upgrading programmes, since they now had a "model and a structure" which they could follow and use.

A number of problems with the ESP programme were identified by Ministry personnel. Chief amongst these was the limited number of visits which the supervisors were able to make to the schools. The officers felt that more visits were desirable. It was not possible for them to increase the number of visits they said, however, unless additional staff were employed. One officer suggested that extra office staff, for instance, would release the professional officers for "more productive work" such as school supervision.

A lack of communication between the Ministry personnel involved in ESP was reported by one officer with the suggestion that regular meetings of school supervisors should be held so that the strategies used on school visits could be discussed and standardized. Another officer suggested the need for "a more definite schedule of visits". Instead of officers arriving at schools "whenever it suited them", he suggested they should be required to visit students "on fixed schedules" so that the students would know in advance when they would be observed teaching. A number of officers expressed concern about the role played by local tutors. They acknowledged that the tutors could handle the science content of the ESP programme but were unsure that they "could cope with the professional requirements". Three officers suggested that experienced educators should be employed as education tutors and "visit" the different tutorial groups. Some concern was also expressed about the limited attention and backup that was given to students in the interior regions. One officer commented that the greater the distance from Georgetown the less attention the students received, and a second officer suggested that,

> "For far-out-of-town areas, one would need to think of a parallel, additional support for teachers".

The effect of ESP on recruitment to the College of Education programme was noted by the Prinicpal of the College and she commented that,

> "Teachers don't want to take the College programme. Why should they travel to Georgetown when they can train in school and the Ministry will travel to them?".

The Views of the Course Writers

Of the eleven people who had written correspondence material for the ESP programme, four had left the country permanently and two were on overseas study leave. Interviews were conducted with two of the remaining five. These two, however, had each written a number of the correspondence units, and the other three had written only one unit each.

Of the two interviewed, one said he was "well satisfied" with ESP and the other reported that it was "basically a sound programme". Both commented on the enthusiasm of the trainees and suggested that the in-service nature of the programme had been its major strength, since the teachers could apply their new knowledge "almost continuously". One of the writers suggested that the distance-teaching structure of the course had "almost forced" the students to learn on their own, and now, he commented,

> "One gets the feeling that they have been taught to do something all courses should do but don't - think and study on their own".

Both writers felt that there was "some" weakness in the professional aspect of the programme. This, they suggested, was mainly due to the fact that the local tutors were teachers rather than teacher educators. One suggested that the tutors should receive a training workshop to prepare them for their role as educators. The other writer, however, preferred the idea of using "visiting" tutors who could help the local tutors with the "professional parts" of the programme. The "Psychology" correspondence unit (no. 7) was described by one of the writers as being "incomprehensible" and in urgent need of revision. He also suggested the need for more "support materials" such as photostat articles and extracts from journals and books. These he felt could be used as,

> " a prop, a supporting body of indirect support".

He also suggested that better use could be made of the film-strips and slides that had been presented to the Ministry by the Overseas Development Association. These were under-used he suggested, because there was no structure or procedure for distributing and collecting them from the local tutorial centres.

Views of the Local Tutors

By January 1981, when the interviews were conducted, five of the seven teachers who had acted as local tutors for the 1977 intake of ESP students had emigrated. The remaining two were interviewed. One felt that the main strength of the programme was its "structured approach" and suggested that the fact that the students received travelling expenses to tutorials and "free study" periods during their normal teaching hours had been major motivational factors for the students. The second tutor had been a school teacher at the start of the ESP programme but in 1980 chose to move to the College of Education. This he commented was partly because of his favourable experience with ESP. He had taught both ESP and College students and suggested there was a friendlier "more informal atmosphere" at ESP tutorials with the students showing a greater "willingness to get involved" in the sessions. This tutor reported that the academic content of a number of the units had been "too difficult". He mentioned that Unit 15 had been particularly difficult for him since it dealt exclusively with physics and his degree had been in chemistry and biology. For the ESP programme the tutors needed to help the students in all three science areas and this was difficult he suggested because most of the tutors were like himself, and had a content background in only one or two of the areas. The late arrival of some of the correspondence materials had aggravated this problem, he felt, because then they had to deal with the material at the tutorials without having adequate time to "read it up". The "legibility of print" had been a "real problem" in a number of the units both for the tutors and for the students, and they suggested that there was a need for "more liaison" and "better communication" between the tutors and the Ministry. Poor communication, one tutor suggested had restricted the use that was made of the audio-visual materials. One tutor felt that not enough emphasis had been placed in the programme on the relationship between science and society. This he noted had been a major aim of the course and yet it had received attention in only one unit (no. 2).

The Views of ESP Students

Group discussions were held with twenty of the twenty-nine students who had "graduated" from the ESP programme in 1981 and interviews were held with two of the successful and one of the unsuccessful students from the 1977 intake.

The students expressed satisfaction with the programme and felt that they had been well prepared for their job. They were highly critical, however, of the organization and coordination of the programme during the 1979 to 1980 period, complaining that they had lost a lot of their enthusiasm because of the numerous delays that had occurred in 1980. Their teaching assessment, they reported, had "dragged on" for months and they had not been informed when the assessment period ended. They only received timetables for their final examinations one week before they were due to write them and they were receiving parts of the final correspondence right up to a few days before the examinations. The students were unanimous, however, in their opinion that the worst problem had been the seven months delay between sitting the final examinations and receiving the results, and many of them spoke about the "tension" that this had caused. The "unhelpful" attitude of people at the Ministry of Education during this period was commented on by a number of the students and some complained that they "still" (February 1981) had not received their travelling expenses for the 1980 January to April (Spring) term.

The students felt that the ESP programme itself had been very successful and many had recommended other teachers in their schools to apply for entry. There were criticisms from the ESP teachers, however, about the general lack of organization in the programme in late 1979 and 1980. The unsuccessful teacher who was interviewed reported that he had "dropped back a year", but this had not been because of the administrative problems but rather because of his own doubts about remaining in teaching. After being introduced to distance-learning methods by the ESP programme, he had enrolled on other correspondence courses and had passed a number of the examinations of the Institute of Administrative Accountants. He was at that time still undecided whether he should complete the ESP programme and remain in teaching or accept a more highly paid job he had been offered by an insurance company.

The Effect of ESP Under Varying Conditions

West (1975) has suggested that one of the most important functions of a contextual evaluation is the assessment of how the curriculum was affected by the varying conditions under which it was implemented. The ESP programme was followed by students from four different tutorial groups and by a small number of students who were unable to attend tutorial sessions (see Chapter Five). Since the programme was applied in different areas and under different conditions it is important to see if the performance of the students was affected by the variation in conditions. A comparison of the performances of the students from the different areas is shown in Tables 6.1 and 6.2 below.

Table 6.1

Comparison of Teaching Grades Awarded to Teachers from Different ESP Tutorial Groups

	Teaching Grades										
Group	A+	A	A-	B+	B	B-	C+	C	C-	D+	N	Mean Grade
Georgetown	-	1	-	-	1	4	1	1	2	-	10	B-
Berbice	-	-	-	1	3	2	2	-	-	2	11 *	B-
West Dem.	-	-	-	2	2	-	2	3	-	-	9	B-
North West	-	-	-	-	1	1	-	1	-	-	3	B-
Others	-	-	-	1	-	1	-	-	-	-	2	B

* One student received an aggotate pass

Table 6.2

Comparison of Science Examination Results of Teachers from Different Tutorial Groups

Group	Mean Science Score	S.D.	N
Georgetown	53.8	8.9	10
Berbice	47.4	4.5	11
West Demerara	53.9	13.3	9
North West	34.7	3.8	3
Others	51	4.2	2

North West - Georgetown $t = 3.4$, 11df 5% significance

North West - West Demerara $t = 2.3$, 10df 5% significance

North West - Berbice $t = 4.5$, 12df 1% significance

The mean teaching grades awarded by the Board of Examiners to students from the different groups are shown in Table 6.1. Students from the four tutorial centres received the same mean grade, and the two students who did not attend tutorial sessions received comparable grades (B+ and B-). The scores obtained by the students from each group in the final science examination were calculated and are shown in Table 6.2. The Georgetown and West Demerara teachers received on average higher examination scores than either the Berbice or the North West teachers. The differences between the three "coastal region" tutorial groups (Georgetown, West Demerara and Berbice) were not statistically significant at the 5% level. However, the science marks gained by all three coastal groups were statistically higher than those gained by the North West "interior" group. Tutorials were organized by the individual tutors in each region. Differences in tutors' abilities and personalities do not appear to have affected the teaching and examination grades of the students in the coastal region. The local tutorial sessions, however, do appear to have had an important impact upon the student's performance. All three students in the North West group were "referred" by the Board of Examiners. This was partly due to poor local administration for project and workstudy exercises, but there had also been frequent problems in organizing tutorial sessions in the area. The first tutor for the North West was an American Missionary Sister who was ordered to return to her convent in the United States for health reasons. She left in June 1978. Another expatriate was recruited in September 1978 to replace the Sister both at her science teaching post and as local ESP tutor, but it meant that the North West students were without tutorial support for six months in 1978 and this lack of support was seen by Ministry personnel as being an important factor in causing the students to be referred.

Of the forty-two students who began training in 1977 only four had ever received visits from the course coordinator about poor attendance at tutorials. Two of these asked, for health reasons, to be allowed to "wait back a year" and finish their training with the 1978 intake of students. The others were the only two students from the coastal region groups to be referred by the Board of Examiners. One had failed in the mathematics examination and had not completed the workstudy assignment. The other had failed to submit project work. It is clear, therefore, that regular attendance at the local tutorial sessions is an important, if not essential, part of ESP training. There is a problem, however, in having regular tutorial sessions for teachers in the remote and isolated regions of Guyana.

Effects of ESP on School Timetables

For the teachers one of the benefits of ESP is that while they are on the programme they are entitled to have a reduced teaching load. It has been difficult, however, to implement this aspect of the programme. In spite of a circular from the Chief Education Officer, and numerous letters from the coordinator informing head teachers that the ESP teachers should receive only four-fifths of a normal teaching load, many head teachers were reluctant to allow for this in the time table. The local tutors and visiting supervisors commented on the difficulties faced by the students in securing the reduction in work load. The teachers reported, however, that by the third year of training they had little difficulty in obtaining this but did have problems in their first year. If the teaching load of an ESP teacher is reduced by one fifth, then either the amount of science teaching is reduced in the school or the "excess" load is shared amongst the other teachers. One effect, therefore, of ESP on the overall school curiculum is to increase the teaching load of other teachers. If the extra load of five or six periods per week can be shared amongst a number of the teachers this may be easily accommodated in a school but it can be difficult if there are only two science teachers in the school or if two or three ESP teachers are teaching in the same school.

The regular visits of Ministry personnel to observe ESP teachers has helped to increase the Ministry's understanding of the situation in schools. ESP has meant that the officers now visit a greater range of schools and are familiar with the situation that exists in less well equipped schools. The regular visits of Ministry personnel have also had a positive effect on the attitudes of head teachers. The Education Officer (Science) has noted, for example, that,

> "The programme has also helped to produce a notable improvement in the attitude of the head teachers in secondary schools towards the teaching of science in their schools. They have seen a fresh impetus coming from the Ministry of Education and many of them, seeing for the first time the possibility of having a permanent science teacher on their staff, have become much more sympathetic towards improving the facilities for teaching science in their schools". (Brophy and Dalgety 1980)

Effects of ESP on School Ancillary Staff

Local tutors and course writers who worked as visiting lecturers at the vacation workshops spoke about the problem of getting the active co-operation of laboratory staff in some of the tutorial centres. In Guyana, school laboratory technicians are public servants and as such are required to work until midday on Saturdays. Normally they have little work to do on Saturdays. However, in the schools used as ESP tutorials centres the technicians are required to set up and put away the apparatus and equipment needed for the ESP practical sessions. This is an additional workload for the technicians. Due to a ruling of the Permanent Secretary of the Ministry the technicians cannot receive additional payment for this extra work. They resent this ruling and on occasions demonstrate this by, for example, not preparing apparatus for tutorials or as reported by one tutor,

"sometimes turning up late on Saturday and thus hindering the work".

Their protest has occasionally affected the vacation workshops since the same ruling applies. The problem has been reduced somewhat by a compromise. Payments are made for work which is notionally done after normal working hours - for instance, a generous allowance for the collection of frogs for dissection. The lack of co-operation of laboratory staff still remains a problem at one Georgetown centre. Vacation and local tutors both suggest that more practical work could be carried out if some "incentive" payments were made to the laboratory staff.

Resources for ESP

(a) Media Materials

Two types of media materials are used in the ESP programme, those produced commercially and obtained mainly through the Overseas Development Association, and those produced in Guyana specifically for the ESP programme. Commercially produced 16 mm films are obtained via the Ministry's Audio-Visual

Aid Unit and are frequently used at the local tutorial and vacation workshop sessions. However, only limited use appears to be made of the film strips, slides and audio tapes obtained from ODA.

(b) Books

In contrast to the media materials, the library books supplied by ODA are extensively used by the ESP teachers and were seen by the course writers, supervisors and local tutors as making a positive and substantial contribution to the programme. The greater use made of the books may be due to the fact that seven copies were obtained of each book but only single copies were obtained of the media materials. Tutorial groups could only borrow the media materials but had their own copies of the books.

Effect of ESP on School Resources

A number of schools have benefited from the in-service nature of ESP. Because of the high turnover of teachers, Ministry personnel were reluctant to send science equipment into many of the schools, particularly those staffed by untrained teachers. The ESP teachers, however, had signed bonds to remain in teaching and as regular contact was set up with them during the supervisory visits, Ministry personnel became more willing to send equipment into their schools. The schools used as local tutorial centres also received additional supplies of equipment and materials. This equipment was not diverted from other schools but came from the Ministry storeroom where most of it had lain unused for a number of years. One effect of ESP, therefore, has been to increase the amount of equipment sent out by the Ministry and head teachers have been quick to recognise that schools with ESP personnel are the main beneficiaries.

The innovatory nature of ESP has aroused interest from outside Guyana and helped the Ministy to acquire materials and equipment for it. For instance, the library books for the tutorial centres were obtained via a visiting ODA officer and the visual aid materials were part of a British Council/ODA pilot scheme to test the feasibility of supplying "audio-visual software" to developing countries. The ESP programme was specifically chosen by the overseas aid body on both occasions.

Summary and Conclusions of the Context Evaluation

The context evaluation has shown that the ESP programme has had a number of "indirect" effects upon education in Guyana but the evaluation has also highlighted a number of weaknesses in the programme itself. ESP's effects on education in Guyana have been largely beneficial. The programme has helped to produce a better rapport between Ministry personnel and teachers - both head teachers and science teachers. Two important features of this rapport are firstly, the "new confidence" of the officers in the Ministry of Science Unit, who are now "more disposed" towards attacking other problem areas and secondly, the good communication they now have with the ESP teachers, whom they now view as a "group" they can "use for implementing" new science curricula. ESP has also encouraged a greater flow of science chemicals and equipment to the schools and in two instances has attracted funding from overseas aid agencies.

The context evaluation has also demonstrated a number of weaknesses in the ESP programme. A number of the people interviewed felt that some improvement could be made in the professional training of the ESP teachers. The administrators suggested that this could best be done by recruiting more staff to help with the supervisory visits. The course writers and supervisors felt, however, that it would be more profitable to provide additional support to the local tutors.

A second problem identified in the evaluation is the limited use being made of the audio-visual aid materials. One local tutor has suggested that while the materials themselves are satisfactory, they are not being used because of the difficulty in borrowing them from the Ministry. Local and visiting tutors have both reported difficulties in getting the cooperation of school laboratory staff and suggest that this has hindered the amount of practical work they were able to carry out.

The evaluation has demonstrated the importance of the local tutorial centres for the ESP programme. The examination results and final assessments grades of students from the three main tutorial centres are similar. In the North West region, however, where there were problems in maintaining the tutorial service. all three students have been referred by the Board of Examiners and of the three students who attempted to follow the programme without attending regular tutorial sessions, only one has so far completed the programme.

The main recommendations that came from the interviews with Ministry personnel, course writers, local tutors and students were:

1. More emphasis should be placed on the professional training of teachers in the ESP programme. To help to do this students should receive more supervisory visits and have a number of tutorial sessions on teaching methods conducted by specialist resource or visiting tutors. The professional training of the teachers could also be improved if the local tutors were to receive a short in-service programme on teacher education.
2. The organization of the ESP programme within the Ministry of Education needs to be improved, particularly with respect to the marking of examination scripts and assessment of teaching performance.
3. Additional members of staff should be recruited to work on the programme. There is a specific need for someone to be appointed to take charge of the production and lending of all ESP materials. If this were done, the production of the correspondence units and the use of the audio visual materials would be greatly improved.
4. Some form of additional support or alternative tutoring arrangement is required for students in the remote and isolated regions.

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Chapter Seven

Identifying the Characteristics of Effective Science Teaching

The first stage in the evaluation of ESP involved evaluating the curriculum materials. The second stage looked at the programme in terms of its context within the Guyanese education system. The third stage, which is described in the following three chapters, involved evaluating the programme in terms of the performance of the teachers it trained. In Eggleston's terminology this would be the "product evaluation", in West's the "extrinsic evaluation". However, evaluating a training programme in terms of teachers' performance first requires the criteria of the teaching performance to be decided.

There have been many attempts to identify such criteria. Barr (1961) reviewed seventy-five doctoral studies on this topic undertaken in one American state alone. Avalos (1980) reviewed the results of 589 studies carried out in third world countries into the relationship between teaching performance, teacher characteristics and pupil achievement. Husen (1978) reviewed sixty-four such studies in Less Developed countries and Rosenshine (1971), fifty in developed countries. In 1974 Heath and Nielson reviewed teacher effectiveness studies and noted,

> "research into the relationship between teacher characteristics and student achievement has been conducted for more than fifty years. A large number of studies of this relationship have been done, but reviewers of this body of research generally conclude that an educationally significant relationship simply has not been demonstrated".

Adams and Biddle (1970) have commented that evaluations of teacher efficiency are "consistently inconsistent", while Rosenshine and Furst (1973) have suggested that,

> "It is possible that the patterns of effective teaching for different ends are so idiosyncratic that they will never be isolated".

In 1977 Power wrote of the "fruitless enterprise" of attempting to link ratings of teachers with pupil growth and in 1979, Galton and Eggleston noted that studies which had attempted to relate prescriptions of "good" teaching with pupil achievement had "failed to establish significant correlations". However, despite these generally negative comments, for the ESP programme to be evaluated in terms of teachers' teaching performance it was necessary to identify the criteria for effective or satisfactory science teaching in Guyana.

Difficulties in Measuring Teacher Effectiveness

There seem to be two main reasons why the results of the research studies into teacher effectiveness have been so disappointing. Firstly, the studies have used many different techniques for assessing performance. In some studies, for instance, performance is assessed by observers using observational schedules, or category systems, such as the Flanders Interaction Analysis or the Science Teaching Observation Schedule (STOS), Galton and Eggleston (1979). Rosenshine (1971) refers to these as low-inference measures of performance because the category items focus upon specific, denotable objective behaviours that are recorded as frequency counts. Other "effectiveness" studies, however, use high-inference measures of performance, such as rating scales, in which the observer is expected to infer the frequency of a particular behaviour, for example, by recording that the particular behaviour occurred "very often", "sometimes", or "never". The problem is that these different test instruments can yield different results and even the same instrument can yield different results if applied under different conditions (Dunkerton and Guy 1981).

Not only have teacher effectiveness studies used different instruments but they have also used different criteria for assessing effectiveness. Some, such as Jones (1956) have used composite measures of effectiveness;

many have used just pupil achievement as the measure of effectiveness, and yet others have chosen to measure teacher effectiveness in terms of attitudional change in pupils. There is evidence that the different measures produce different results. Snider (1966), for example, used two different tests of pupils' physics achievement in his study and found that while certain teaching behaviours were significantly related to pupil attainment on one test they were not significantly related to it on the other. Chall and Feldman (1966) report a similar finding using two tests of pupils' reading achievements.

A second major problem encountered by those who have reviewed studies of teacher effectiveness stems from the fact that the studies have been carried out in many different situations and under a wide range of environmental conditions. Avalos (1980), for example, reviewed studies from places as far apart and culturally different as Paraguay, Iraq, Uganda and Malaysia. Teacher effectiveness in Paraguay was assessed in terms of the science achievement of fourth and sixth grade pupils, while in Malaysia it was based on the reading achievement of pupils in primary schools. The generalizability of results from such studies of teacher effectiveness may be extremely limited, yet as Shavelson and Russo (1977) have noted, often,

> "While the measurement is taken in one particular setting at a particular point in time, the measurement is interpreted as generalized over many settings at different points in time".

As the general characteristics of good teachers were not clearly identifiable, there was a problem in evaluating ESP of how to establish valid criteria for assessing the performance of science teachers. This was resolved by determining the skills and abilities that were needed specifically by ESP teachers to teach the particular science courses used in Guyanese secondary schools.

The approach adopted was to determine skills and competencies that Guyanese science educators wanted to produce in secondary school science teachers and then to see if the ESP teachers had acquired these. The skills and competencies that Guyanese science educators wish to develop in science teachers were identified using a three-stage strategy. Stage 1 involved a review of the major surveys which have identified competencies thought to be important for science teaching. Stage 2 related the results of these surveys to research findings and Stage 3 used the information collected in Stages 1 and 2 to identify the skills and competencies that were considered by science educators in Guyana to be most important for science teaching.

Stage One

Surveys of Desired Teaching Characteristics

Twelve major surveys have attempted to identify the teaching competencies which science educationalists feel are important for science teaching. Some have reported on the opinions of school science teachers, others on the opinions of science supervisors and research workers and one on the opinions of "hiring officials". The twelve surveys are listed in Table 7.1 below.

Butjow and Qureshi (1978) - see also Qureshi (1967) - have attempted to identify and validate "observable competencies" for prospective high school science teachers in the USA, competencies which would be "realistic" and "relevant" to actual teaching situations rather than an idealised list. They first obtained a random sample of the names of twenty-one high school science teachers from a list of 201 names of teachers who had been nominated as being highly competent. The researchers interviewed the teachers and from the interviews they identified and ranked twelve competencies which the teachers regarded as being important for science teaching. They then videotaped the same teachers teaching a science lesson and had the lessons rated by a panel of fourteen judges. From these ratings they identified a set of five competencies which were,

> "both highly rated by the participating teachers and were judged as being significantly demonstrated in the classroom".

Five competencies, therefore, were highly regarded by the teachers and were seen to actually exist in their teaching behaviour. Qureshi identifies the five as, the teacher must,

1. know his subject and keep striving to update his knowledge,
2. have a good rapport with his students,
3. make his lessons interesting without wasting time,
4. be able to control discipline problems to protect the learning experiences of his students, and
5. plan lessons in advance with the idea of presenting the scientific concepts and ideas in an organized and clear manner.

These five basic competencies can be summarized under the headings, Subject Knowledge, Rapport, Presentation, Management and Discipline and Organization and Planning.

In 1975 Houshell and Dieter used a slightly different technique for identifying important teacher characteristics. They obtained self-image scores of forty-three teachers who were 1970 winners of the Outstanding Biology Teacher Award of the US National Association of Biology Teachers. They then compared the self-image of these "outstanding" Biology teachers with that of "normal" teachers. The "outstanding" teachers scored significantly higher on ten scales and significantly lower on one scale. They were more orderly and placed greater emphasis on organization and planning; they were more dominant and sought to sustain leadership roles; they were more poised, self-controlled and persistent; more likely to try to understand other people's behaviour. Again, the differences can be summarized into a number of categories such as rapport, organizational ability and discipline and control.

Simpson and Brown (1977) also used a group (thirty in number) of "outstanding" science educators in their study. Their group included junior high school and senior high school science teachers as well as head teachers, supervisors and university and college lecturers. The researchers used a list of twenty-three "basic competencies" for teaching secondary school science which had been drawn up by the 1974 National Science Teachers' Association ad hoc Committee on The Education of Teachers of Science. The panel of "outstanding" science educators ranked these twenty-three items but also added a number of new items of their own. Simpson and Brown then carried out a factor analysis on the results and obtained what they describe as "seven fundamental areas of skills representing basic science teaching competencies". These were,

1. Knowledge of Science,
2. Professional Knowledge and Attitudes,
3. Human Relations Skills,
4. Planning Skills,
5. Instructional Skills,
6. Management Skills, and
7. Evaluation Skills.

In their book, "Innovation in Teacher Education" Hayson and Sutton (1974) discuss the results of an analysis of the reports of fifty school science supervisors. In these reports, the six characteristics most frequently noted by the supervisors as being linked with good teaching were,

1. Confidence and calmness ... (in 18 reports),
2. Keenness, energy and enthusiasm ... (in 18 reports),
3. Ability to plan and organize practical work ... (in 15 reports),
4. Ability to use the voice well ... (in 13 reports), and
5. Knowledge of the subject ... (in 13 reports).

Prospective employers of science teachers were asked by Tamppari and Johnson (1975) what were the factors which make a science teacher attractive to an employer. Comments were obtained from the "hiring officials" of a 10% sample of 2,771 schools. According to them the most desirable characteristics were,

1. Enthusiasm and motivation,
2. Ability to communicate enthusiasm,
3. Science knowledge,
4. Successful student teaching experience, and
5. Ability to relate science to relevant applications.

A survey carried out by Their (1976) at an international conference on teacher education for integrated science asked forty conference members from twenty-eight different countries to list up to three goals or objectives which"were of most importance for the teacher of integrated science". From the replies, the most important areas were,

1. Competency in integrated science ... (19 responses),
2. Understanding and transmission of the overall relationship of science to school and society ... (15 responses),
3. Flexibility and creativity in approach ... (15 responses),
4. Ability to convey competence to students ... (13 responses),
5. Methods - attitudes, humanistic approach ... (12 responses),
6. The provision of experiences relating to the child's intellectual development ... (9 responses).

In a survey in which a group of 344 science teachers in twelve US states were asked to rate their own knowlege and abilities, Lawrenz (1974) reports that the abilities which were most highly rated were,

1. Knowledge of subject matter,
2. Effective evaluation of students,
3. Effective evaluation of curriculum.

Woolnough (1980) has written of a recent survey in the UK. In this study a questionnaire was sent to science tutors in sixty-three institutions which taught PGCE courses, and also to Senior Science Advisers in 101 Local Education Authorities. The questionnaire was also sent to heads of science departments and probationary science teachers in a sample of four LEAs. Each person was asked to rate the importance of twenty-seven different science teaching skills. Woolnough reports that the seven skills which were considered to be of most importance were,

1. Lesson planning and preparation,
2. Lesson presentation,
3. Practical work organization,
4. Teacher demonstration,

5. Safety in the laboratory,
6. Discipline and class control, and
7. Class questioning skills.

Contrary to Chiapetta, Shores and Collettes' 1978 view that there is no body of research which identifies the skills on which science educators concur are essential for science teaching, a pattern is beginning to emerge from recent research. Further evidence to support the pattern comes from four studies which Chiapetta and Collette themselves carried out in 1978 and 1980. In these studies the researchers asked science teachers (1978a, 1980), science supervisors (1978b) and science education researchers (1978c) to identify secondary school teaching competencies. In each case a Delphi technique was used. This technique involved the researchers selecting a sample of 100 people representative of the respective population and asking them to suggest competencies. A panel of judges then categorized these suggestions. A second sample of 100 people from the same population then identified the taxonomic level of each item and finally a third sample of 100 ranked the competencies on their importance for science teaching. In this way the researchers identified fifteen competencies which each group considered important. There was, however, a large overlap between the items on the four lists, with, for example, both the teachers and the educational researchers agreeing that the most important competency for science teaching was the teacher's ability to provide " a humanly supportive environment".

One of the problems in identifying important skills for science teaching stems from the fact that the authors of the different research studies often use different terminology to describe the same skill area. Butjow and Qureshi (1978), for example, report the importance of the teacher being able to "have a good rapport with the students", Simpson and Brown (1977) refer to the importance of "human relations skills". In one study Chiapetta and Collette (1978a) report the importance of the teacher providing "a humanly supportive learning environment". In their second study, however, they drop the word "learning" and write simply of the importance of a "humanly supportive environment", Chiapetta, Shores and Collette (1978). In all of the four studies, however, the authors were referring to the same skill area or competency.

Competencies For Science Teaching

By analysing the results of all twelve studies the present author has identified nine main competency or skill areas on which there is consensus. The degree of consensus for each is shown in the matrix below (Table 7.1). In this matrix the skills which have been identified as being most important in each of the twelve studies have been categorized into nine competency areas.

There is a strong consensus on the importance of Instruction and Communication (ten studies), Planning and Organization (nine studies) and Subject Knoweldge, Rapport,and Management and Discipline (eight studies each). Evaluation and Questioning (seven studies) and Relating to Pupil Development (six studies) are also generally thought to be important and there is a more limited consensus on the importance of Knowledge of Science Methods (four studies) and Relating to Pupil's Environment (three studies).

Confirmation of the perceived importance of these areas comes from a number of other studies. Moore (1978) investigated specific needs which science teachers felt were limiting their teaching effectiveness. He identified twenty such factors; the six factors which teachers considered to be most important were related to Science Knowledge, Science Methodology, Instructional Methods, Management, Establishing Rapport and providing "appropriate and meaningful science experiences." Studies of pupils' perceptions of good teaching characteristics also confirm the importance of basic competency areas identified in the teachers' surveys.

Table 7.1

Results of Twelve Surveys of Science Educators' Opinions on Comptencies for Science Teaching

Research Study	Butjow and and Qureshi (1978)	Simpson and Brown (1977)	Chiappetta and Collette (1978a)	Chiappetta and Collette (1978b)
Group surveyed	science teachers	science teachers and supervisors	science teachers	science supervisors
Rapport with pupils	Must have good rapport	Human relations skills	Humanly supportive learning environment	
Subject Knowledge	Must know subject	Knowledge of science (products)		
Planning and Organization	Must plan lessons in advance	Planning skills	Utilizes an organized approach	Plans and organizes appropriate instruction
Instruction and Communication	Must make lessons interesting without wasting time	Instructional skills	Employs a variety of instructional techniques	Employs a variety of instructional strategies and techniques
Management and Discipline	Must control discipline problems	Management skills	Conducts safely a productive laboratory	Demonstrates effective management of laboratory
Evaluation and Questioning		Evaluation skills	Evaluates student progress	Evaluates student progress and success
Science Methods		Knowledge of science (processes)	Integrates inquiry and science process with instruction	Emphasises inquiry and process approach
Relate to Pupils' Environment				Organizes a relevant science curriculum
Relate to Pupils' Development		Professional knowledge	Implements the psychology of learning	Interprets psychology of learning as it relates to science instruction

Table 7.1 continued (i)

Research Study	Chiappetta and Shores and Collette (1978c)	Chiappetta and Collette (1980)	Hayson and Sutton (1974)	Their (1974)
Group surveyed	science education researchers	science teachers	science supervisors	science educators
Rapport with pupils	Humanly supportive environment	Humanistic learning environment	Enthusiasm - keen lively approach	Humanistic approach
Subject Knowledge	Sound subject knowledge	in depth knowledge of subject	Knowledge of subject	Competency in integrated science
Planning and Organization	Plans and organizes instruction	Organizes the classroom	Ability to plan and organize practical work	
Instruction and Communication	Able to communicate effectively/ variety of instructional technique	Effective communication skills	Ability to use voice well	Able to convey to others/ flexible creative in approach
Management and Discipline		Controls the classroom	Confidence and calmness	
Evaluation and Questioning		Effective evaluation of students	Sound questioning technique	
Science Methods	Uses inquiry, process and discovery approach	Emphasises the investigatory nature of science		
Relate to Pupils' Environment				Relates science to school and society
Relate to Pupils' Development	Relates psychological development to subject matter	Promotes individual instruction		Provides experiences related to pupils' intellectual development

Table 7.1 continued (ii)

Research Study	Woolnough (1980)	Houshell and Dieter (1975)	Tamppari and Johnson (1975)	Lawrenz (1974)
Group surveyed	science tutors, advisers and teachers	biology teachers	Hiring officials	science teachers
Subject Knowledge			Above average academic ability. Broad science background	Knowledge of subject matter
Rapport with pupils		Cheerful, friendly	Highly motivated	
Planning and Organization	Lesson planning and organization			
Instruction and Communication	Lesson presentation/ teacher demonstration		Able to communicate interest and desire	
Management and Discipline	Discipline and class control/safety in laboratory	Poised, self-controlled, self-assured		
Evaluation and Questioning	Class questioning skills			Effective in evaluating students and curriculum
Science Methods				
Relate to pupils' Environment			Relates science to practical applications	
Relate to Pupils' Development				

Surveys of Pupils

Baybee (1978) used a fifty item questionnaire to study the perceptions of groups of outstanding, average and below average pupils. In each case he asked the pupils to rate the teacher they "liked best". He found there was close agreement between the perceptions of the three groups; all agreed that the two most important characteristics were (a) the teacher's "adequacy of relations with students in the class" and (b) his "enthusiasm in working with students". The teacher's "knowledge and organization of subject matter" and his "adequacy of plans and procedures in class" were also rated highly. Baybee carried out a second study in 1975 in which he sought the opinions of pupils, students and teachers on the ideal elementary science teacher. The number of teachers involved was small (forty-three) but for the three groups the most important characteristics were,

1. Adequacy of relations with students,
2. Enthusiasm,
3. Adequacy of science methods,
4. Knowledge and organization of science subject matter, and
5. Adequacy of plans and procedures.

In a UK study, Gillian and Choppin (1977) asked 413 sixth form pupils, who hoped to enter teaching, to write descriptive paragraphs on the characteristics of a "good" and a "bad" teacher. They then carried out a content analysis of the paragraphs and characterized the responses under thirteen headings for "good" and "bad" teachers. For these pupils the most important characteristics of a "good" teacher were,

(a) Ability to control class (65% of pupils)

(b) Interested in and sympathetic towards pupils as individuals (63% of pupils)

(c) Able to present the subject so that pupils understand and learn (52% of pupils)

(d) Patience (51%)

(e) Teaches in an interesting way. Inspires pupils with enthusiasm and confidence so that they want to learn (40% of pupils)

(f) Maintains high standards of behaviour and commands respect of pupils (39% of pupils).

In this study and in Baybee's two studies, therefore, the opinions of the pupils closely reflect those of teachers, educators and employers in that all three pupil studies noted the importance of "rapport". Both Baybee's studies noted "subject knowledge" and "planning", unlike the study by Gillian and Choppin which noted the importance of "management and discipline" and "instruction and communication".

These studies of Baybee and of Gillian and Choppin in turn are supported by a considerable body of evidence obtained from research carried out on college and university students' perceptions of the characteristics of "good" instructors, lecturers and professors (see, for example, Drucker and Remmers 1971, Downie 1952, Costin 1968, Gadzella 1968, Musella and Rush 1968, Crawford and Bradshaw 1968 and Whitely and Doyle 1979). The results of these seven studies are summarized in Table 7.2 below.

The main skill areas identified from this table are similar to those identified for school science teachers. The consensus of the students is that for college and university teaching the most important competencies are,

(a) Planning and organization (noted in 6 of the 7 studies),

(b) Subject knowledge (noted in 5 studies)

(c) Rapport (noted in 5 studies) and,

(d) Instruction and communication (noted in 4 studies).

The student and the pupil studies are in close agreement with each other and with the consensus of opinion of teachers and educators. There is general recognition of the importance of a teacher having skills in "establishing rapport", in "subject knowledge", in "planning and organization" and in "instruction and communication". At school level the importance of the teacher having good class management and discipline has been noted by both teachers and pupils, but this area is considered as being less important for

Table 7.2

College and University Students' Opinions About Lecturers

	Downie (1952)	Drucker and Remmers (1951)	Costin (1968)	Gadzella (1968)	Musella and Rush (1968)	Crawford and Bradshaw (1968)	Whitely and Doyle (1979)
Subject Knowledge	Subject Knowledge		Interested in subject	Knowledge and interest in subject	Knowledge of subject	Knowledge of subject	
Rapport	Is interesting and motivates students	Interesting and stimulating			Enthusiastic attitude	Enthusiastic	Motivating and stimulating
Instruction and communication			Explains clearly logical sequence	Flexible	Able to explain clearly		expositional skills
Management and discipline							
Planning and Organization	Well prepared	Adequate preparation	Well prepared	Good preparation	Systematic approach	Well planned and organized	

university and college teaching, perhaps because indiscipline is unlikely to be a problem at this level.

In research literature, therefore, there is consensus on the competencies which are important for science teaching. Nine skill areas for which there is most agreement are ranked below according to the number of times they were listed in the twelve surveys in Table 7.1.

1. Instruction and Communication
2. Planning and Organization
3. Knowledge of Subject
4. Rapport
5. Management and Discipline
6. Evaluation and Questioning
7. Relating to Pupils' Development
8. Science Methodology
9. Relating to Pupils' Environment.

Stage Two

Research Findings on Teaching Competencies

The first stage of the strategy used to determine the skills and competencies that Guyanese science educators wanted to produce in secondary school science teachers identified nine competencies which were generally considered to be important for science teaching.

The signs or criteria of teaching success are not external pre-ordained things, but are as Fairbrother (1977) suggests,

"decided upon by common sense backed by consensus of opinion".

However, the nine competencies identified from the surveys are difficult to use as criteria for evaluating teaching. It would be difficult, for example, to obtain a single measure of a teacher's competency in establishing and maintaining a good "rapport" with his students. In order to establish feasible measures of teaching behaviour a further survey of the literature was undertaken. In this second survey the author sought to identify the individual skills within each of the competencies.

Instruction and Communication

In his 1971 review of teacher effectiveness studies Rosenshine identified eight studies in which observers' ratings were made of the "clarity of presentation". In the studies these ratings were compared with pupil achievement. Rosenshine reports that statistically significant correlations were found between observers' ratings and pupil achievement in all eight studies. There is strong evidence to suggest, therefore, that the "clarity" of a teacher's presentation is an important aspect of his competency in Instruction and Communication. Rosenshine also reviewed two studies in which teachers' "pacing" of lessons was correlated with pupil achievement. The results of one were statistically significant. In the other they failed to reach the level needed for statistically significance. Reviewing eight studies on teaching "flexibility" and pupil achievement, Rosenshine found that not one of the eight obtained significant correlations between the flexibility of teacher behaviour and pupil achievement. In a 1956 study, however, Jones used a composite rating of teacher effectiveness - based on teaching practice grades, placement bureau records and head teacher ratings - and found that the most effective teachers were more flexible than normal teachers. In an early teacher effectiveness study, Jane (1945) reported that there was no relationship between a teacher's speech ability and pupils' immediate or delayed recall of factual information. More recently Tisher and Power (1975) reported that pupil "inactivity" is negatively associated with their achievement in and attitude to science.

For a teacher to have competence in Instruction and Communication, research to date suggests that he or she needs to present the work clearly, to pace the work to suit the pupils and to keep them actively involved in the work.

Planning and Organization

Six studies which compared pupil achievement with teachers' lesson organization were reviewed by Rosenshine. Only two of the studies reported statistically significant correlations, but in all six the correlations between pupil achievement and teacher organization were positive. Rothman (1969) in a study of physics teachers in America has also reported greater pupil achievement in classes where teachers had an "orderly" view. Whether or not a teacher had a "business-like behaviour" was investigated in seven of the studies reviewed by Rosenshine. In these, observers and students rated teachers on their task or goal oriented behaviour. Significant correlations between pupil achievement and the ratings for business-like bahaviour were found in six of the seven studies. Since Rosenshine's review, Tisher and Power (1975), Markell and Mayer (1975), Lawrenz (1975) and Manley (1975) have all reported significant positive correlations between student outcomes and teacher task-oriented, or goal-directed, behaviour.

The relationship between pupil achievement and the amount of time a teacher spends in preparing lessons was investigated by Torrance and Parent (1966) but no significant correlation was found between the two. Husen (1978) reports two studies which investigated this relationship in developing countries. In one case there was a positive though non-significant correlation; in the second study, three significant correlations were reported between preparation time and various measures of pupil achievement. One of these, however, showed that preparation time and pupil achievement and pupil achievement were negatively related.

Planning and Organization is important, therefore, for effective teaching but it cannot be measured simply in terms of the amount of time a teacher spends in preparing lessons, rather it is his orderliness or goal directedness which has been found to be important for effective teaching.

Knowledge of Subject Matter

In a review of seventy-five doctoral studies which investigated teacher effectiveness, Barr (1961) reported that,

> "the evidence presented seems to support the thought that academic and professional knowledge are important qualities differentiating good and poor teachers".

Husen (1978), reviewed eleven studies in developing countries which investigated levels of teacher attainment and pupil achievement. He reported that there were significant correlations in only four of the studies. Rosenshine reviewed six such studies in developed countries and noted that the results were "negligible" and "inconsistent". Avalos (1980) after reviewing 589 teacher effectiveness studies in Less Developed Countries concluded that,

> "The effect of higher qualifications upon student achievement was equally non-conclusive".

Rothman et al (1969) in a study of physics teaching found no overall relationship between the teachers' knowledge of physics and their pupils' achievements in and attitude to physics. In a follow-up study, Rothman (1969) reported that pupils did best in classes taught by experienced teachers who were well prepared in both physics and mathematics. In a study undertaken by Lawrenz (1975) 236 secondary school science teachers from fourteen states in the USA were required to complete the National Teachers Examination in Science; their pupils then sat a student science examination. Lawrenz reports that the teachers' subject knowledge was negatively - though not significantly- related to student achievement. Crowther (1978) reports, however, that in English primary schools the teacher's self-image and confidence in teaching science is directly related to their secondary school and college science background. Similar findings are reported for student teachers in the USA by Campbell and Martinez-Perez (1977).

Two controlled studies have investigated the effect of teachers' subject knowledge on pupils' achievements. Campbell (1978) used two groups of teachers, with both groups having the same science background in college. The one, experimental, group received a six hour self-instructional programme and a two day workshop on content and skills related to certain new science teaching materials. The other, control, group did not receive any additional training for the new materials. Both the experimental and the control groups then taught the new science materials to their normal classes for a five month period after which the pupils sat a Basic Science Achievement Test. The pupils of the experimental teachers performance on the test was significantly better than that of the control group of pupils.

In a similar study, Nelson (1978) worked with students in a pre-service science methods course. An experimental group received a forty-five minute lesson on the science and teaching of levers. The control group were given background materials and told to spend the same amount of time preparing their lesson. Both groups of teachers taught a lesson to a class of fifth or sixth grade students and the pupils' achievement in each class was then tested. Pupils taught by the experimental group did significantly better on the test than did those taught by the control group of teachers. Nelson then looked to see if there was any relationship between the teacher's general science knowledge and the pupil achievement. He identified the teachers who had grade point averages of one standard deviation above the mean in college science examinations and those who had an average of one standard deviation below the mean and found that the achievement of the fifth and sixth grade pupils did not relate to the measure of science knowledge of their teachers.

There is no consistent evidence to support the view that pupil achievement in a subject will be affected by their teacher's general level of knowledge in that subject. There is evidence to suggest, however, that a teacher's specific knowledge of the content he is required to teach will help to improve pupil achievement.

Rapport

In his review of teacher effectiveness studies, Rosenshine (1971) reports on a substantial number of studies in which the effect of the teacher's ability to establish a good "rapport" (with students) on student achievement was investigated. He noted seventeen studies of the effect of teacher criticism of pupils, and in nine of these there were significant positive correlations between the level of teacher criticism and pupil achievement. In ten of the sixteen studies in which the direction of the relationship could be identified, the trend was that strong criticism from the teacher had a negative correlation with pupil achievement. Of fifteen studies which investigated teachers' use of "Praise" five reported significant positive correlations with pupil achievement and ten did not. There was consistent evidence to support the view that teachers' enthusiasm could affect pupil achievement since all seven studies which Rosenshine reviewed reported significant correlations between teacher enthusiasm and pupil achievement. Of nine studies which investigated teachers' use of student ideas, Rosenshine reports that not one yielded a significant correlation with student achievement, and out of sixteen investigations into pupil achievement and the way teachers used approval and disapproval statements, only two reported significant correlations. There were "mediocre results" to support the view that "teacher warmth" could influence pupil achievement. Of seven studies which investigated the teachers' involvement of pupils and their achievement, only one obtained a significant correlation (ibid). Pupils' perception of their teachers' self-image was noted by Jungworth and Tamir (1973) as being a good predictor of pupil achievement in biology. In physics teaching, however, Rothman (1969) reported that pupil attitude but not achievement was related to teacher attitude. Manley (1977) suggests that pupils' attitudes are also affected by the amount of "favouritism" displayed by the teacher, with attitudes being more positive the less "favouritism" there is displayed by the teacher. Pupils' "openmindedness" was linked by Kadleck (1976) to science teachers' teaching style. The more the teacher listened to and accepted ideas from pupils the higher were the pupils' scores on measures of "openmindedness". Cable and Hounshell (1972) reported that pupils in biology classes did significantly better on tests of biology knowledge if their teachers had a "capacity" for "intimate contact". Lengthy one-to-one teacher student interactions, however, were reported by Shymansky (1976) as being distractive for students and as reducing productivity and learning effectiveness and he recommends that in science teaching pupil teacher interactions should be reduced to a "bare minimum" while pupils are engaged in independent activities.

Galton and Eggleston (1979) have used a Science Teaching Observation Schedule (STOS) to obtain information on teaching styles in science. They report that in fourth form classes there are three predominant styles. In the first style the teachers are seen as being "problem solvers" and involve their pupils in the lesson by competitively challenging them with a "comprehensive array of questions". In the second style, identified by Galton and Eggleston, the teachers act as "informers" - frequently giving statements of facts to their pupils and rarely involving them directly in the lesson, except to ask questions which require factual recall of knowledge. In the third teaching style - the Enquirers - the teachers are "pupil-directed" and child-centred and place emphasis on the active involvement of pupils. Galton and Eggleston report that there was "little consistent support" for the effectiveness of style two and that pupils did best where they were free to talk and communicate with the teacher as in styles one and three.

Research findings support the view, therefore, that it is important for science teachers to be able to establish and maintain a good "rapport" with their pupils, and not display favouritism. The teacher's ability to establish rapport cannot be measured simply by assessing the amount of praise they give, nor merely by the amount of student talk in their lessons. Evidence suggests that the teachers' overall teaching style is important and should involve the pupils in all aspects of the lesson. Showing favouritism and employing strong criticism mitigates against good rapport.

Management and Discipline

In an early review of teacher effectiveness studies, Barr (1961) summarized the results of twenty-four investigations in which the teacher dominance was found to be positively related to pupil achievement. He suggested, however, that it was only a "minor discriminating quality". Houshell and Dieter (1975) in their survey - reported on page 140 - however, found that outstanding biology teachers were more self-controlled, poised and dominant. Rothman et al (1969) in studying physics teachers reported a relationship between pupil achievement and the dominance of the teacher and concluded that,

> "Student growth in physics interest seems to occur when their teachers are aggressive and dominant with their class".

In 1975, Lawrenz reported that pupil achievement was negatively and significantly related to their ratings of the teacher's formality. Pupil achievement and attitude have also been shown to be negatively associated with measures of the teachers' managerial ineffectiveness (Tisher and Power 1975).

While the evidence is limited, what there is supports the view that management and discipline skills relate to pupil performance in science teaching.

Evaluation and Questioning

Research into the effects of teacher evaluation skills on pupil achievement has been largely limited to the area of evaluation via verbal questioning. Rosenshine (1971) reviewed five studies which investigated the relationship between the frequency of teachers' factual questioning and pupil achievement.

In all five cases there was no significant correlation between the two factors. Three studies investigated the amount of "higher level" questioning in a lesson (that is, higher than just factual recall) and its effect on pupil achievement. Two of these studies reported significant correlations between higher level questioning and pupil achievement. Rosenshine also reports on two experimental studies in which the same teachers taught the same material to two groups of pupils, with the experimental group of teachers concentrating on asking "higher level questions". In both studies no significant differences were found in the gains made by the experimental and control group pupils. Reviewing three studies which investigated the "probing" strategy of teachers, Rosenshine noted that all three reported significant positive relationships between pupil achievement and the use of a probing strategy by the teacher. In 1976 Nelson and Abraham also investigated the effect of using a probing strategy. They suggested that a "probing" strategy involves a teacher asking questions which draw from the pupils their observations; questions which they suggest would raise the pupils' level of thought, for example, by asking them to verify or infer. A non-probing strategy, they suggest, involves using only questions which look for specific answers. In their study Nelson and Abraham applied probing and non-probing treatments to classes in inner city and suburban areas and collected classroom observational records. They then tested the pupils on measures of their "inquiry skills". The classes taught with the probing strategy did significantly better on measures of inference and accuracy. In the suburban schools the "probing" classes also did better on measures of the frequency of observations but in the city schools it was the pupils who were taught via the non-probing strategy who did better on these measures.

Two different question styles in science teaching have been identified by Guthrie (1976). In the first style, the teacher asks questions which are based in the third person and the pupils are seen as being "outsiders" to the problem posed. In the second style, the teacher places the pupils "at the focus of the problem" and asks them to respond on a "quasi-experience" base. Guthrie reports that teachers who used the second style were able to increase the amount and the length of student responses. Students taught via this style also did significantly better than those taught via style one on tests of achievement and retention.

Galton and Eggleston (1979) have investigated the questioning style of science teachers and have reported that for physics and for biology teaching with above average pupils, achievement was greatest when the teacher used a questioning style which challenged the pupils with comprehensive arrays of questions.

Using pre-service elementary teachers, Santiesteban (1976) carried out an experimental study of two groups of teachers. The experimental group were trained to ask questions which involved observation and classification. The control group were not given any specific training. Both groups then taught fifteen minute microteaching lessons which were recorded and analysed and the pupils were asked to complete an attitude questionnaire. The analysis showed that the experimental teachers did ask more questions involving observation and classification and the pupils taught by this group had significantly more positive attitudes to the subject than the control group.

One questioning skill which has aroused considerable interest in the past decade is the "wait-time" allowed by a teacher after a pupil replies to a question. Rowe (1974) analysed over three hundred observational tapes of lessons and found that after a pupil responds to a question most teachers wait for less than one second before reacting , for example by making a statement or asking another question. Rowe trained teachers to wait for a period of between three and five seconds before making any reaction and then recorded them teaching. Over nine hundred tapes of these lessons were recorded and analysed and Rowe reports that when teachers used the increased wait-time, pupils gave more responses, asked more questions and made more inference statements; the replies that they did give were also longer. Moriber (1971) in a study of the wait-time allowed at university level by four university instructors suggested, however, that merely increasing wait-time will not in itself improve a teacher's questioning ability but must be linked to an improvement in the quality of the questions asked. In a recent study in Australia, Tobin (1980) has confirmed Rowe's original conclusions for school teaching. His study involved pupils in twenty-three classes in eleven schools in Australia.

Tobin first of all investigated the wait-time allowed by the teachers of the classes and found that on average they waited for only 0.5 of a second before reacting to a pupil's response. He then divided the teachers into experimental and control groups. The experimental group were asked to extend their wait-time and the control group to maintain it as it was. Comparing the achievement of the pupils taught by the two groups of teachers, Tobin found that a significant increase in the level of pupil achievement occurred when the teachers were able to extend their mean wait-time beyond three seconds.

Questioning technique is an important skill area for effective teaching. Good technique does not appear to depend on the number of questions asked but rather on the use of different levels of questioning and on the time allowed for the pupils to reply.

Relating to Pupil Development

The concept that teachers should be able to understand their pupils' needs and capabilities has had widespread acceptance amongst educationalists for years. Spencer writing in 1854 noted that teaching should proceed from the simple to the complex and that teachers should take care to determine what was simple and what was complex in terms of the pupils' experience. Montessori developed her teaching method using specially graded apparatus which was designed to suit the different levels of the pupils' development

(Knox 1961) and Sir John Adams is quoted as suggesting that,

> "In order to succeed in teaching John Latin, the master must, therefore, know something both of John and of Latin" (ibid).

It is only within the past decade, however, that researchers have succeeded in demonstrating the importance of matching science teaching to the cognitive level of the pupils. In a series of investigations Shayer has highlighted the problems that can arise if teachers attempt to teach concepts which are above the cognitive level of their pupils (Ingle and Shayer 1971, Shayer 1972, Shayer 1974, Shayer and Wylam 1977 and Shayer 1978). In the 1978 study, for example, he reports that because of the mismatch between the content and pupils' cognitive levels, over 80% of the pupils studying the Nuffield Combined Science Programme were unable to understand large portions of the course. In some cases over 50% of the course units were too difficult for the pupils to follow. Ryman (1976) investigated the formal thinking level required for the Nuffield Biology programme and confirmed Shayer s finding that the level of thinking was mismatched with the pupils' cognitive levels. Adey (1979) has reported similar findings for the West Indian Science Curriculum (WISC) which is used extensively in the Caribbean. He noted the discrepancy between the actual cognitive level of the pupils and the level required to understand the curriculum materials, ezpecially in the first year materials.

As well as affecting student achievement the inadequate matching of content to pupils' ability can also affect the pupil's attitude to learning. Manley (1977) after studying student attitudes in eighty chemistry classes in the USA reported that pupils' attitudes to chemistry varied directly with their perception of learning difficulty.

The evidence that is available supports the view that science teachers must be able to relate their teaching to the cognitive development of their pupils.

Science Methodology

Scientific methods include the use of inquiry or problem solving approaches. Many studies have investigated the difference between expository and discovery or inquiry based teaching methods and Hermann (1969) reviewed thirty-five of them. There are few studies, however, that have investigated the relationship between pupil achievement and the teacher's own knowledge of problem solving or inquiry based methods. One such study was carried out by Lawrenz in 1975. He investigated the relationship between pupil achievement and their teachers' knowledge of science and science methodology. A sample of 236 science teachers in fourteen states in the USA completed tests of their science knowledge and science process skills. Their pupils then completed tests of science achievement. Lawrenz reports that the pupils' achievements were negatively related to the teachers' subject knowledge but were positively related to their knowledge of science methodology. He concluded that,

> "These results could indicate that knowledge of science processes and knowledge of science subject matter are not necessarily related and that knowledge of science process may be a more valuable teacher characteristic".

Campbell and Martinez-Perez (1977) have reported that the self-concept of student teachers was directly and positively related to their knowledge of science process skills.

Taking the evidence that we have for teachers' science process knowledge along with the results of observational studies - such as Galton and Eggleston (1979)-which have shown the benefit and importance of teachers adopting a "Problem-solving" or "Inquiry" based teaching style, it is safe to conclude that for effective science teaching, teachers should be knowledgeable of and skilled in the use of science methods.

Relate to Pupil Environment

The need for science teachers to make the content of their teaching relevant to the pupils' environment is widely advocated by science educators. For example, in their 1972 report on "The Training of Teachers of Science and Mathematics", The Royal Society emphasized the importance of school science being,

> "shown to be relevant to modern society".

In their 1979 Consultative Document - Alternatives For Science Education - The Association For Science Education warned of the "urgent need" to scrutinize science curricula in order to consider their relevance to the changing industrial and social context, and in their recommendations they noted that,

> "emphasis must be placed on developing an understanding of the usefulness of scientific knowledge and processes in society and in everyday life" (p. 53).

Similar recommendations have also been made by Layton (1973) and by Lawton (1973). In spite of the widespread acceptance of the need amongst educationalists there is still a considerable amount of ambiguity, however, as to how science programmes could or should be made relevant to the pupils' environment. In a survey of the science tutors in fifty colleges of education in England and Wales, Lloyd-Jenkins (1972) reported that while the tutors were "alive to the need for relevance" in college science courses, they were,

> "a little vague as to the best way of achieving this" (p. 132).

As noted in Chapter Five, the science course writers for the Emergency Science Programme in Guyana while identifying the need for relevance also had difficulty in incorporating it into their correspondence units.

Although the need for relevant content has widespread acceptance amongst educationalists, there is little evidence to support this view. Barr in a 1931 study on teacher effectiveness used supervisors' ratings to identify forty-seven "good" and forty-seven "poor" teachers. He then observed the teaching of all ninety-four teachers and identified elements characteristic of the "good" and of the "poor" teachers. One important characteristic he noted was that over 50% of the good teachers made "frequent use of pupils' experiences" as compared with only 8% of the "poor" teachers. Kelly (1980) in a study of the teaching of specific topics in biology has reported that pupils' understanding and achievements in genetics and evolutionary theory were greater when the teachers' teaching styles were linked to the pupils' everyday or "natural" knowledge. A study is at present being conducted in the USA into the relationship between pupil achievement and "content" relevance and first reports suggest that a positive relationship does exist (Shavelson 1981 - private communication).

At present, therefore, there is little evidence to support the "accepted" opinion that science needs to be made relevant to the pupil's environment. It appears, however, that current research will help to substantiate the link between effective teaching and "relevant curriculum materials".

Stage Three

Teaching Skills for Guyana

To determine the skills and competencies that Guyanese science educators wished to produce in secondary school science teachers a three stage strategy was used. In Stage One, nine teaching competencies thought by science educators to be important for science teaching were identified. In Stage Two, the evidence to support the educators' opinions for each of the nine was analysed and where possible skills important within the competencies were identified. Stage Three of the strategy sought to identify science teaching skills considered to be important by Guyanese science educators and this involved developing a list of skills which the educators could be asked to rate. Sander (1966) has reported five general characteristics of skills. A skill, he suggests,

1. is a physical, emotional and/or intellectual process,
2. requires knowledge, but knowledge alone does not ensure proficiency,

3. can be used in a variety of situations,

4. will improve through practice, and

5. is composed of a number of sub-skills which can be identified and practised separately.

Sutton (1977) notes that the term skill implies something which can be acquired or improved. He warns, however, that in science teaching there is no evidence of the "indispensibility" of any one skill.

Using the analogy of a conductor conducting an orchestra, Dock (1980) has warned that,

> Skills alone are not enough for good teaching ... Questioning, establishing set, explaining, being sensitive to feedback, are individual skills of teaching, but it is their effective orchestration which is the hallmark of a good teacher".

This analogy does help to illuminate the role of the teacher. The conductor however, needs the individual skills - represented by the different instruments - before he can orchestrate them together.

To identify the skills educators felt were important for science teaching in Guyana, considerable use was made of Guyanese resources. Published opinions, such as those of Perry (1975), Impey (1975) and Broomes (1975) were analysed, but the main emphasis was placed on three Guyanese publications which listed skills for science teaching. These were,

1. Objectives For a Training Programme For Teachers of Science at Primary Level (Impey 1974),

2. Assessments of Teacher's Teaching Performance In Science (Lalgie 1976), and

3. Teacher Assessment Scale (Ministry of Education U.D.)

Using his own experience of the situation in Guyanese schools and guided by the findings of teacher effectiveness studies in Stage Two above, the present author analysed the three Guyanese lists to help identify skills which were pertinent to each of the nine competency areas. Altogether over eighty skills for science teaching were identified and where possible the format or wording of the original Guyanese source of each was retained. The skills were classified into the nine competency areas and in a few cases where the same skill was clearly important for more than one area they were listed under each.

A preliminary list and categorization of the skills was presented separately to three experienced science educators, one from a developed and two from developing countries (Canada, Malaysia and Pakistan). They were asked whether or not they agreed with the categorization of the skills within the different competency areas and if there were any additional skills they considered to be important for these areas. The author interviewed the three educators separately and, following discussions with them modified the original list and prepared the final sort of skills. The nine competency areas were then randomly ordered and a draft copy was prepared of the questionaire "Skills For Science Teachers". This draft was piloted in May 1980 on a group of eight experienced teachers who were candidates for the Masters Degree in Science Education. A number of ambiguities were identified in the pilot study. These were modified and the modifications were discussed with the pilot group. Part of the questionnaire asked the respondents,

> "Are there any other skills which you feel are essential for a science teacher? If so, please describe the skill or skills below ..."

Some suggestions for additional skills were made, two of which were reported by a number of respondents, namely for a skill within the "Science Methods" competency that the teacher should be able to,

> "encourage pupils to record what they have observed"

and for a skill within the "Knowledge of Subject Matter" competency that the teacher should be able to,

> "apply correctly those principles and concepts which are relevant to the curriculum being followed".

Both of these "items" were added to the list of skills and the final draft of the questionnaire prepared (See Appendix 2). The questionnaire consists of eighty-six skills categorized into nine competency areas.

The questionnaires were distributed in August 1980 to all thirteen educationalists who were directly engaged in training or supervising science teachers in Guyana. Respondents to the questionnaire were asked to rate each of the nine competencies on their importance for science teaching. Then they were asked to rate each skill on its importance within the given competency. The respondents were also asked to identify any skills which they considered were important for the competency but were not listed for it in the questionnaire. Finally, respondents were asked to identify the three competencies they felt were "most important for science teaching in Guyana" and the three they considered to be "less important". Replies were received from eight of the thirteen science educators, including science education officers, university and college lecturers in science education and two ESP local tutors. The questionnaire had asked educators to rate the skills and competencies on their importance,

> "for teachers teaching science to forms one to three in secondary and community high schools in Guyana ,

(that is secondary schools). Of the five people who did not reply three were engaged in training teachers at primary level. The replies received, therefore, represented the opinions of a large proportion of the people training science teachers for secondary schools in Guyana. From the replies of the science educators the nine competencies were ranked according to their perceived importance for science teaching in Guyana. These are shown below,

<u>Rank Order</u>

1. Knowledge of Subject Matter
2. Making Learning Relevant to the Pupil's Environment
3. Science Methods
4. Organization and Planning
5. Instruction and Communication
6. Evaluation and Questioning
7. Rapport
8. Relate to Pupil Development
9. Discipline and Management

The total score for each skill item was then calculated by adding the scores given by the individual educators. It was intended that the four skills which received the highest score within each competency would be identified. Because of the actual scores obtained, however, it was not always possible to isolate the top four skills. In some cases it was the top five, or the top three skills, that formed a natural cluster and were, therefore, selected.

The Skills for Science Teachers questionnaire (SST) had identified, therefore, the competencies which Guyanese science educators felt were most important for science teaching in Guyana and the skills which they felt were most important within each competency. These competencies and skills were later used to prepare the Science Teacher's Self-image Scale (STSIS) and are shown in that form in Appendix 2.

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Chapter Eight

Performance Evaluation (i)

The research strategy outlined in Chapter Four for the evaluation of ESP calls for a comparison to be made of the teaching performance of a group of ESP trained teachers with that of a comparable group of college trained teachers. Opportunities to set up classical research situations of experimental versus control groups are rare in in-service evaluation, partly, as McCabe (1980) suggests because courses and programmes cannot usually be arranged that way and partly because many of the variables cannot be controlled.

Fortunately, in comparing ESP with college trained teachers many variables are comparable. Both the ESP programme and the science programme at the Lilian Dewar College of Education are designed specifically to train teachers of science for the secondary and community high schools in Guyana. The Board of Examiners of the Ministry of Education is responsible for the certification of both programmes and the certificates awarded are deemed by the Board to be of equivalent standard. The Board appoints the same panel of educators to assess the teaching performance of the two groups and the same rating techniques and report forms are used for all the assessments. Both programmes have the same minimum entry requirements of four GCE O level passes with at least one being in a science subject. While the output of science teachers from the college programme has been small over the past decade, the output in 1980, the highest ever recorded, meant that the college group qualifying in 1980 was of comparable size to the ESP group in that year.

There are, therefore, a number of important similarities between the ESP and the college trained teachers. Not only had they to achieve the same entry qualifications, but also they were trained to teach the same school programmes, awarded equivalent teaching certificates by the same examining board, assessed by the same supervisors who used the same techniques , and groups of comparable size both qualified in that particular year. ESP was proposed as an alternative to the college programme. One means of legitimizing this alternative, therefore, would be to demonstrate that the teachers trained via ESP could teach science as well as college trained teachers. The problem was in deciding in what way the teaching performance of the two groups should be compared.

As was noted in Chapter Seven, there is no single agreed and satisfactory criterion for establishing teacher effectiveness. Supervisors' ratings have been found to be unreliable and yield inconsistent results (Rosenshine 1971). Self-ratings, although they have yielded significant results on a number of occasions (Rosenshine 1971, Crowther 1978 and Campbell and Martinez-Perez 1977), have also been criticized as being inaccurate and exaggerated (Laurenz 1974) and pupils' ratings, while they may have a "particularly good history" (Rosenshine 1971), appear to be influenced by many extraneous factors such as the teacher's age, attractiveness and sex (Howard and Bray 1979, Goebal and Casher 1979).

Since no satisfactory single criterion has been identified to date, a pluralistic strategy has been adopted as suggested by Elliott (1977), by Fairbrother (1977) and by McCabe (1980). This involves making a comparison of the two groups of teachers on a number of different criteria, which themselves reflect different perspectives of the teaching effectiveness of the teachers.

The strategy adopted for this performance evaluation, therefore, was to compare the ESP and the Lilian Dewar college trained science teachers on a variety of measures of teaching effectiveness, including:

(a) supervisors' assessments,

(b) self-ratings,

(c) head teachers' assessments, and

(d) pupils' reports.

(a) Supervisors' Ratings

After reviewing twelve studies involving supervisors' or observers' ratings of teachers (Rosenshine 1971) reported that there was "moderate" support for the value of this form of assessment. Although only three of the studies obtained significant findings linking pupil achievement with the observers' ratings of the teacher,

> "the overall trend was very consistent; there were no negative correlations or results favouring low-achieving teachers" (ibid).

Both the ESP and Lilian Dewar (LDC) science teachers had been observed and assessed for their final teaching assessment by the same panel of "Ministry" supervisors and the same assessment technique had been used for the two groups. The teachers could be legitimately compared, therefore, on the scores they obtained in their final teaching assessment.

Table 8.1

Final Assessment Grades of ESP and LDC Teachers (1980)

Grade	A+	A	A-	B+	B	B-	C+	C	C-	D+	
LDC	-	-	3	8	7	3	4	1	-	-	n = 26
ESP	-	1	-	4	6	6	5	3	2	2	n = 29

Mean LDC grade = B (range C to A-)

Mean ESP grade = B- (range D+ to A)

Difference between two groups using Mann Whitney U test (z = 2.54

Significant at the 5% level

Making such a comparison we find that on the ten point grading scale used by the examiners, the grades awarded to college trained teachers were higher on average than those awarded to ESP teachers - the average college grade being B compared with the average ESP grade of B-. The comparison is not as straightforward as it might appear, however, the college trained teachers were assessed whilst on a six week teaching practice during which they taught on average eleven periods each week. Because they were geographically so widespread and because normally they taught in schools through the whole year, the final assessment of the ESP teachers took place over a more extended period of three months during which the teachers taught an average twenty-three periods a week. Neither group was told when a Ministry assessor would visit the school to observe a lesson. So the average grade B of the LDC trained teacher was based on their being required to prepare about sixty-six lessons during the assessment period while for the average B- grade ESP trained teachers were required to prepare almost 300 lessons.

(b) Self-ratings

Rosenshine reported three studies of the relationship between self-ratings and pupil achievement. All three, however, obtained significant correlations between teachers' self-ratings and the achievement of their pupils (Medley and Mitzel 1959, McCall and Krause 1959 and Aspey 1969). More recently Aspey and Buhlem (1975) have also found student achievement positively related to teacher's self-image and other studies have found that a teacher's self-concept or self-image is a good predictor of his science skills (Campbell and Martinez-Perez 1977) and correlates significantly with the emphasis on science in his training course (Crowther 1978).

Teachers' self-image inventories for Guyanese teachers have not been developed. Inventories developed for North American teachers, such as the Tennessee Self-Concept Scale (Campbell and Martinez-Perez 1977) or for British teachers such as Crowther's Self-Image Scale (1978) would be of limited benefit for assessing the self-image of Guyanese science teachers because of their bias towards North American and European culture and values. To compare the self-image of the ESP and LDC teachers, therefore, it was necessary to construct an instrument.

The views of Guyanese science educators concerning which competencies and skills were most important for good science teaching in Guyana had already been derived from the responses given to the Science Educators' Questionnaire (see Chapter Seven). A self-image scale suitable for Guyanese science teachers was developed with the aid of these responses and took the form of a four page questionnaire in which teachers could rate their own abilities on the competencies and skills considered by the Guyanese educators to be important for science teaching. This Science Teachers Self-image Scale (STSIS) is made up of four sections. Section One consists of a list of thirty-six items in which the teachers are asked to rate both their own performance and that of the ideal science teacher using a ten point scale. These items were derived from the responses of the science educators to the educators' questionnaire and they represent teaching skills important for the competencies identified in Chapter Seven. Section Two consists of four autobiographical questions which refer to age, sex, training programme followed and the type of school the teachers teach in. There is also one question in which the teachers are asked to state the type of school they would most like to teach in. The third section of the questionnaire deals with the qualifications teachers had before they began their training programme, and Section Four asks them to write a "paragraph or so" on how well they feel their training programme prepared them to teach science.

The STSIS questionnaire was piloted on a group of six Certificate of Education biology students in the Education Department of Keele University. All six were able to complete the questionnaire within forty minutes. They identified a number of misprints and queried the wording of two items. There was also some misunderstanding over two questions which related to specific types of school (for example, community high school) since these were unfamiliar to students in England.

No major problems were encountered with the scale. The certificate students were able to follow the instructions and found the wording of all but two of the items clear and understandable. These two items were discussed with the students and modified so that they felt they were now clear. Of the nine competencies which form the basis of the thirty-six skills the students felt they were most competent in Rapport, Knowledge of Subject and Evaluation and Questioning and least competent in Instruction and Communication and Organization and Management. Their teaching methods tutor at the university agreed with their assessment of relatively low competence at that stage in Instruction and Communication, and in Organization and Management but did not feel that their relatively high self-image in Rapport was justified. The final draft of the STSIS questionnaire was prepared taking into account the findings of the pilot study. A copy of the questionnaire in its final form is shown in Appendix 2.

The STSIS questionnaires were posted in January 1981, along with covering letters, to every teacher who had qualified from the ESP and LDC science programmes in 1980. Included with the questionnaire were stamped addressed envelopes. Altogether fifty-one copies of the questionnaire were sent out; twenty-nine to ESP teachers and twenty-two to LDC teachers. (Although twenty-six students had qualified from the LDC programme in 1980, by January 1981 when the researcher visited the Teaching Service Commission in Georgetown the were aware of only twenty-two of the students having taken up teaching appointments).

Twenty-four of the twenty-nine (83%) ESP, and nineteen of the twenty-two (86%) LDC teachers completed and returned their questionnaire. The teachers were asked not to write their names on the forms and were told in the covering letter that any information they provided would be "treated in the strictest confidence" by way of encouraging them to provide realistic and truthful assessments and comments about themselves and their training programmes. However, since it was intended to compare the teachers' self-image with other measures of their teaching effectiveness it was necessary for the researcher to be able to identify individuals. This was achieved by coding each questionnaire with a code, based upon the number of times the letter " o " appeared on page two of the questionnaire. So, it was possible to identify all the teachers who did return questionnaire and also those who did not. There was no distinctive feature of thos who did not return the questionnaire

The results obtained from the STSIS questionnaire are set out in Tables 8.2 to 8.14 in Appendix 1. From the returns it was possible to make a number of comparisons between the ESP and the LDC teachers.

(1) Self-image

By adding the ratings the teachers gave themselves on each of the thirty-six items an overall score on self-image for each teacher was obtained. The thirty-six skills were also broken down into the nine competency areas and hence the teachers' self-image in each competency area could be compared. Finally, the ratings for each individual skill were established and the teachers' self-image on the different skills were determined and compared.

Self-image ratings for the twenty-four ESP teachers are given in Table 8.2 and for the nineteen LDC teachers in Table 8.3 in Appendix 1. The self-image of the two groups are alike. The mean overall rating for the ESP teachers was 296 (sd 35.9) and that for the LDC teachers was 306 (sd 30.6). Using a t test to compare the means of the two groups gives a t value of less than one, so there is no significant difference, at the 5% level, between the overall ratings of self-image given by the two groups.

The teachers' self-ratings within each of the nine areas of competency were also compared. Self-ratings for the ESP teachers in the nine areas are shown in Table 8.4 and for the LDC teachers in Table 8.5. Comparing the self-ratings of the two groups, as in Table 8.6, we find that there is not a significant difference between the ratings in eight of the nine competencies. Only in Evaluation and Questioning is there a statistically significant difference, at the 5% level.

The ratings of the two groups in the thirty-six individual skill items are shown in Table 8.7. The difference between the ratings for thirty-four of the thirty-six does not reach the level of statistical significance. A difference at the 5% level is reached only for two items (Numbers 13 and 19). In Item 13 the teachers were asked to rate their ability to,

> "Suggest examples of scientific knowledge and skill which are applicable to the social and economic life of the community"

and in Item 19 they were asked to rate their ability to,

> "indicate the relevant prerequisite knowledge and skill needed for a lesson and find out if the pupils have these".

The LDC teachers self-ratings were higher in both cases.

(Item 13 $t = 2.2$ for 41 df significant at 5%)

(Item 19 $t = 2.8$ for 41 df significant at 5%)

The teaching areas in which each group felt most and least competent respectively were identified by calculating the group's mean ratings for the items of a competence. To do this the group's ratings for each competence (shown in Table 8.6) was divided by the number of items within the competence. For, instance, the ESP mean rating for Science Methods is 33 - this was calculated from ratings on four items (Numbers 4, 6, 14 and 29) and so the ESP mean rating for the items on Science Methods is 8.25. In Table 8.6 the mean rating of the ESP teachers on Instruction and Communication is 42, but this was calculated from ratings on five items, so the mean item ratings for this area of competency is 8.4, showing that the ESP teachers' self-ratings in Instruction and Communication are relatively higher than their ratings in Science Methods. The mean item ratings of the two groups of teachers were calculated for all nine areas of competency and then ranked. The summary of the results is shown in Table 8.6a below. There is only a low and non-significant correlation between the two groups' rankings of the relative importance of the nine competencies.

Although there is not a statistically significant difference between the ratings teachers gave themselves on any of the nine individual competencies (for instance, there is not a significant difference between ESP ratings on Knowledge of Subject with those on Pupil Development) the two groups rank their relative competence in the nine areas in different ways.

Table 8.6a

Rankings on Self-Image of ESP and LDC Teachers
on Nine Areas of Competency

Competency Area	ESP	LDC
Science Methods	5	7
Discipline and Management	1	4
Instruction and Communication	3	3
Organization and Planning	5	9
Evaluation and Questioning	7	1
Relevance	8	7
Rapport	4	2
Pupil Development	9	5
Knowledge of Subject	1	5

Spearman's Rank Order Correlation P = +0.24

Not significant at 5% level

According to the rankings, ESP teachers feel most competent in their Knowledge of Subject and Discipline and Management and least competent in the way they can relate their teaching to Pupil Development. LDC teachers, however, feel that they are most competent in Evaluation and Questioning and least in Organization and Planning.

In summary, we find that the ESP and LDC teachers have similar self-images of their abilities as science teachers. There was not a statistically significant difference in the ratings they awarded to themselves nor in self-ratings for eight of the nine competence areas. LDC teachers had higher self-ratings in one area, however, that of Evaluation and Questioning.

(2) Image of the Ideal Science Teacher

As well as providing a measure of the teacher's self-image, the STSIS questionaire also provided information of the teacher's view or image of the ideal science teacher. Ratings given by the ESP and LDC teachers on each of the thirty-six items for the ideal science teacher are shown in Tables 8.8 and 8.9 in Appendix 1. From these results the Ideal Teacher's mean score or rating for each of the nine areas of competence was calculated and these are summarized in Table 8.10. The views of the ESP teachers and the views of the LDC group of teachers concerning the ideal science teacher do not differ significantly. Ranking the competencies according to how important each group thought they were for the ideal science teacher (as in Table 8.10) we find there is little correlation between the rankings of the ESP and the LDC teachers (Spearman P =+0.11). If we discount, however, the ratings on one of the areas, namely that of Science Methods, and look at the way the two groups rank the remaining eight areas, we find that a much stronger relationship exists. (Spearman, P =+0.61). Both groups here agree that the two most important areas for a science teacher are Instruction and Communication and Instruction and Evaluation and Questioning. The main difference between the two groups' image of the ideal science teacher is the importance attached to Science Methods. ESP teachers rated it as the most important of the nine, whilst LDC teachers felt it was least important.

(3) School Type Preference

In question 4 of Section Two of the STSIS questionaire the teachers were asked to state what type of school they were teaching in. Five different types of school were indicated, namely the junior section of a primary school, the all age section of a primary school, the community high school, the junior secondary school and the senior high school. In question 5, the teachers were asked to indicate which of the five types of school they would most like to teach in. The replies given by the twenty-four ESP and nineteen LDC teachers to questions 4 and 5 are shown in Tables 8.11 and 8.12, in Appendix 1. No ESP or LDC teachers taught in primary school and only two from each group taught in community high schools. Three ESP and six LDC teachers taught in senior high schools but the majority of both groups taught in junior secondary (79% ESP and 58% LDC).

The results in Tables 8.12a and 8.12b show that there is a distinct and statistically significant difference between the types of school the two groups prefer to teach in. While only 7 (29%) of the ESP teachers wished to teach in the predominantly urban senior high schools fourteen (74%) of the college trained teachers wished to teach there (Chi square = 8.4 for 1df significant at 1%). The combined replies to questions 4 and 5 give a measure of how content the two groups of teachers were to be in the schools in which they taught.

The ESP teachers are the more content. Only six out of the twenty-four (25%) wished to change compared with eight of the nineteen LDC teachers (42%) (Chi square = 1.4 for 1df not significant at the 5% level).

(4) Teachers' Age and Sex

In Section Two the teachers were asked about their age and sex. Summaries of their replies are shown in Tables 8.14a and b in Appendix 1. The teachers were asked to record which one of four age groups they belong to.

The largest number of college teachers are in the 21 to 23 age group while the largest number of ESP teachers are in the 25+ category. However, the age difference between the two groups is not statistically significant at the 5% level (Chi square = 3.75 for 3df).

The results in Table 8.14 also demonstrate that there is no significant difference between the sexual composition of the two groups (Chi square = 0.5 for 1df), though, there is a slightly higher percentage of female teachers amongst the college group - 53% compared with 42% in the ESP group.

(5) Qualifications on Entry to Training

In Section Three of the STSIS questionaire the teachers were asked to record what O and A level GCE qualifications they had before commencing training. Only two of the forty-three teachers had A levels, and both were from the ESP programme. Replies on GCE O level passes held by the two groups are summarized in Tables 13a and b in Appendix 1. On entry to training, for both programmes, the teachers had an average of six GCE O level passes (ESP 6.5, LDC 6.2).

Although the two groups were similar in the number of O level passes, they differed significantly in subject passes. Only five (26%) of the LDC teachers had passes in physics compared with 19 (79%) of the ESP teachers. Only eight LDC teachers (42%) had passes in chemistry compared with twenty-two (92%) ESP, and eleven (58%) had passes in mathematics compared with twenty-one (88%) for ESP. A significantly greater number of ESP teachers, therefore, had passes in O level physics (Chi-square-Yates correction = 9.9 for 1df significant at 1% level) and a significantly greater number had passes in chemistry (Chi-square-Yates correction = 10.1 for 1df, significant at 1%). Although a greater percentage of the ESP teachers had passes in mathematics, the difference between the two groups did not reach the level of statistical significance at the 5% level (Chi square = 3.45 1df).

(6) Free Response Replies

In Section Four of the STSIS questionaire the teachers were asked,

"Now that you have completed your training programme and are teaching full-time we would like you in this final section of the questionnaire to write a paragraph or so giving your views on how you feel that your training programme has prepared you to teach science".

There were a number of differences in the replies given by the two groups. The comments from the ESP teachers generally described how they felt the programme had changed them. For instance, thirteen of the twenty-four wrote that they felt more "confident" or more "competent" after following the programme and nine wrote how they had become more familiar with the use of apparatus. They wrote, for example,

"I now feel more competent ... able to set up and assemble more apparatus"

"I am in a better position to teach lab skills"

I also gained experience in using new equipment".

Three of the ESP teachers expressed some criticism of their programme. One wrote that it,

"did not prepare me to handle actual teaching situations, for example, over (practical) crowded classrooms or dealing with mentally 'backward' children".

Another commented that the science content seemed to be quite "arbitrary and irrelevant" and the third felt that although the programme had equipped him to teach integrated science up to form four he did not feel it had provided him,

"with enough science knowledge for the teaching of specific subjects in form five".

In contrast to the ESP teachers, the LDC teachers were less inclined to write about the effects their training had on them but rather wrote about the programme itself. Writing for instance that,

"The course was good, content well defined and up to date. People pleasant". and

"The course was a thorough one".

Some did note, however, that the programme had prepared them to teach science ...

"has prepared me admirably ..."

"helped me a great deal ..."

"has equipped me fully ..."

Five LDC teachers complained that they had not been prepared to face the "real" situation in the schools.

"prepared me to teach science theoretically ... my study ... was based on an ideal teacher in ideal conditions, whereas in the real situation it was completely different"

"did not prepare me adequately for the task I am faced with ..."

"I feel that in a few years from now there wouldn't be anyone going to training college to do science because when you go out in the school, it is something else ..."

Four of the teachers also criticized conditions in the college, especially the lack of facilities and shortage of lecturers.

"My training programme did not prepare me adequately to teach science ... mostly due to the fact that there was a shortage of lecturers in all the science subjects"

"a few things which should and must be rectified ... the shortage of educational personnel, lack of facilities, the attitude of the people in charge ..."

The majority of teachers in both groups, however, wrote favourably about their training, although more criticisms were expressed by the college trained group. All forty-three replies to Section Four of the STSIS questionnaire are reported in full in Appendix 1.

(c) Head Teachers' Opinions

The opinions of head teachers have traditionally been accepted as a valid measure of teachers' performances for promotional purposes. In the UK, for example, head teachers are entrusted with the responsibility of selecting and recommending the best teachers for appointment as senior teachers and as heads of department. Similarly within schools promotion through the salary scales is based almost exclusively on the head teacher's recommendation. Surprisingly little research has been carried out, however, into the validity of head teachers' opinions. Yee (1970) and Leeds (1969) both investigated the relationship between head teachers' rankings and those made by pupils but found little correlation between the opinions of the two groups. Robbins (1967) compared head teachers' rankings with those obtained via interaction analysis and via pupils. He found that the principals and the observers agreed on teacher behaviour only "to a limited degree".

Although only a few of the rank order correlations in this study reached conventional levels of significance, almost all showed a positive trend. Principal and pupils agreed on teacher behaviour to a greater extent than principals & observers. In four of the twelve schools studied significant correlations were found between the rankings of six teachers made by principals and pupils. The more experienced the head teacher the greater his "awareness" of teacher behaviour. Clarke (1961) has also reported that the more experienced principals are, the better they know their subordinates.

ESP and LDC teachers teach in many different kinds of school throughout Guyana and it was not possible to visit every school during the fieldwork period of the evaluation. Fortunately, there are six schools in which 1980 "graduates" from both the ESP and LDC science programmes teach, and the researcher was able to visit each of these schools and conduct interviews with the head teachers. The researcher was known to all six head teachers as he had visited these schools on a number of occasions during the 1976 to 1979 period when he was responsible for teacher education in science at the Ministry of Education in Georgetown. The interviews were conducted in privacy, were loosely structured and followed the same pattern in all six schools.

Head teachers were first of all shown the letter from the Chief Education Officer of the Ministry of Education which mentioned the researcher's connection with the UNESCO Institute For Education and asked them to co-operate with the study. (A photocopy of the letter is enclosed in Appendix 2) The head teachers were then told by the researcher that the purpose of the study was to investigate the effects of the different types of training of science teachers which were available in Guyana. It was emphasised that the researcher no longer had any official position at the Ministry of Education. The heads were assured that anything they said would be dealt with in the strictest confidence and that neither they nor the teachers concerned would be identified in any subsequent reports or publications. In two of the schools the head teachers asked for the head of the science department to be present during the interview to assist them with their replies, and this was agreed to by the interviewer.

After naming the ESP and the LDC teachers that he wished to discuss, the interviewer asked the head to,

> "Tell me what you think about ...(a) ... and ... (b) as science teachers, excluding as far as possible their personalities".

((a) and (b) were named teachers in the school.) Detailed notes were made of the replies. When the head made his general comments the interviewer then asked him to compare the two teachers on their;

(i) class control

(ii) preparation of work

(iii) confidence in subject

(iv) attitude to teaching higher forms.

Finally, the head teachers were asked if there were any other comments they would like to make about either teacher.

Results of the Interviews with Head Teachers

School A

In school A the head master felt that both the ESP and LDC "use the same approach" of "discovery of learning". The ESP teacher he noticed did "a lot of experiments" in which the children were asked to "find out" things for themselves. He had seen the LDC teacher with a lot of materials but "didn't know her so well". Both teachers he noted still used a "fair amount of chalk and talk" and sometimes "rush pupils to answers". He felt that there was "not much in the way of difference" between them on their class control, lesson preparation and content confidence. The ESP teacher taught fourth and fifth form in two GCE O level science subjects, and the LDC teacher did not teach any fourth or fifth form classes.

School B

In this school the head of the science department was present during the interview and the head allowed him to make most of the comments. Both the ESP and LDC teachers were "new" to the school having come at the start of the academic year five months earlier. The ESP teacher was reported as having a "cool" control of the students but the LDC teacher had a "weakness in class control". The ESP teacher was also "far more thorough" in her preparation of work and although the LDC teacher did prepare, her "thoroughness was not very evident". The college teacher was "hesitant" about working in the upper forms and was reported as "shying away" from the third and fourth forms and as having "a strong preference for first forms". The ESP teacher did not have the "same degree of shyness". Both were teaching fourth forms, however, and had "responded positively to the challenge".

School C

It was difficult to get a comparison of the ESP and LDC teachers in School C because the headmaster reported that he had very little contact with the LDC teacher and "didn't know so much about him". The ESP teacher he reported was "very dedicated" and "likes to know his efforts bear fruit via exam results". He was "always in control" of his form and of his content. His work was "prepared very carefully" and he was on "very friendly terms with the senior boys and girls". When asked about the class control of the LDC teacher the head said he "didn't know" and had "no idea" about his lesson preparation as he "never saw (name) in action". The ESP teacher taught fourth and fifth forms. The LDC teacher taught fourth form but had "asked for" a fifth form.

School D

In this school the acting headmaster was also the husband of the ESP teacher. He asked that the comparison of the ESP and LDC teachers should be made by the Head of the Science Department. He was present, however, during the interview. The Head of Department was an experienced trained graduate. She reported that the LDC teacher had "poor class control" and "discipline". She felt that this was due to the fact that he did "little practical work" and commented that "he prefers blackboard teaching" and "lacks confidence in practical work and content". She had noted that once when he did do a practical on the preparation of oxygen he was unaware of the possible dangers in the experiment and allowed water to "suck back" towards the flask. The ESP teacher, she reported, was in charge of WISC for the school, had "good" class control and preparation of work and had "confidence in her content". Neither of the two taught fourth of fifth form; the Head of Department felt the ESP teacher would be willing to do so. The LDC teacher had been asked to take a fourth form chemistry class but had refused.

School E

The head teacher in this school felt that the ESP and LDC teachers were both "applying methodically the skills" they had learned during their training. Both made "optimum use of the limited equipment" the school had. The ESP teacher had better class control but the head felt that the LDC teacher "would develop with time". The two of them he felt were competent up to third form and both were willing to teach upper forms. His one criticism was that neither of them made "enough use of actual specimens". The LDC teacher he reported as being "very energetic" and having the "potential to teach higher".

School F

This was the only urban school of the six in the survey. The ESP teacher had been posted there two years earlier after seeking a transfer from a school in a rural East Indian area in order to attend the main hospital in Georgetown for medical treatment. At the time of the interview with the headmaster this ESP teacher had been seeking a transfer back to the rural area for a number of months.

The headmaster reported that the LDC teacher "seems to be capable" but "his professional performance" was "affected by his expectation of school that doesn't exist". Regarding content confidence, the head felt that the LDC teacher knew "what he was about". He was not able to give a judgement on his class control but commented that "as far as I can gather he is capable". The head felt that he "seemed" to prepare his work but needed to "get across the seriousness" of it. He did not think that the LDC teacher was hesitant about teaching fourth or fifth forms.

The ESP teacher, the head reported, needed "more application towards preparation of work". His content confidence was "quite shaky" and his class control was "affected by his lack of preparation and his inability to relate to students". He "liked and enjoyed" teaching upper forms, however. The ESP teacher did not attend any of the school's "social events" and the head suggested that his "cultural and environmental upbringing" was responsible for his lack of rapport and felt that he was "more used" to "passive" rural pupils than the "dynamic" children of the urban area.

The comments of the six head teachers on class control, preparation of work and attitude to higher forms are summarized in Table 8.15 in Appendix 1. Most of the heads felt unable to make specific comments about the content confidence of their science teachers, but where comments were made they are recorded in the reports on the individual school. In Table 8.15 we see that five of the six ESP teachers were reported as having good class control and as preparing their work. Four taught upper forms although all six were willing to. Of the six LDC teachers, two were reported as having good class control. In two cases the heads "didn't know" and in the final two the teachers were seen as having "poor" or "weak" control. Three of the college teachers needed more preparation of work. Three taught upper forms, although one was said to shy away from fourth and fifth forms; one college teacher had refused an opportunity to teach a fourth form.

(d) Pupils' Reports

In contrast to the small amount of research into the use of head teachers' ratings of teachers, there has been a considerable amount of research in the past decade into the use of student or pupils' ratings as a measure of teacher effectiveness. Rosenshine (1971) reviewed twelve studies involving student ratings of teachers and found that the "overall trend" of the results was positive and "very consistent". Jungworth and Tamir (1973) reported that the pupil's image of a biology teacher was a very good predictor of the pupil's own success in that subject and Laurenz (1977) found that the student perception of a classroom environment was "consistent over time". Student ratings of teachers have been criticized, by Whitely and Doyle (1979) as being biased by the student's like or dislike of the subject matter and by Howard and Bray (1974) and Goebal and Cashen (1979) because of the influence of extraneous variables such as the teacher's age, sex and attractiveness.

Initially it was planned to use a student rating scale similar to the one developed by Tamir and Zoor (1977) in Israel; their work , however, was carried out on pupils who all belonged to one age group. The researcher knew from previous experience in Guyana that it was unlikely that the ESP and IDC teachers would all be teaching the same age group. The pupils were likely to come from different age groups, different races and different cultural environments. Pupils from such widely differing backgrounds would be likely to place different interpretations on the meaning of words and phrases used in a printed rating scale and wording which could be understood by first form pupils was likely to be seen as childish and naive by fifth formers - so the idea of using a printed scale was rejected. Instead, the pupils were asked to give free response written reports of about half a page in length on "My science teacher and the way he (or she) teaches science". This method while it may provide less precise measurements than a rating scale has the advantage of allowing a more open investigation of the pupil's perspectives of teachers and teaching effectiveness. A science teacher's performance in Guyana could be affected by factors not identified from the opinions expressed by the science educators and head teachers. The pupils' free response replies provided an opportunity for them to emerge. The same six schools used in the survey of head teachers' opinions were also used to collect the pupils' reports. As had been expected, it was not possible to collect reports from the same age group in every school. In most cases, however, reports about ESP and LDC teachers in a particular school were collected either from the same class or from a similar class.

In School A, reports were collected from two equivalent second form classes. In School B, the ESP and LDC teachers both taught the same fourth form class for different O level science subjects. It was possible, therefore, to collect reports from the same pupils about the two teachers. School C was the only school in which the ESP and LDC teachers did not teach equivalent classes. The policy of the school was that a single teacher should teach the same subject to all four classes in each year. The ESP teacher taught all the second form classes and the LDC teacher all the third forms. It was necessary, therefore, in this school to compare the reports of a second form class with those of a third form class. In School E the reports of two equivalent second forms were compared and in School F, where the two teachers taught the same fourth form class for different science subjects, it was again possible to get the same pupils to write reports on both the ESP and LDC teachers.

In each case, the reports were written and were collected by the researcher in the absence of the teacher concerned. In School E, the head teacher was present in the large "open plan" building while the reports were being collected, but in the other five instances the pupils' reports were written in the absence of all staff from the room. The pupils were told not to write their names on their reports and were assured that their replies would be treated in confidence. They were also asked not to name their teacher and told that the study was being carried out on behalf of an overseas organization that wanted to "know about the different methods that teachers in Guyana use to teach science".

Written reports were obtained from 330 pupils in the six schools, an average of twenty-six for each teacher. The smallest class consisted of seven pupils and the largest of forty-three. Each report was read by the researcher and categorized as being either "favourable", "neutral" or "unfavourable" about the teacher. "Favourable" reports were those describing the teacher in positive terms such as, "interesting", "helpful" or "courteous". "Neutral" reports were those which described the teachers or their work in terms which were neither favourable nor critical. For instance,

"Teaches me about living things and non-living things" or

"She tells us what the topic is and what we are going to experiment on".

"Unfavourable" reports were those which expressed some criticism of the teacher or his work, even if the rest of the report was generally favourable. For example,

> "He is very good in science but I am experiencing that he does not know how to explain himself".

During the first reading of the reports "key words" or phrases were identified and noted by the researcher (Steadman 1976). These were words or phrases which occurred relatively frequently in the scripts and which could be used to describe the teaching style of a science teacher. Five key phrases were identified. The first was "Good Teaching" and it was categorized by a pupil referring to the teacher either as "teaching well" or as being a "good teacher". Care was taken to include only specific references to the persons teaching and phrases or sentences such as those below were excluded,

"I like the way he teaches me",

"He is a good man" and

"is good to me".

The second key word identified was "Kindness" and depended on the number of pupils who referred to the teacher as being "kind" or "considerate". Pupil participation in class "Experiments" and practical work was the third key word and teacher "Demonstrations" of practicals was category four. The final category was dictation of "Notes", either verbally or on the blackboard and this was identified by the pupil reporting, for example, that the teacher "gives us notes" or "writes lots of notes for us to study". The word count for each category was taken by counting the number of pupils who used the word or phrase and not by counting how often it appeared in individual scripts. Thus, if one pupil made three references to doing experiments with the teacher this was classified as a single count.

Results from the Pupils' Reports

The information obtained from the reports of the pupils in the six schools is shown in Table 8.16 in Appendix 1 and summarized in Table 8.16a below

Table 8.16a

Summary of Pupils' Reports about ESP and LDC Teachers
(percentages in brackets)

Number mentioning Key word	Pupils Taught by ESP Teachers	Pupils Taught by LDC Teachers
Good teaching	68 (39	55 (35)
Kindness	29 (17)	51 (33)
Experimental work	29 (17)	18 (12)
Practical demonstration	30 (17)	27 (17)
Gives notes	14 (8)	12 (8)
Total number of reports collected	174	156

Comparing the pupils' reports for the six ESP and six LDC teachers we find that there is no statistically significant difference between the two groups , in four of the five categories shown in Table 8.16a. The LDC teachers, however, received a significantly higher number of reports which mentioned kindness (Chi-square = 11.5 significant at the 1% level). ESP teachers received a higher percentage of reports on good teaching, for experimental work and for demonstration of practical work, but the differences were not significant at the 5% level. There was very little difference in the percentage of the scripts reporting the dictation of notes by the two groups of teachers.

Comparing the teachers in the schools individually, it is found that in five of the six, the LDC teachers received a higher percentage of comments about kindness. ESP teachers received a greater percentage of the reports on "Good Teaching" and pupil participation in three schools and an equal percentage in a fourth. A measure of total practical work was obtained by combining the references each teacher received for pupil "Participation" and teacher "Demonstration". On such a comparison, the ESP teachers received a higher percentage of reports on practical work in five of the six schools.

The different pupils' images of the two groups are not unexpected. The college teachers are younger and less experienced than the ESP teachers. It is not surprising, therefore, if the ESP teachers do have more class control, and since they are younger it should also be expected that the college teachers might concentrate more on their relationships with the pupils. Looking at the six ESP and six LDC teachers on whom the pupil reports were prepared, it is interesting to note that in all four cases where the LDC teachers received a higher percentage of comments on kindness they were younger than the ESP teacher. Summarizing the information on the age and "kindness" of the twelve teachers as in Table 8.17 below, we find that of the six schools there was only one in which the ESP teacher was younger than the LDC teacher. Here (School B) the two teachers received the same number and percentage of reports on kindness.

Table 8.17

Comparing Teacher's Age and Pupils' reports on Kindness

School	ESP Teachers		LDC Teachers	
	Age group	% kindness	Age group	% kindness
A	23+	4	21+	20
B	Under 21	57	21+	57
C	25+	30	21+	43
D	25+	23	23+	54
E	23+	7	21+	7
F	25+	7	Under 21	28

Some indication of the different image the two teachers present to the pupils can be seen in the pupils' reports. Writing about the "older" female ESP teacher in School F, one pupil commented,

> "She always sit and talk to us like her own children".

In a report on the young male LDC teacher in the same school, we read that,

> "He is a kind and handsome one. Our science teacher is not a stone hearted one ... He always speak polite to us ..."

One of the boys in this teacher's class reports, however,

> "Many times he make silly mistakes. He is not strict on the girls of our class, many time when there is a group of girls with one or two boys and they keep making noises he chase the boys out of the class and leave the girls".

Summary of the Results from the Comparison Study

As part of the evaluation of ESP, the twenty-nine teachers who qualified from the programme in 1980 were compared with the twenty-four teachers who qualified from the college science programme in the same year on a number of important criteria, including final teaching assessment, self-image, head teacher's assessment and pupils' reports. The ESP teachers compare favourably with the LDC trained teachers. LDC teachers had a slightly higher grade average on final teaching assessment (one grade on a ten point pass scale) obtained under conditions which favoured them . There was not a significant difference between the two groups' overall assessment of their own competence as science teachers, though LDC teachers did have significantly higher self-ratings in one of the nine areas of competence judged to be important for teaching science in Guyana.

The two groups had similar views of the relative importance of the nine areas of competence for science teaching. There was a correlation coefficient of $\rho = +0.61$ for their rankings of eight of the nine areas and there was not a significant difference in the ratings the two groups gave for any of the nine competency areas. For ESP teachers, however, Science Methods was ranked as the most important while for the LDC teachers it was the least important. There was a significant difference, at the 1% level, between the views of the two groups on teaching in urban based senior high schools with a much higher percentage of the college trained teachers preferring to teach in them 74% compared with 29% of the ESP group.

Although there are more ESP teachers in the 25+ age group there is not a significant difference between the composition of the two groups with regard to either their age of their sex. Neither is there a significant difference in the number of GCE O level passes the students possess on entering training. ESP teachers, however, have significantly more passes at O level in physics and in chemistry. In their replies to a free response question about their training programmes, the majority of both groups wrote favourably about their programmes, though the LDC teachers were more critical, commenting especially on the lack of staff and facilities, and five of them (26%) felt that the college programme had not prepared them adequately to face the "real" situation that existed in schools.

Head teachers' views were obtained in every case where a direct comparison was available, namely in the six schools in which both ESP and LDC teachers taught. The head teachers in these six schools were interviewed and asked to compare the two teachers specifically on their abilities as science teachers. In most cases - in five out of six - the ESP teachers were seen as having good class control and good preparation of work, and all six were willing to teach fourth and fifth form classes. Only two of the six college teachers were known by the head teachers to have good class control; two others were reported as poor or weak in class control. The head teachers reported a lack of preparation by three of the six college teachers and two of them were seen as being hesitant about teaching upper forms.

After interviewing the head teachers the researcher asked pupils of the same twelve teachers (six ESP and six LDC) to write a short report on their science teacher and the way he or she taught science. Three hundred and thirty such reports were collected, 176 for the six ESP teachers and 154 for the six LDC teachers, and these were analysed using six measures of the pupils' views about ESP and LDC teachers. There was no significant difference in the views of pupils about ESP and LDC teachers on five of the six measures. A significantly greater number of pupils, however, mentioned kindness when referring to the LDC teachers. ESP teachers received a higher percentage of reports on good teaching and in five out of six schools also received more reports about doing practical work.

Conclusions From Comparison Study

In this comparison of science teachers trained through a distance-teaching approach with thos trained via an equivalent college-based course, little difference was found between the teaching effectiveness of the two groups. Though the college teachers did have slightly higher grades on final teaching assessment, the ESP teachers felt as competent as the college teachers. In three of the six schools where a direct comparison could be made between ESP and LDC teachers, the ESP teachers received more positive reports form the head teachers. In these same six schools, reports were collected from pupils taught science by either an ESP or a LDC teacher. Over 80% of the pupils wrote favourably about the two groups of teachers. The only significant difference between the pupils' reports was that the LDC teachers were more often reported as being kind. ESP teachers had better O level science qualifications at the start of their training programme and fewer wanted to teach in the urban based senior high schools (both differences were statistically significant at the 1% level).

All the evidence gathered from supervisors, head teachers, pupils and from the teachers themselves indicates that the ESP teachers are as good as the college trained teachers at teaching science in Guyana though some differences between the two groups do emerge. The main strength of the college teachers would seem to be their ability to interact with their pupils. They felt more competent than ESP teachers in their Evaluation and Questioning ability and a greater number of their pupils wrote about their kindness (differences both significant at the 5% level). In contrast to the college teachers the main strength of the ESP teachers is their class control and subject knowledge. Head teachers commented favourably on their class control. They have better O level science qualifications than their college trained counterparts. They see Science Methods as being the most important of the nine competencies for science teaching and their main comments about their training programme was on how it made them feel "more confident" in front of the pupils and "more familiar" with the use of equipment.

The ESP teachers are as good as the college trained teachers at teaching science. The ESP programme has the advantage, however, that the teachers are trained in their own schools, schools which are mostly in rural areas where it has always been difficult to recruit trained science teachers, for even when college students themselves were recruited form rural areas, they have tended to drift back after training not to rural but to urban schools, a trend which is also seen clearly amongst the LDC teachers qualifying in 1980.

By virtue of its in-service nature, the ESP programme may help overcome this drift towards the towns and city and results obtained from the STSIS questionaire show that the ESP teachers are less likely to want to move to the senior high schools of the urban areas. The significantly higher science qualifications of the ESP teachers also help to confirm that there is a need for an in-service training programme such as ESP. Almost all of the teachers accepted for the ESP programme were well qualified and hence eligible to apply for the college training programme. Most had been teaching for two years or more, but for financial or domestic reasons did not wish to follow a college-based programme. For instance, a number of the East Indian girls had to live with their parents but their homes were too distant from the city to allow them to attend the college, and a number of the men had to work on family smallholdings. The in-service distance-teaching approach of ESP allowed for the training of people who might otherwise never have been able to become trained teachers.

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Chapter Nine

The Criterion Performance of ESP Teachers

In Chapter Four it was proposed that two methods should be used for evaluating the performance of ESP teachers. In the first, their teaching effectiveness was to be compared with that of an equivalent group of college trained science teachers. This was carried out and, as reported in Chapter Eight, the ESP teachers proved to be as effective as college trained teachers at teaching science in Guyanese schools. Assessing a teacher in this way, that is by comparing his or her performance with that of a large number of other teachers - norm-referencing - is not in itself sufficient unless it can be shown, in some way, that the teaching is adequate or satisfactory. It is important, therefore, to determine whether ESP teachers can satisfactorily perform the role for which they were trained. To find out if they can do so one must first determine what is meant by teaching satisfactorily, and once more, problems arise as to what criteria can be used to judge whether someone is or is not a good (or satisfactory) science teacher.

The identification of criteria whereby someone can be rightly judged as being able to perform a job satisfactorily is a perennial problem. One technique commonly used is to measure their general ability or intelligence (for instance, when a person's ability to perform the role of a civil servant or police officer is assessed by the number of high school grades or GCE O level passes he or she has obtained). GCE and high school examinations make no attempt to assess a person's performance in either of these two roles but rather try to measure their general ability in particular subject areas such as English language, English literature, mathematics and history. It is questionable therefore, whether such criteria are valid measures of job performance. McClelland (1973) has suggested that the evidence in favour of these critera,

> "... is a whole lot less satisfactory than one would think it ought to be ..."

For instance, Holland and Richards (1965) and Elton and Sheval (1969) found no consistent relationships between college students' scholastic aptitude scores and their actual accomplishments in social leadership, in the arts, in science, in music, in writing or in speech and drama and Thorndike and Hagen (1959) in their investigation of the relationship between aptitude test scores and occupational success concluded that,

> "there is no convincing evidence of any relationship of test scores to success within occupation for those men who entered a specified occupation" (p. 367)

Chiselli (1966) reviewing fifty years of research into the relationship between intelligence test scores and job proficiency concluded that the correlation between the two was only 0.23.

Because of the evidence that "traditional" methods of measuring job proficiency were inadequate, alternative methods for measuring proficiency were devised. Following the 1964 Civil Rights Act in the USA much consideration was given to establishing guidelines for effective job selection and two federal agencies were set up - The Equal Employment Opportunities Commission and The Office of Federal Contracts Compliance - to check how well the Civil Rights Act was being implemented. Using the recommendations of a panel of psychologists these agencies now advocate the use of,

> "a total personnel assessment system in job selection" (O'Leary 1973)

and have emphasised the need to develop criterion-related measures of job proficiency. Following on their recommendations McClelland (1973) suggested,

> "If you want to test who will be a good policeman, go find out what a policeman does. Follow him around, make a list of his activities, and sample from that list in screening applicants".

Job simulation, or job sampling tests, therefore, are being advocated as an alternative to traditional pencil and paper aptitude and intelligence tests for testing job proficiency. (O'Leary 1973, McClelland 1973 and Shavelson, Beckum and Brown 1974)

The (1972) report of the International Commission on the Development of Education (UNESCO 1972) recommended that the "master concept" for educational policies in developed and developing countries should be one in which education is seen as being a lifelong process. From this viewpoint education is seen not merely as being a preparation for life but rather as an integral part of life itself, a lifelong process stressing indivudual and collective fulfillment through continuing personal growth (Skager and Dave 1977). However, as yet it is neither an integrated theory nor an educational philosophy but rather a way of conceptualising and communicating,

> "Worldwide trends towards the enhancement and variegation of education's role in society" (Skager 1978).

Since 1972, the UNESCO Institute For Education in Hamburg has been concentrating its efforts towards both trying to promote and clarify the idea of lifelong education (Hawes 1975), and to that end has produced a series of monographs and books, and has carried out a number of studies (UIE 1978a). From the perspective of lifelong education each method of learning, whether it be carried out in a traditional formalized institution of learning (Formal Education) or via an out-of-school institution (Non-formal Education), is a legitimate way of gaining knowledge, skills, attitudes and values. It was felt, however,

> "If these alternative (i.e. non-formal) forms of education are to be legitimized by the general public as well as by those who allocate educational resources and opportunities, evaluations of them must provide evidence that they lead to the same outcomes as do the formal educational institutions" (UIE 1978b)

UIE were interested, therefore, in devising a way of legitimizing Nonformal Educational Projects (NFEPs). They sought to develop "a generalizable scheme" for the recognition of the knowledge and skills etc. obtained through NFEPs and considered that job or task sampling offered one way in which such a scheme could be developed (UIE 1979a). They decided, therefore, to evaluate this approach to evaluation to see if it could be used to develop the "generalizable scheme" they sought. Accordingly, in 1978, the project "The Evaluation of Learning in Nonformal Educational Settings" was launched by the Institute. Based on four case studies the project seeks to develop and try out a particular methodological approach (namely a task or Criterion Sampling Approach) for evaluating student achievement in NFEPs. If this approach proves to be successful UIE suggests that,

> "An initial step will have been taken in providing a means for legitimizing nonformal eduactional programmes" (UIE 1978b)

The project is a metaevaluation, that is, an evaluation of a methodological approach to evaluating the outcomes of specific nonformal educational programmes, of which ESP is one. In April 1980 the author was approached by the Senior Research Specialist of the Institute and invited to consider extending the evaluation studies of ESP that were already in hand to include a Criterion Sampling Approach and by so doing become one of the Four NFEPs of the project. The invitation was accepted.

Criterion Sampling

Most traditional tests depend upon norm-referenced measurement in which a candidate is assessed by comparing his or her performance with that of a large number of other candidates. Criterion-referencing assesses a candidate against a "fixed", pre-determined standard. If a candidate achieves a score above the "fixed" or criterion level he "passes" irrespective of such considerations as the number of other candidates who have either "passed" or "failed" and irrespective of the supply of, or demand for, people with the "pass" qualification. Criterion Sampling, therefore, involves "quota free" selection (Hambleton and Novick 1973).

The term "criterion-referenced" measurement (CRM) is credited by Sumner and Robertson (1977) to Glaser (1963) who suggested that underlying achievement measurement is the notion of a "continuum of knowledge acquisition" ranging from no proficiency to perfect performance and that a student's position on this continuum could be assessed by CRM independent of reference to the performance of others. A criterion-referenced test therefore,

> "is one that is deliberately constructed to yield measurements that are directly interpretable in terms of specified performance standards" (Glaser 1971).

Gavin (1970) has suggested that criterion-referenced as opposed to norm-referenced tests should be used in situations where public safety, economic responsibility or other "ethical considerations" demand that certain tasks be performed only by those "qualified" for them. Ebel (1971) however, has warned of the limitations of criterion-reference tests, pointing out that they do not provide information about the relative excellence or deficiency of candidates and that because of the different perceptions, values and standards that people have, it is often time-consuming and difficult to get valid criteria needed for criterion testing. Block (1971) in reply to Ebel has argued that most learning is sequential in nature and CRM, therefore, will help to provide evidence as to what a pupil or trainee has not yet learned. He also suggests that far from being time-consuming and invalid, identifying the objectives or criteria for CRM will in fact provide a key for effective teaching.

Criterion Sampling is a particular form of criterion-referenced testing, one,

> "in which the student's performance on standardized samples of the tasks for which he has been trained is systematically observed, measured and evaluated" (UIE 1979a)

Traditional tests require indirect "symbolic" responses from candidates, responses which may have little to do with the individual's usual behaviour. In a CSA evaluation an individual is assessed by the score he or she achieves on a number of situational performance tests which do reflect real life situations. A second characteristic of CSA is that it attempts to standardize test conditions, by testing the candidate's performance on a sample of the tasks he would normally carry out in the every day situation. This technique, therefore, allows for direct "low inference" observations to be made of different aspects of the candidate's performance in sharp contrast to traditional "high inference" measures which attempt to assess the individual by looking at his global or overall performance. CSA standardizes test conditions while at the same time approaching the "authenticity" of real life (Fredensken 1975). A key feature of CSA, therefore, is its use of standardized tests to measure a sample of the skills or tasks a candidate would be expected to perform in the real life situation. UIE have reported that,

> "Good examples of the CSA are not readily available in the published literature" (UIE 1979a).

Situational tests, however, have been widely reported, for example, in the simulation of patients in medical research (Barrows and Bennett 1972) and in "in-basket" exercises used in the assessment of, administrators (Frederiksen et al 1972), and head teachers (Shulman 1965). Shavelson, Chadwell and Izu (1977) have used situational tests to investigate the relationship between a teacher's prior information about students and his subsequent estimates of students' aptitude. Situational tests are widely used in military and civilian training and leadership tests (Parsons 1972, Shavelson 1968, Holman 1965 and Bray and Grant 1966).

The Strategy For the CSA Evaluation of ESP

The CSA evaluation of ESP was based on the guidelines for course teams produced by UIE (1979b) but modified to suit the particular context of the ESP programme. The five basic stages recommended by UIE, however, were followed.

Stage A Identification of Programme Goal to be Evaluated. UIE requested that each case study should measure,

> "the extent to which ONE of the nonformal educational programme's most important goals had been achieved" (ibid).

The first step in the CSA evaluation of ESP, therefore, was to identify and select this goal.

Stage B Determination of Performance Criteria to be used for Evaluating the Goal. This required the identification of the skills and tasks a candidate should be able to perform if he or she has the the required level of competence.

Stage C Construction of Criterion Sampling Instruments (to measure the teacher's performance of the skills and tasks identified in Stage B). For CSA purposes tests must be standardized and yet be true to the real life situation. Situational tests must be developed, therefore, which when taken as a whole would show whether or not the candidate was able to carry out the job for which he was trained.

Stage D Testing of Teachers' Criterion Performance. After developing and piloting the instruments were used to test the performance of a sample of the ESP teachers and hence determine if the teachers had in fact achieved the criterion standard for their job.

Stage E Evaluation of CSA as a means of Evaluating ESP. Having tested the situational performance of a sample of the ESP teachers, the final stage of the case study was to determine the applicability and utility of the CSA method for evaluating ESP. The results obtained via CSA were compared with those obtained from other evaluation methods and the views of the participants of the ESP programme on the suitability of the CSA evaluation collected and analysed.

Stage A Identifying the Goal

The general aim of the ESP programme is to increase the number of trained science teachers in secondary schools in Guyana, and the five goals given in the ESP proposal (see Appendix 4) and accepted officially for certification purposes, all seek to help satisfy this one general aim. Whether it be to provide the students with enough science content (Goals 1 and 2), with enough educational theory and practice (Goal 4), with enough background in other areas (Goals 3 and 5), all share the same purpose, that is, to train the students so that they can teach the science curricula used in Guyanese secondary schools, specifically the proposed integrated science programme of CXC and the WISC and SDSP programmes. It was decided, therefore, to use the Criterion Sampling Approach to evaluate whether or not this basic aim of ESP had been achieved. The CXC Integrated Science Project is in its pilot stages and its course materials are being evaluated and modified. It was decided, therefore, to evaluate the ESP teachers' ability to teach WISC and SDSP, the two curricula in use in Guyana at present.

Stage B Performance Criteria for Evaluating Science Teaching

The second stage of the CSA evaluation is concerned with identifying what a "graduate" of ESP should be able to do if the programme has achieved its basic aims. It was necessary, therefore, to address the question: what does a science teacher need to be able to do in order to teach WISC and SDSP? This evaluation is not concerned with determining if the teachers are "good" teachers but whether or not the ESP programme is successful in creating the skills and competencies that Guyanese educators sought to produce in science teachers. The answer to this was determined by identifying the competencies and skills which were considered by Guyanese educators to be important for teaching WISC and SDSP in schools in Guyana (Chapter Seven).

Stage C Construction of Criterion Sampling Instrumentation

According to McClelland (1973) the best predictors of a student's behaviour in real life situations are measures of his performance on samples of the situations themselves. CSA uses such an approach since it tests the performance of the students on a sample of the criterion behaviours for which they have been trained. Having identified the full list of competencies and skills that ESP teachers should have at the end of their training, the next step was to obtain a sample of these in order to test student performance. The sample of skills and competencies can be drawn in a number of different ways. The sampling method chosen for ESP was a modification of that recommended by UIE (Shavelson 1980). Instead of taking a random sample from the universal set of science teacher task/skills, it was decided to take a stratified random sample. The questionaire responses were used to identify the three competency areas which the Guyanese educators felt were the most important for science teachers to have. These were:

1. Use of scientific methods
2. Knowledge of subject
3. Relate to pupil's environment

The skills rated by the educators as being important for these three competencies were compiled into three separate lists and a random sample of two skills was drawn from each list. In this way a stratified random sample was obtained of the skills which science educators in Guyana think are most important for teaching WISC and SDSP in Guyanese schools.

The six skills identified were:

<u>Knowledge of Subject</u>

1. Observe safety precautions for any situation that is likely to arise in his/her teaching.
2. Use correctly all the different apparatus and materials needed for the science curriculum being used by his/her classes.

<u>Use of Science Methods</u>

3. Guide pupils to make conclusions from their observations.
4. Encourage pupils to record what they have observed.

<u>Relate to Pupils' Environment</u>

5. Relate new experiences to pupil's previous experiences.
6. Adapt a lesson plan to suit the specific local conditions of a school.

Having identified the sample of skills to be tested the next step was to design "situational" tests to measure the teacher's ability to perform these skills. Both the WISC and the SDSP programmes have prepared and published detailed teacher's guides (Adey 1976, Impey1974a) and an analysis was made of these to identify all those tasks in which these six sample skills were needed.

Test 1 To test the ESP teacher's skill in observing safety precautions

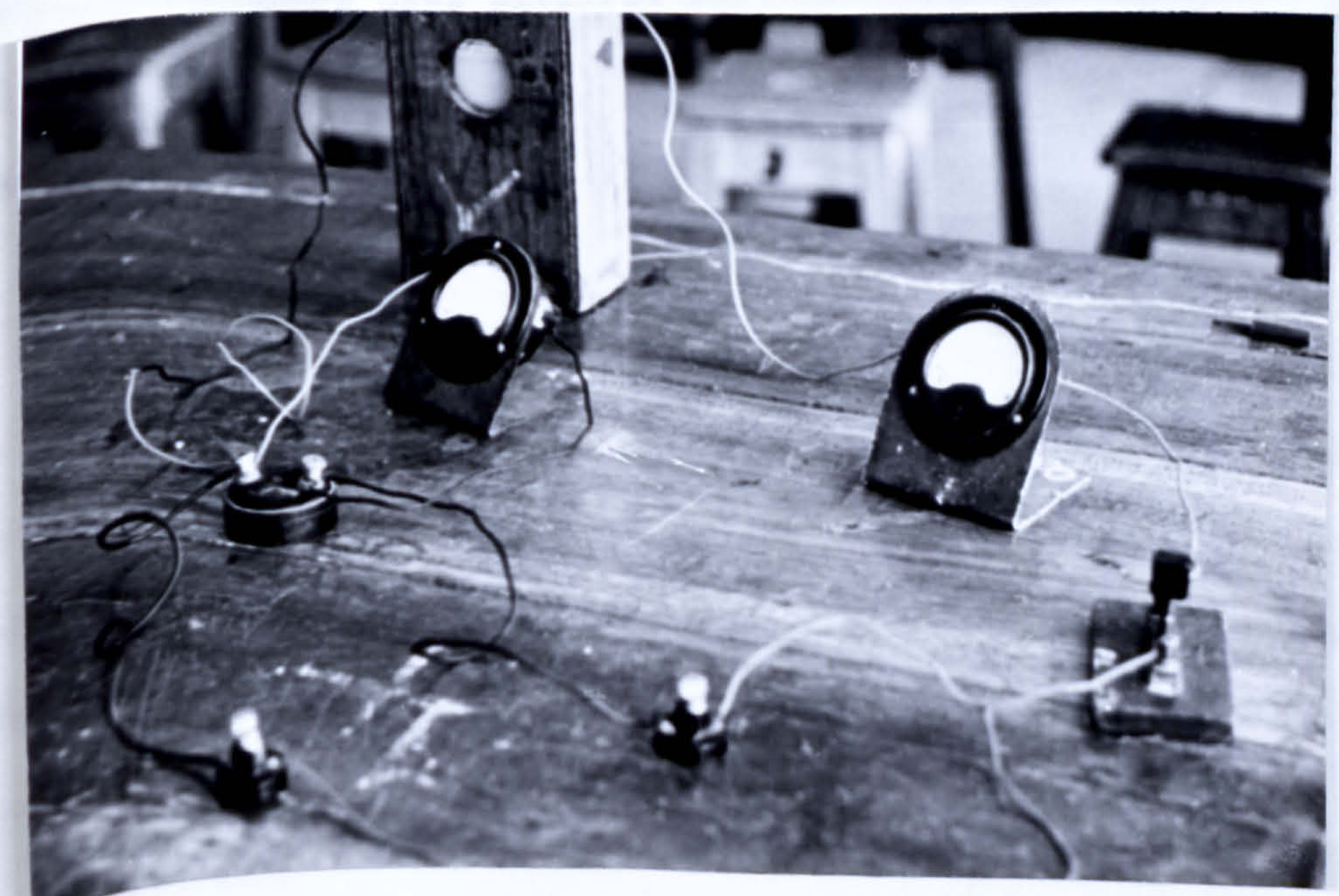
The Ministry of Education supply to secondary schools a safety booklet which also forms part of the correspondence materials supplied to ESP teachers (Ministry of Education 1978). By means of this booklet, twenty potentially dangerous situations, which could arise during the teaching of WISC or SDSP, were identified. From these twenty, twelve which could be simulated in a static display (i.e. without actors) were selected for use. These included, a spirit burner left burning close to an open bottle of alcohol, a reagent bottle left at the edge of a bench and a bottle of mercury left uncorked. (A photograph of some of the potential dangers used in the test is shown on page210a and the twelve are listed in Appendix 2). The ESP teachers' "safety skill could be tested, therefore, by them recognizing and overcoming these twelve potential dangers.

Test 2 To test the ESP teachers' skill in using science apparatus

To develop a situational test for Skill 2 it was first necessary to determine what a teacher would have to know and do to be able to "use correctly all the different apparatus and materials needed for the science curriculum being used by his/her classes". In order to use science apparatus and materials correctly it was decided a school teacher would have to be able to identify and assemble it into the form required for the pupils to carry out the classroom or laboratory activity, and also would have to be able to

Some of the Simulated Dangers in CSA Test 1

One of the Assemblies set up in CSA Test 2



"manipulate", "read" or "use" it to the degree of accuracy required. Three sub-tests were designed accordingly to test the teachers' skill in these aspects of using the apparatus.

For sub-test 2a, a complete list of the equipment needed to teach WISC and SDSP was prepared. (Equipment required for optional activities was excluded). A random sample of one-third of the items was then selected. This sample would be used to test the teachers' ability to recognize the various items of equipment needed to teach WISC and SDSP.

Sub-test 2b. An analysis was made of the teacher's guides of WISC and SDSP to identify tasks which would require teachers assembling items of equipment or material. Many such tasks were identified. From the analysis it was clear, however, that they could all be grouped into one of three categories:

1. those requiring the teachers to assemble items of glassware,
2. those requiring them to assemble items of electrical apparatus, and
3 those requiring the cutting, folding or bending of materials such as paper, rubber, wire and sheet metal.

Representative tasks were selected from the teacher's guides for each of the three categories. (The second photograph on page 210a shows one of the assemblies set up by the teachers during sub-test 2b).

Sub-test 2c. In the WISC teacher's guide there is a recommendation that the pupils should be able to take measurements to an accuracy of $\pm$ 2% . It is reasonable to expect teachers to be able to use the same instruments to at least that degree of accuracy. Measurements of length, volume, weight, temperature and time are needed throughout WISC and SDSP so sub-test 2c was designed to test the teachers' abilities to take such measurements to this degree of accuracy.

<u>Test 3 To test the teachers' competence in Skill 3, 4 and 5</u>

This test was designed to assess the teachers' skill in:

guiding pupils to make conclusions from their observations (skill 3)

encouraging pupils to record what they have observed (skill 4)

relating new experiences to pupil's previous experience (skill 5).

It was decided that teachers would be asked to teach the same content, in the same laboratory using identical sets of apparatus but teaching different though comparable groups of pupils. The teachers would be required to prepare a lesson on a given topic for a group of four children of specified age and ability. They would be provided with identical sets of equipment and given a specific objective which the pupils should have achieved by the end of the lesson. Having prepared written notes on the lesson the teachers would then be asked to teach their lesson to a small group of pupils randomly drawn from the same age and ability "band" of the one school.

The teachers' skill in relating new experiences to the pupil's previous experience would be judged from the way they proposed to do this in their lesson plan. Their skill in "guiding" pupils to draw conclusions from their own observations would be judged both from the way they proposed to do it and from the conclusions that the pupils wrote. Lesson notes and pupils' written responses would also be used to assess the teachers' skill in encouraging the pupils to record their observations.

Test 4 To test the teacher's skill in adapting lessons to suit local conditions

Of the two science programmes taught by ESP teachers, one, the SDSP programme of the community high schools was specifically designed to suit conditions in Guyanese schools. It requires a minimum of equipment and the lesson plans can be followed in almost every school without major modification. The WISC programme, however, was originally designed for use in Trinidadian and Barbadian schools and was piloted in only a few, relatively well-equipped Guyanese schools. Many of the lesson plans are not suited to Guyana and often the lessons needed to be adapted to suit local conditions (Brophy and Dalgety 1981).

It was decided that as the ESP teachers were much more likely to have to adapt WISC materials in their everyday teaching, then the CSA test should evaluate their skill in adapting aWISC lesson to suit local conditions. Using random number tables, one of the fourteen units in WISC was selected. After excluding optional and homework lessons, all lesson plans in this unit were then listed and using a random number table once more, one lesson was selected from a list of twenty. The lesson selected in this way was lesson 14.3 "Power: the rate of energy conversion". This double period lesson seeks to introduce the pupils to the time factor involved in energy conversion and to get them to record the number of Joules of energy converted per second when they lift loads. The lesson also seeks to introduce the pupils to the Watt as a unit of power. The WISC teacher's guide sets out the lesson plan in detail. The main activity of the lesson involves the pupils using a block and tackle, a set of weights and a stopwatch. Almost certainly the schools in which ESP teachers will work will have neither a block and tackle nor a stopwatch. Test 4, therefore, measures the teachers' skill in adapting a lesson to suit local conditions by the way they are able to adapt this WISC lesson to suit a (common) local condition of shortage of equipment. In the test the teachers were given a photocopy of the WISC lesson plan and asked to adapt it so that the same objectives could be achieved by a class of pupils without the use of a block and tackle or stopwatch.

Stage D Procedure used for testing teachers' criterion performance

For the CSA test conditions to be standardized all the teachers were tested in one place. The twenty-nine ESP "graduates" come from many different regions and it was not possible with the finance available to bring all of them to one centre for testing. So, the performance of a sample of fifteen ESP teachers was evaluated. However, since some of the teachers lived at considerable distances from the capital eighteen "graduates" were invited to take part in the CSA evaluation. The tests were carried out over a three day period in January 1981 at Queen's College in Georgetown, with teachers from Region 1 being tested on the 26th, those from Region 2 on the 27th and those from Region 3 on the 28th. The tests were carried out in the same laboratory and in the same order for each group. Of the eighteen people invited seventeen arrived for the test, one of whom for personal reasons had to leave after completing two of the four tests.

Test 1 Procedure

In test 1 twelve potential dangers were simulated in the school laboratory. The teachers were provided with Worksheet 1, "Safety in the Laboratory"* and were required to identify the dangers, record them on their worksheet and suggest a way in which each could be either prevented or overcome.

Test 2 Procedure

For sub-test 2a the sample of items of WISC and SDSP equipment were placed on a bench along with a number of items randomly selected from the list of equipment. All items were then numbered. The teachers were provided with Worksheet 2, "Identifying Science Apparatus"* on which the names of thirty-one items to be identified were given. They were then required to identify each item by writing its number alongside the name on the worksheet.

In sub-test 2b each teacher was provided with Worksheet 3 "Assembling Science Apparatus"* and assigned a position at a laboratory bench. Each person was provided with the individual items of apparatus and was required to assemble them as specified in the worksheet.

In sub-test 2c the teachers were provided with Worksheet 4, "Using Science Apparatus"* and were asked to take five measurements using the five different instruments. The teachers were informed both verbally and on the worksheet itself that marks would be awarded for the accuracy of measurement.

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* Copies of the worksheets used for the situational tests are given in Appendix 2.

After completing Test 2 the teachers were allowed a lunch break of one and a half hours, but the group from Region 3 preferred to take a break of only half an hour so that they could travel back to Berbice before nightfall.

Test 3 Procedure

The teachers were given Worksheet 5, "Science Teaching Methods"* and asked to spend thirty minutes preparing the lesson plan. Originally it had been planned to select at random pupils from the entire first form of one school for Test 3, but the size of the school's first form and the constraints of the school time table made this plan unrealistic. The first form of the school was grouped into three ability bands with the middle band consisting of three classes; within each band the pupils were unstreamed. The procedure adopted for Test 3, therefore, was to select twenty-four pupils from one middle-band class each day and then randomly ascribe four pupils to each teacher (so each day six teachers taught four pupils). All the teachers taught at the same time but in different parts of the same laboratory. They were provided with identical sets of equipment and were asked to teach for the same length of time (a single thirty minute school period).

Teaching in the same room as the others is not an unfamiliar experience to teachers in secondary schools in Guyana. Most, if not all, ESP teachers can expect at some time in their career to teach in an open area shared by more than one class. The conditions for Test 3, therefore, reflect the real life situation in Guyana.

Test 4 Procedure

In Test 4 the teachers were given a copy of Worksheet 6, "Adapting a Lesson Plan to Local Conditions"* and a copy of lesson plan 14.3 from the WISC teacher's guide. In the guide a number of alternative activities are

* Copies of the worksheets used for the situational tests are given in Appendix 2.

suggested for this lesson. These, however, were not included in the photocopies provided for the CSA test. The teachers were asked to write a report on how they would modify the lesson if they had neither a block and tackle nor a stop watch.

Scoring Criterion Performance

It has been suggested that scoring is probably the major technical limitation of a situational test (UIE 1979) and it took considerable time and effort to develop a scoring procedure for the ESP tests. One concept which was found to be of benefit was Fremer's (1972) suggestion of minimal competency levels. Using this approach a minimal standard is pre-specified, a standard which a candidate must achieve before he can be judged as being competent to do the job for which he was trained. The problem is how to specify what this standard should be. Zieky (1973) has identified seven ways in which standards can be set for criterion reference tests. These include "inspection-based" judgements (in which the tests are reviewed as they are performed) and "judgemental" methods (in which the test items are assessed by a panel or committee of judges and a consensus arrived at). Both judgemental and inspection-based methods were used to develop the marking schemes for the ESP tests. A panel of three judges was appointed to draw up the marking scheme. One member of the team represented the Science Unit of the Ministry of Education, one the Course Writing Team and the third the local tutors. All three were also members of the panel of assessors appointed by the Board of Examiners to make the final teaching assessment of ESP and College of Education students. This Criterion Panel met in Queen's College while the CSA tests were being carried out. They read the materials, observed the tests and then met in a separate room to prepare a marking scheme. If they had difficulty in arriving at a consensus they obtained a sample of the candidate's "scripts" and used these to reach final agreement. The Panel devised detailed marking schemes for each of the six skills. As well as setting minimal competency levels for each they also identified levels which would denote a high level of competence in each skill.

The marking scheme and the criterion levels set by the Panel are included in Appendix 2. A separate marking scheme was designed for each of the six skills tested. The raw scores were then converted so that each skill was marked out of the same total of 100.

The scheme for marking Skills 3,4, 5 and 6 provided relatively sharp criteria with which the teacher's competence could be judged. For example, the scheme for Skill 6 provided five acceptable responses. If the teacher gave any one of these, he achieved the criterion score. If he provided any other response he failed the test. Skills 1 and 2, however, involved the teachers gaining marks on a number of items. The criterion panel decided that no one item could, by itself, differentiate between adequate and inadequate performance of the skills and so they set minimum scores which the teachers had to achieve before they were judged as being adequately competent. There are conceptual problems, however, with using accumulated scores in criterion-referenced testing. For example, in setting the "criterion" or pass level, the panel were likely to use norm-referenced judgements of what score could be expected of an average teacher. Angoff (1974) has reported that accumulated scoring is compatible with criterion-referenced testing and suggests that many criterion-referenced evaluations are in fact based on norm-referenced tests, being based, for example, on the performance expected from pupils of a particular age group. The CSA tests for Skill 1 and 2 used this approach.

Results of the CSA Test

Using the marking scheme and the criterion standards set by the Panel the performance of the ESP teachers was assessed on a representative sample of the skills considered by Guyanese science educators to be important for teaching science in Guyana. The assessment included the extent to which the ESP teachers achieved overall competence and their competence in each of the six skills.

The results of the CSA test are set out in Table 9.1 in Appendix 1 and are summarized in Table 9.2 below. All sixteen teachers achieved the required competence level.

Table 9.2

Competence of ESP Teachers as Measured by CSA Test

	Competence Level		
Competency	High level of Competence	Adequate level of Competence	Below required level of Competence
Subject Knowledge	0	16	0
Science Methods	7	9	0
Related to environment	6	9	1
Overall competence	0	16	0

Skills 1 and 2 are different aspects of the same competence - Knowledge of subject matter - so the scores were combined for these two skills to obtain a measure of how competent the teachers were in "Subject Knowledge". The results show fifteen of the sixteen to be competent. Similarly, by combining scores for Skills 3 and 4 all sixteen were found to be competent at relating to their pupils' environment. Fifteen of the sixteen ESP teachers were competent, therefore, in all three areas considered by Guyanese science educators to be of particular importance for science teaching. All the teachers scored above the level needed for adequate overall competence. Since these sixteen were a representative sample of the twenty-nine who have so far qualified through ESP it was clear that the programme had achieved its major goal of training teachers to teach WISC and SDSP.

Practical Problems Encountered During CSA Test

It took longer than anticipated to assemble the equipment needed for the situational tests with the result that, although some piloting had been carried out, on the spot piloting of the tests was not as thorough as one would have wished, and a number of practical difficulties arose during the situational testing - difficulties which would have been eliminated with proper piloting.

The three main problems encountered were,

(i) Difficulty of keeping conditions standardized.

In a research laboratory it may be comparatively easy to maintain standardised conditions but in an effort to reflect the authenticity of real life the CSA tests were carried out in an ordinary school laboratory and here it is difficult to maintain standardization. This was particularly noticeable in Test 1 which measured the teachers' safety skill. One of the "dangers" which the teachers were expected to recognize was that a reagent bottle (on the edge of a bench) could be easily overbalanced and its contents spilt. Each day the "dangers" were checked before the first student was allowed into the laboratory. Cn the first day, however, the researchers failed to keep checking that the "dangers" continued to exist for each student and only at the end of Test 1 was it discovered that at some time during the test, one of the teachers had moved the reagent bottle slightly back from the edge of the bench. This may have made the "danger" more difficult to recognize for the other teachers. On the second day of testing one of the teachers was observed picking up the bottle to read the label and then setting it down slightly further back from the edge.

(ii) Differing interpretation of instructions.

In order to maintain standardization over the three days the instructions for the tests were printed on worksheets and verbal instructions kept to a minimum. It was difficult to be sure, however, that each candidate was interpreting the instructions in the same way. In Test 4, for instance, in which the teachers were asked to modify a lesson plan, some interpreted the instructions to mean that they had to write out a new lesson plan whilst others interpreted them as meaning that they had to write only about the modifications they would make. Fortunately the Criterion Panel were close by and able to give a judgement which was then announced to all the candidates.

(iii) Fatigue

Many of the teachers were noticeably tired by the time they came to do Test 4. In order to arrive at the test centre for nine a.m. some had left home at six-thirty a.m. and had travelled distances of up to a hundred miles. Most had eaten only small snacks for lunch and so in such circumstances it was not surprising that by the time they began Test 4 they were clearly fatigued.

Reliability of the CSA Test

Traditional indices of consistency are not appropriate for criterion-referenced tests (Popham and Husek 1969) as these were designed for use with norm referenced measurements and depend upon the existence of differences among the candidates' scores. Criterion-referenced tests are intended to apply to situations in which there may be no difference among the students' true scores. In a CSA test, for example, it could happen that all the people in a population are above the criterion score and thus the true score variance could be zero. A CSA test, therefore, could reliably indicate that all the candidates have demonstrated the criterion performance but still have a conventional reliability co-efficient of zero.

The problem of obtaining a reliability index for a criterion-referenced test has been recognized for some time and a variety of approaches have been proposed (see Hambleton et al 1978). The most appropriate criterion method for anyone familiar with conventional reliability measures is the one developed from classical test theory by Livingston (1972). In this method a reliability co-efficient is calculated based on the deviation of scores from the criterion rather than from the mean. Calculated in this way the co-efficient will have many of the important properties of conventional norm-referenced reliability measures including its interpretation as a ratio of variances. It has been argued, however, that as Livingston's co-efficient is a function of the criterion as well as of an individual's responses, it should not be interpreted as if it were a conventional reliability index. (Shavelson et al 1972). Nevertheless, the Livingston method for calculating reliability is recommended by UIE (1979), especially for criterion tests where only a single administration of the test is possible. The CSA results for ESP were obtained for a single test and so Livingston's method was used to calculate reliability. The co-efficient obtained was $\hat{K}^2_{XT} = 0.9$ demonstrating a high degree of reliability for the CSA test.

The tests which assessed the teachers competence in particular skills were all marked using criterion scoring. As noted on page 217, Test 1 and 2 were assessed using accumulated scores. Test 2 scores were based on three sub-tests but Test 1 scores were based on the marks teachers accumulated on twelve items. Since this approximated to a short norm-referenced test, a split-half reliability was calculated for it based on the odd and even items in the test. Using Pearson's Product Moment correlation and the Spearman Brown reliability formula, a reliability figure of .67 was obtained. This is a moderately high figure for a sub-test of twelve items.

Validity

Before claiming that the satisfactory results of the CSA test demonstrate that ESP has achieved its main goal, it is necessary to show that the CSA method itself was a valid measure of the teachers' school performance on this occasion. In order to do this it is necessary for there to be a positive relationship between the CSA test and the teachers' teaching of science in their schools.

Concurrent Validity

A method commonly used to demonstrate the validity of a new test depends upon correlating the results of that test with the results of an independent and previous test, one which itself has been shown to be a valid measure of the behaviour under test. Such validity is referred to as concurrent validity. In order to demonstrate concurrent validity for the CSA test, therefore, another independent measure of the ESP teachers' performance is needed. Unfortunately, the other measures that are available have not themselves been shown to be valid. Comparing the CSA results of the sixteen ESP teachers with the grades they were awarded in their final teaching assessment we find that there is a weak correlation between the two measures ($r = +0.13$). Final teaching grades, however, were decided using ratings obtained from a panel of supervisors who observed the teachers in their individual schools. Different teachers were rated by different supervisors, in different situations and in a process that took place over a period of three months. That there is such a low correlation between CSA test results and final teaching assessment is not surprising in the circumstances. Indeed there is little evidence to show that the supervisors' ratings can measure a teacher's everyday teaching (Rosenshine 1974) and it is this which the CSA tests set out to do.

A higher correlation could be expected between the results obtained in the CSA test of "Science Knowledge" with those obtained in the final (written) examination in science and indeed there is a significant positive correlation between the teacher's competence in subject knowledge (as measured by their combined scores on Skills 1 and 2) and the score they obtained in their final science examination ($r = +0.53$ significant at 5% level).

McClelland (1973) has proposed that the criteria for establishing the validity of criterion-reference tests,

> "really ought to be not grades in school, but 'grades in life' in the broadest theoretical and practical sense".

The problem, however, is to determine a way in which "grades in life" can be determined for Guyanese teachers.

Predictive Validity

Clearly it would be best to go to their schools to find out how well the ESP trained teachers performed in their "job situation". It would be of little benefit simply to observe them teaching and rate their performance, as this was how the final teaching grades were obtained. Since it was an accurate rating of a teacher's everyday performance that was required rather than a rating of one individual lesson it was felt best to ask those who worked with him in the school, his fellow teachers and his pupils. The great majority of schools in Guyana are still based on a traditional authoritarian model with decision making power within the school being firmly held by the head teacher. In a few of the larger schools, there are heads of department to whom some authority is delegated, but in general those who are likely to know about a teacher's performance are head teachers on the one hand and pupils on the other.

Interviews with Head Teachers

Interviews were conducted with the head teachers of fifteen of the sixteen teachers who took part in the CSA test, and these were conducted in the same way as the interviews with head teachers described in Chapter Seven. In this case, however, the heads were asked to report only on ESP teachers.

There was an overlap of interviews in one school since one of the teachers who had been selected for the CSA evaluation also taught in one of the six schools in which both ESP and LDC teachers taught. As in Chapter Eight, the author was well known to all the head teachers interviewed as he had visited the schools while working at the Ministry of Education. Again, as in the previous interviews a few of the head teachers in larger schools asked for the head of the science department to be allowed to take part in the interview. At the time the head teachers did not know the results of either the CSA test or the final teaching assessment and examination grades awarded to the teachers. They did know, however, that the teachers had been awarded teaching certificates.

As in the previous interviews, the head teachers were asked to,

"Tell me what you think about .... as a science teacher?"

After they had finished discussing their general comments, they were asked four specific questions relating to the ESP teacher's class control, lesson perparation, confidence in subject and ability to teach higher forms.

From the replies it became clear that the head teachers assessed the teachers mainly on their general attitude, maturity and confidence. They spoke about their "good" teachers as being "keen", "dedicated", "confident in himself", "firm - not hesitant", "very confident in his work". When they were critical of teachers, however, they referred to them as being "nervous and hesitant", "hasn't matured as a person, still childish", "a bit emotional". Of the eleven heads interviewed only one had ever taught science, most were hesitant to discuss topics especially related to science teaching. They felt unable, therefore, to comment on two of the three competencies tested in the CSA test, namely "Use of Science Methods" and "Relating to Pupil's Environment".

The replies to the four specific questions are summarized in Table 9.3 in Appendix 1. Twelve of the fifteen teachers were said to prepare their work well; all were seen as being confident in content although the heads felt that four of them would need some help to teach fifth form classes. Ten of the fifteen were regarded as having good class control and twelve were reported as being willing to teach GCE forms. From the interviews it is clear that all the teachers were regarded by their headteachers as being competent to teach WISC and SDSP. Most were also considered to have good class control and lesson preparation.

Since the heads were asked to comment on the ESP teachers on four specific points, each teacher could receive a discrete number of favourable comments, ranging from zero to four. The number of favourable comments received by each teacher (in Table 9.3 in Appendix 1) was calculated and as shown in Table 9.4 below, a significant difference was found between the number of favourable comments head teachers made about the five teachers who received the highest overall CSA scores and the comments they made about the five teachers with the lowest overall scores. Head teachers' comments discriminated positively, therefore, between the teachers who gained the highest and lowest CSA scores.

Table 9.4

Summary of Head Teachers' Comments About CSA Teachers

CSA Scores	Favourable Comments from Head Teachers (max. = 20)	Mean
Top 5 of teachers	19	3.8
Middle 5 of teachers	17	3.4
Bottom 5 of teachers	14	2.8

Difference between top and bottom groups
t = 3.2 for 4df (significant at 5% level)

From school timetables and from notes made during the interviews, a second significant correlation was noted between head teachers' opinions and CSA scores. In Guyana, as in many developing countries, head teachers tend to give the higher ability classes to the teachers in whom they have the most confidence, especially with regard to their subject knowledge. For instance, head teachers will frequently give GCE classes to untrained teachers who have a pass at A level GCE in preference to trained teachers with O level qualifications. In Guyanese schools a good measure of a head teacher's confidence in a teacher's subject knowledge would be whether or not he timetables that teacher to take a GCE class.

Eleven of the teachers tested in the CSA tests taught GCE classes. Four other teachers taught only junior forms although there were GCE forms in their schools. Using a Point Biserial correlation the CSA results of the eleven "GCE" teachers were compared with those of the four who taught only junior forms. The results are shown in Table 9.4 in Appendix 1. There was a strong and highly significant relationship between the teaching of a GCE class and CSA score ($r = +0.80$, $t = 4.8$ for 13df, significant at the 0.1% level).

Pupils' Opinions of Teachers

As reported in Chapter Seven, pupils' opinions have been reported in a number of studies as being effective measures of teaching performance. The CSA results obtained by the teachers were compared, therefore, with reports on their teaching performance wirtten by a class of pupils they taught. The technique is similar to that used in Chapter Eight for comparing pupils' opinions of ESP and LDC teachers. Classes taught by fifteen of the sixteen teachers invovled in the CSA tests were visited. These were in the same schools in which the head teachers were interviewed. Although reports could not be obtained from children all of the same age group, wherever possible they were obtained from pupils in form 3 with staff absent from the room and with the pupils having been assured that their reports would be treated in confidence.

Written reports were obtained from 443 pupils; an average of thirty for each teacher (range 9 to 50). Each report was read by the author and categorized as being either "favourable", "neutral" or "unfavourable" about the teacher. Three hundred and seventy-one (84%) were found to be favourable, describing the teachers, for example, as being "interesting", "helpful", and "courteous and attentive". Fifty-eight (13%) described the teachers and their work in terms which were neither favourable nor critical, for example,

> "First she would tell us about the topic. Then she would give us a list of thin we would use for the experiment ..." and

> "Our science teacher teach us about experiments and observation and we get notes and we do mass and weight".

In fourteen (3%) of the reports criticism was expressed about the teachers.

> "He is very good in science but I am experiencing that he does not know how to explain himself".

> "... but something I found out, bad about him is that he does not go according to the syllabus".

During the first reading of the reports common key words and phrases were identified and noted. A content analysis was then carried out using the key words and phrases as classification categories. Care was taken to include only specific references to teaching performance. The results from this analysis of pupils' reports are shown in Table 8.6 in Appendix 1. Forty-eight percent of the pupils reported that the teacher was either a "good teacher" or that he taught "well". The results from the pupils' reports correlate only slightly, however, with the results obtained from the CSA test. There is a negative but extremely low correlation ($r = -0.05$) between the proportion of pupils in a class who wrote that their teacher was a "good" teacher or taught "well" and the scores obtained by that teacher on the CSA test. No word or phrase could be identified in the reports which could be used as a direct measure of a teacher's subject knowledge. It was hypothesized, however, that teachers who scored highly on Skill 2 - Use of Apparatus - would be more likely to use apparatus in school than those who obtained low scores for this skill. A greater percentage of their pupils, therefore, could be expected to write about the teacher's use of apparatus. On analysing the data, however, no evidence was found to support this hypothesis. The problem stems largely from the fact that the ESP teachers teach in so many different schools and to such a range of pupils. For example, a number of the teachers who scored highly in the CSA tests, did not have functioning laboratories, and others taught GCE classes without having the equipment for the course. On the other hand, some of the teachers who scored the lowest marks of the CSA tests for Skills 1 and 2 taught only junior classes in schools which were equipped for this.

During the initial reading of the scripts it was noticed that many of the pupils reported on the written work they did in science. Since one of the CSA tests measured the teacher's ability to encourage pupils to record their observations it was hypothesized that there would be a significant relationship between the percentage of pupils in a class reporting the recording of work and the teacher's CSA score for Skill 3. Such a correlation did exist, although it was not significant at the 5% level ($r = +0.32$).

It was also hypothesized that teachers who frequently dictated notes - either verbally or on the blackboard - would be unlikely to encourage their pupils to draw their own conclusions from their observations and so could be expected to score poorly on the test for Skill 4, which was a test of this ability. There is, in fact, a negative correlation between the percentage of pupils who report that their teacher "dictated" notes and the teacher's score in guiding pupils to draw their own conclusions from their observations ($r = -0.37$, not significant at 5%).

Teachers who were reported by the pupils as encouraging them to write notes did score highly on the test for encouraging pupils to record observations. If they were reported to be dictating notes, however, they scored poorly on the test of their skill in guiding pupils to draw conclusions from their observations.

Although there were no statistically significant correlations between that data collected from the pupils' reports and the CSA scores, the large number of the pupils (84%) who wrote favourably about the performance of ESP teachers helps to confirm the CSA finding that ESP teachers are competent to teach science. There was a positive correlation ($r = + 0.32$) between the CSA test of a teacher's skill in encouraging pupils to record work and the number of pupils who reported that he did this, and there was a negative correlation ($r = -0.37$) between the CSA test of a teacher's skill in guiding pupils to make their own conclusions and the number of pupils who reported that he dictated notes. Though the two results were not statistically significant, their trend is in agreement with the CSA results.

The reliability of the key word technique used to analyse the pupils' reports was calculated by getting two raters to identify the occurance of the key words in a random sample of the scripts. Using a Pearson Product Moment correlation and the Spearman Brown formula, the inter-rater reliability for the key word technique was calculated as .86. The technique was also found to be stable over time since there was a high correlation between the results obtained by the researcher for the same random sample of scripts on two occasions which were nine months apart ($r = .90$, reliability = .95).

ESP Participants' Views on CSA

As well as comparing the CSA results with the results of other measurement techniques, it was decided to test the validity of the approach by asking participants of the ESP programme whether or not they considered that the CSA test could evaluate the ESP programme. Interviews were conducted with the ESP teachers involved in the CSA test, and with other participants of the ESP programme such as course writers, local tutors and supervisors.

(a) ESP Teachers

Each day after they had completed the tests the ESP teachers were asked to given written replies to two questions asking how relevant they thought the CSA test was to their everyday situation and how effectively they thought the complete "package" of four tests would assess their ability to teach WISC and SDSP. When everyone had finished writing, the group were invited to discuss the tests. The researcher led the discussion and made notes of the points raised. The teachers felt that the test was relevant to their everyday teaching situation and many used comments such as "well proportioned to WISC", "relevant", or "closely related to WISC". A number of the teachers suggested that as well as evaluating skills the tests also provided them with a rewarding learning exercise.

One teacher felt that the test content was biased towards physics, and so, those who taught physics would be at an advantage. In the discussion that day, a number of the teachers disagreed with this comment, however, and suggested that the test reflected the balance of content in the WISC and SDSP programmes. There were a number of criticisms about the length of the test with some teachers reporting that they were too tired to give their best performance in Test 4.

(b) Administrators' and Educators' Opinions

Those involved in the running of ESP were interviewed about the CSA evaluation. One week before the interviews they were provided with a three page description of the evaluation procedure, asked to read it and prepare comments about CSA's suitability for evaluating ESP. Amongst those interviewed were members of the Criterion Panel, the Education Officer with overall responsibility for science education in Guyana, the co-ordinator of the ESP programme, science education officers who had helped supervise and assess the teachers, members of the Course Writing Team and local ESP tutors. All the people interviewed had received copies of the Science Educator's Questionaire used in developing the test.

(i) Administrators' Views

The administrators felt that CSA could provide a viable means of evaluating ESP. Some concern was felt, however, over the method used to obtain the views of Guyanese educators. One administrator reported that it had been extremely difficult to rate the skills in the questionaire since there were so many different schools in which ESP teachers could be asked to teach and what could be a highly important skill in one situation would be of relatively minor importance in another. A second administrator felt that the questionaire should have been developed using Guyanese sources only rather than being based on sources from developed countries. The problem of obtaining a true measure of a teacher's performance from a single observation was commented upon.

(ii) Supervisors' Views

Supervisors felt that the main benefit of the CSA approach lay in its ability to test a teacher's performance in a practical yet controlled way. The test of safety skills was particularly praised. One supervisor wondered whether CSA could measure a teacher's "willingness" or "attitude" to perform a skill rather than his ability to perform that skill. Thus it was suggested that the best measure of a teacher's performance should be what he actually does rather than what he can do. Another supervisor felt that there had been a bias towards physics content in the test and suggested that the evaluation should have,

> "sacrificed statistical purity of randomness to get a more deliberately representative sample of the skills".

In contrast to one of the administrators referred to above, one of the supervisors felt that, in developing the CSA test, there was too much attention paid to the views of the Guyanese educators in developing the CSA test, and as a result the evaluation had been too narrow. It told us, he suggested, only about the teacher's performance on skills thought to be important by Guyanese educators. Surely, he argued, these were the skills that teachers were most likely to have since if the educators thought they were important they would be the ones emphasized in the training programme.

(iii) Views of Local Tutors

The local tutors felt that the CSA approach used would provide a good evaluation of the Emergency Science Programme. They liked, especially, the two tests related to subject knowledge and suggested that tests of the different skills would help in diagnosing weaknesses in training. One tutor felt that the marking scheme should have allowed for some marking to be done on an observational basis, with assessors rating the teachers' performance on the different skills. It was also suggested that the equipment used in Test 2 could have caused some problems for students from rural regions. It was pointed out that there is no one source of equipment for Guyanese schools and during the past decade science materials have been purchased from the UK, the USA, Canada, GDR and the Republic of China. While all the teachers could be expected to be familiar with a lever balance, the UK model used in the test itself could be unfamiliar to them and would place those who were familiar with, for example, the Canadian model at a disadvantage.

(iv) Course Writers' Views

The Course Writing Team members felt that CSA was a "very promising evaluation method" and that it could provide a valid evaluation of the ESP programme. They disliked the fact, however, that the assessment of the teachers was made on a "once and for all basis" and suggested that this could affect the reliability of the assessment since a teacher could be demonstrating an atypical performance of his ability. The role of the Criterion Marking Panel they regarded as being crucial in a CSA evaluation and suggested that great care should be taken in selecting members of this panel. They should be people "steeped" in the actual performance and knowledge of the skills being tested and yet at the same time they cannot be people who are so "set in their ways" that they are unable to rethink or change their minds after discussion and reflection. People with this combination of experience and flexibility it was suggested were rare and yet were essential for good CSA evaluation.

The validity of the CSA test was assessed, therefore, by comparing the CSA results with,

teaching assessment scores,

science examination results,

comments and judgements of head teachers, and

reports from pupils,

and by asking the participants of the ESP programme to discuss the suitability of CSA as a means of evaluating ESP. There was a low correlation between CSA and teacher assessment scores but the results of the CSA test of science knowledge correlated significantly and positively with the science examination scores, and with head teachers' judgements of the teachers' science knowledge. The overall CSA results were supported by the comments head teachers made on four aspects of the teachers' performances, with teachers who had received high CSA scores getting significantly greater numbers of favourable comments than those with low CSA scores. Pupils' reports confirm the CSA finding that ESP teachers were competent to teach science.

Two moderate (though non-significant) correlations were identified between teaching characteristics noted in the pupils' reports and CSA tests of individual skills. Participants in the ESP programme, both staff and students, reported that they considered the CSA test to be an effective and valid way of evaluating the ESP programme.

Summary of the CSA Evaluation

This Chapter describes how a Criterion Sampling Approach was developed and used to evaluate the Emergency Science Programme. The evaluation itself forms part of a multi-national metaevaluation project, being undertaken by the UNESCO Institute For Education, in which they main purpose is to evaluate the feasibility and applicability of using CSA for evaluating the learning outcomes of nonformal educational programmes.

The CSA evaluation of ESP was developed using the guidelines recommended by UIE. A stratified sample was obtained of the competencies and skills which Guyanese science educators felt were important for teaching science in Guyana and situational tests were developed to test teachers' proficiency in these. A representative sample of sixteen of the twenty-nine ESP "graduates" were assessed in the situational tests. All sixteen teachers achieved the required proficiency or competence level. Forty-four percent of the teachers were found to be highly competent in their use of science methods and thirty-eight percent were highly competent in their ability to relate to their pupils' environment. ESP teachers, therefore, do have the competencies and skills Guyanese science educators feel are important for science teaching and are competent to teach science in secondary schools in Guyana.

The results obtained during the study also demonstrated that the CSA approach was a valid and reliable means of evaluating ESP. It permitted direct "low inference" measurements to be obtained of the performance of teachers from many different schools and areas. These measurements were collected under controlled conditions and provided absolute rather than relative assessments of proficiency and competence. A number of problems were encountered with the CSA approach, however, and these are discussed in more detail in Chapter Ten.

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Chapter Ten

The Evaluation of ESP - Discussion

The strategy used to evaluate the Emergency Science Programme employed intrinsic, contextual and performance methods of evaluation. Each complemented the others, providing information that they did not bring to light, so the three together provided a comprehensive evaluation of the project.

(1) The Intrinsic Evaluation

The intrinsic evaluation involved both a content analysis of the curriculum materials of ESP and a key word analysis of (student) consumer reports about the materials. The content analysis produced a profile of each correspondence unit and information about the overall emphasis of the written materials. The units were found to be heavily content oriented, with an average of 70% of the pages devoted to academic content.

Even though one of the declared aims of the ESP programme was to "foster" in the students an "awareness" of the importance and relevance of science and technology to the achievement of the aims of a developing society, little emphasis was placed on this aim in the correspondence materials, for less than 6% of the units were devoted to topics or activities which related science to society. Sufficient importance was given in the units to the importance of practical work, with 18% of the work in the correspondence units being devoted to this.

Consumer reports, written by the ESP students on the first eight correspondence units provided detailed information on how suitable the students had found the materials to be. A key word analysis of the reports found that six of the eight units were reported as being either satisfactory and interesting or clear and interesting (Units 1, 2, 4, 5, 7 and 8). Three units were reported as being difficult namely Units 3 (mathematics), 6 (ecology) and 7 (psychology). Unit 3 was also reported as being unclear and disappointing.

The results of the content analysis and the consumer reports were compared to see what, if any, relationships existed between the structure of the individual units and the comments written by students. Two statistically significant relationships were identified. There was a significant positive correlation between the number of students reporting a unit to be clear and understandable and the number of pages in the unit which were devoted to self-evaluation. There was also a significant, though negative, correlation between the number of students reporting that a unit was difficult and the number of the pages of the unit devoted to self-evaluation. Both relationships were significant at the 5% level. The more self-evaluation activities in the units, therefore, the greater the number of students who reported that the unit was clear or understandable - the less self-evaluation the greater the number of students who reported it as being difficult.

All the major aims of ESP are reflected in the correspondence materials. However, the stated aim of relating science to society received inadequate attention. Some of the correspondence units were reported by the students as being more difficult than others. There was a link between the number of students who reported a unit as being difficult and the amount of self-evaluation reported in the content analysis. We have reason to believe, therefore, that the next step in the development of these curriculum materials would be to increase the number of self-evaluation tasks set in Units 3, 6 and 7. Only then can we tell the extent to which the low incidence of self-evaluation causes the units to be difficult.

(2) The Context Evaluation

Interviews were conducted with people involved in many different ways with the ESP programme. All spoke favourably of ESP and many noted that it had advantages over the college based programme. The fact that the ESP programme enabled teachers to implement new knowledge and training immediately into schools was seen by a number of those interviewed to be one major advantage. Ministry personnel saw the programme as having helped to develop a better working relationship between them and science teachers. It was the context evaluation that highlighted the importance of tutorial sessions for training via the ESP approach. The coordination of the programme during 1980 was strongly criticized by a number of teachers. The breakdown in organization and the difficulties reported by supervisors in carrying out school visits and by tutors in obtaining audio-visual materials indicate that a strong central administration of the programme is essential.

(3) Performance Evaluation

The performance of teachers trained via the ESP programme was assessed using both norm-referenced and criterion-referenced measurement techniques.

Norm-referenced

The ESP teachers' performances were compared with those of the LDC teachers using teaching assessment grades, teachers' self-image ratings, comments of head teachers and written reports of pupils. The ESP teachers had an average grade of B- as compared with the college students average of B, a difference that was statistically significant at the 5% level. There was no significant difference in the self-image of the two groups and both had similar views of the skills and competencies which would be displayed by the ideal science teacher. Biographical data collected from the self-image questionnaires established that while there was not a significant difference between the number of GCE O level passes obtained by the ESP and LDC teachers, the ESP teachers were significantly better qualified in science subjects. There was also a significant difference between the type of schools that the two groups of teachers preferred to teach in, with the LDC teachers having a stronger preference for the predominantly urban based senior high schools and the ESP teachers preferring the predominantly rural junior secondaries. Both groups of teachers wrote that their training programmes had prepared them adequately for their teaching roles. A greater number of the LDC teachers, however, wrote critically about their training.

In schools in which both ESP and LDC "graduates" taught, head teachers gave more favourable comments about the ESP teachers. Pupils' reports about ESP and LDC teachers were collected from comparable classes in these same schools and the majority (over 80%) wrote favourably about their science teacher (for both the LDC and the ESP teachers). ESP teachers received a higher percentage of reports for good teaching and practical work. LDC teachers, however, received a significantly greater number of reports mentioning kindness (significant at the 5% level).

(4) The Criterion Sampling Evaluation

The skills and competencies felt to be most important for teaching science in Guyana were identified by science educators in Guyana. The three most important competencies to emerge were, the teacher's competence in:

a. Use of Scientific Methods,

b. Knowledge of Subject Matter, and

c. Relating to the Pupil's Environment.

Situational tests were then developed to assess ESP teachers' performances on these skills under simulated classroom conditions. A random selection of sixteen of the twenty-nine ESP "graduates" undertook the tests and demonstrated that they had the required level of competence. On the basis that the teachers were a random selection of the twenty-nine ESP "graduates" and the skills tested were a random selection of those considered most important for teaching science in Guyana, the results allow the conclusion to be drawn that ESP teachers are competent to perform those skills which Guyanese science educators say are amongst the most important for teaching science in Guyana.

Findings Common to More than one Source

McCabe (1980) suggests that a pluralistic evaluation strategy, in which a variety of disciplines and techniques are used, is likely to be more productive for evaluating curriculum projects. Information from one source, he suggests, may in itself be inconclusive but information assembled from a number of alternative sources, when taken together may permit a more conclusive decision to be reached.

When this policy was adopted it was found that the different sources and techniques involved in the ESP evaluation supported each others' individual findings in a number of ways. For instance, the intrinsic evaluation noted the high value given to the practical work both in the correspondence units and at the tutorial and vacation sessions. In the contextual evaluation ESP teachers were reported as being better than LDC teachers at practical work, and in their free response replies on the self-image questionnaire ESP teachers commented that their training had made them familiar with the use of science apparatus. ESP teachers also received a higher percentage than LDC teachers of the pupils' reports which referred to practical work, and all sixteen ESP teachers assessed in the Criterion Sampling Test demonstrated that they were competent in their use of science apparatus. There is substantial evidence, therefore, from a variety of sources that teachers trained via the ESP programme are competent in their use of science apparatus and that they can competently undertake the practical work involved in teaching science in Guyana.

There is also evidence from a number of sources drawing attention to the low priority given in the ESP programme to the relevance and importance of science to society. The intrinsic evaluation noted that little attention was given to this in the correspondence units. In the context evaluation the need for ESP to include more work on the relevance of science to society was reported in the interviews. In the performance evaluation ESP teachers rated themselves significantly lower than the LDC teachers on only two out of thirty-six skill items, both of which were related to making science teaching relevant to society. In the Criterion Sampling test, two of the sixteen teachers did not achieve the criterion level set on the skill of relating new experiences to pupils' previous experiences. Evidence from the intrinsic evaluation, the context evaluation, and from both the norm and criterion-referenced evaluations all indicate, therefore, that more emphasis should be given in the ESP programme on preparing the teachers to relate science to the society in which they teach.

A number of sources indicate that there is a difference in the way that ESP and LDC teachers interact with their pupils. LDC teachers received a significantly greater number of pupils' reports on friendliness and the LDC teachers rated "rapport" as being their second highest competency. ESP teachers, on the other hand, rated Discipline and Management as their highest competency. In their free response replies in the questionnaire, 54% of ESP teachers mentioned that they were confident in the classrooms and head teachers interviewed for the performance evaluation talked about the good class control of the ESP teachers. LDC teachers appear, therefore, to place greater emphasis on their relationship with the pupils while ESP teachers, perhaps because they apparently undertake more practical work, would seem to place more emphasis on their class management and control.

Evidence from a number of sources can be either corroborative or conflicting. Lefrere (1981) has suggested that research literature is "vague" on the question of how to deal with "apparently inconsistent" evaluation data which has been collected from different sources or by using different techniques. The sources and techniques used for ESP have generally provided results which are supportive of each other rather than conflicting. In one area, however, there is an apparent inconsistency. According to both tutors and Ministry personnel interviewed in the context evaluation there was a friendly relaxed relationship between ESP staff and students, while according to the ESP teachers in both the groups discussions and in the individual interviews personnel at the Ministry of Education were said to be "unhelpful". It is considered unlikely, however, that this inconsistency has arisen from the evaluation techniques themselves but rather seems to represent a real and major difference in the way that ESP staff and students view their relationship.

The findings of this evaluation study show that the ESP teachers are competent to teach science in secondary schools in Guyana and that they can perform this job as competently as science teachers trained via the college of education programme. Nevertheless, there are differences between the two groups of teachers. There is evidence from a number of sources to show that the LDC teachers have better rapport with their pupils. The ESP teachers, however, are more content to remain in rural junior secondary schools, and evidence from a variety of sources suggests that they have more knowledge of science subject knowledge, are better able to handle practical work, and have better class control than the college trained teachers.

The Correlation of the Results of the Different Evaluation Techniques

The evaluation of ESP used a number of different measures of teachers' performances and since the data for these measures was collected either from the same teachers or from a representative sample of them it is useful to compare the results of the different measures and this has been achieved by means of a correlation matrix. The source of data for each of the six evaluation techniques which form the basis of the comparison is shown in Table 10.1 below. The scores the ESP teachers achieved on their final science theory examination are used here as an alternative measure of the teachers' subject knowledge.

Table 10.1

Sources of Information for Six Measures of ESP Teachers' Performances

Technique	Source of Data
Supervisors' teaching assessments	All 29 ESP "graduates"
Science examination scores	" " " "
Self-image scores	24 of the 29 ESP "graduates"
CSA scores	A stratified random sample of 16 of the 29 "graduates"
Head teachers' opinions (GCE and non-GCE classes)	15 of the 16 CSA sample of ESP "graduates"
Pupils' reports	" " "

The scores for each of the six measures are brought together in Table 10.2 in Appendix 1. The correlations between the scores awarded to teachers on each measure and those awarded on each of the other five techniques were calculated. Six sets of scores give thirty possible and fifteen different correlations. These are shown in the correlation matrix Table 10.3 (Appendix).

Table 10.4

Correlation Between Three Measures of ESP Science Teachers' Science Knowledge

	CSA	Science Examination	Heads' Opinions
CSA	X	+0.53*	+0.80**
Science Examination	+0.53*	X	+0.42
Heads' Opinions	+0.80**	+0.42	X

* Significant at the 5% level
** Significant at the 1% level

Also, the CSA scores the teachers gained on Science Knowledge (Skill 1 plus Skill 2 scores in Table 9.1 Appendix 1) were calculated and these were correlated with the teachers' science knowledge as measured by the science examinations and with the head teachers' opinions (on science knowledge for teaching GCE classes). These correlations are shown in Table 10.4 above.

From Table 10.3 it is clear that there were no statistically significant correlations between any of the six measures of teachers' performances.

Supervisors' Assessments

The supervisors' assessments correlated poorly with the science examination scores (0.04), CSA scores (0.13) and pupils' reports (0.07). They had higher correlation - though still not statistically significant - with teachers' self-images (0.37) and with head teachers' opinions (0.33). Few other studies have investigated the relationship between different measures of teaching performance. The correlation of 0.07 for pupils' reports compares favourably with the low and non-significant correlations between supervisors' and pupils' ratings reported by Webb and Nolan (1955). The 0.33 correlation between supervisors' ratings and head teachers' opinions is lower than the 0.77 correlation reported by Robbins (1967) but his study was for a group of only six teachers and his result was not significant at the 5% level.

Science Examination

There was an almost zero correlation between the teachers' science examination scores and supervisors' assessments (0.04), pupils' reports (0.05), and the CSA scores (0.09). A closer relationship existed, however, between science knowledge scores and heads' opinions (0.42) and teachers' self-images (0.31). The science examination scores were significantly and positively related (at the 5% level) to the scores the teachers obtained in the CSA test of Science Knowledge (0.53 - see Table 10.3). The CSA tests designed to measure science knowledge, did correlate significantly, therefore, with a second measure of science knowledge, namely the science examination.

CSA Scores

The overall CSA scores correlated poorly with all other five measures of teaching effectiveness. There were low negative (non-significant) correlations between CSA scores and teachers' self-images (- 0.24) and CSA scores and pupils' reports (- 0.05) and low positive correlations with supervisors' ratings (0.13), science examination scores (0.09) and heads' opinions (0.19).

However, CSA scores for science knowledge correlated highly and significantly (at the 1% level) with head teachers' placements and as reported in Chapter Nine, in interviews,head teachers could and did differentiate between teachers who scored highly on the overall CSA tests and those who had the lowest scores.

Self-image

The self-image scores of the teachers correlated moderately with four of the other five measures of teaching performance and with the exception of the negative correlation with CSA, self-image was the measure which correlated most consistently with the others. The correlation coefficients between self-image and the other measures were, respectively, supervisors' assessment (+0.37), science examinations (+0.31), heads' opinions (+0.34), pupils' reports (+0.35) and with CSA scores (-0.24). The correlations between self-image and heads' opinions (0.34) and self-image and pupils' reports (0.35) compare favourably with Yee's (1970) findings that teachers' responses to a teaching attitude inventory correlated positively with head teachers' ratings (0.24) and with pupils' ratings (0.14). However, the correlation of 0.31 between self-image and science examination scores is lower than the 0.61 correlation reported by Campbell and Martinez-Perez (1977) although their figure was for science process knowledge rather than subject knowledge.

Heads' Opinions

As reported in Chapter Nine head teachers in Guyana will frequently use their own judgement of a teacher's subject knowledge to decide whether or not the teacher should be time-tabled to teach a fourth or fifth form class. Head teachers' placements correlated positively (though not significantly) with four of the other measures of teaching performance - supervisors' assessment 0.33, science examination 0.42, self-image 0.34 and CSA 0.14 - and negatively with the pupils' reports (-0.39) (Table 10.2) Head Teachers' placements also correlated positively and significantly with the CSA test of subject knowledge (0.80, significant at the 1% level) (Table 10.3).

In other research studies head teachers' ratings have also been found to correlate moderately and positively with teachers' teaching attitudes (Yee 1970) and with observers' ratings (Robbins 1967), and either low or negative correlations between head teachers' and pupils' ratings have been reported by Yee (1970) and Leeds (1969).

Pupils' Reports

There were low, almost zero, correlations between pupils' reports and supervisors' assessments (0.07), science examination scores (0.05) and CSA scores (-0.05). Pupils' reports correlated moderately with teachers' self-image (0.33) and moderately, though negatively, with head teachers' placements (-0.39). Low correlations between pupils' and head teachers' ratings have been reported by Yee (1970 and 1967) and Leeds (1969) and in both studies by Webb and Nolan (1955) and Robbins (1967) low correlations were found between pupils' and supervisors' (or observers') ratings.

The results in Table 10.3 demonstrate that no single evaluation technique has effectively measured all aspects of the ESP teachers' performance. Of the six techniques used the two which correlated most consistently with other measures were the self-image scores and head teachers' judgements.

In Table 10.4 head teachers' judgements about teachers' ability to teach fourth or fifth form classes were shown to correlate positively with science examination scores and positively - and significantly - with the CSA scores of science knowledge. It appears, therefore, that the head teachers' judgements were based on their estimate of the teachers' academic content knowledge. However, the multiple correlation between head teachers' judgements (their GCE placements) with science examination and CSA science knowledge scores is 0.80 and is no higher than the individual correlation between heads' judgements and the CSA scores. A partial correlation analysis, with the science examination scores partialed out, gives a partial correlation between head teachers' judgements and CSA science knowledge of 0.75. With the CSA science knowledge scores partialed out, however, the correlation between head teachers' judgements and science examination scores is almost zero (-0.01). The partial correlation of the CSA science knowledge scores is higher than the combined correlation of head teachers' judgements with science examination and supervisors' assessments (0.53). These results are consistent with the interpretation that in making their decisions about a science teacher's ability to teach fourth or fifth form classes head teachers base their judgement on the teacher's subject knowledge , rather than their pedagogical skills. However, their judgements are based on the teachers job-related science knowledge, . CSA tests would appear, therefore, to reflect the teachers' performance in the real life on the job situation better than the written examination of science knowledge.

The Evaluation Techniques Reviewed

The Intrinsic Evaluation

Of the three methods used to evaluate the ESP programme - intrinsic, context and performance - only the intrinsic looked specifically at the curriculum materials and did not require data to be collected from the field. Two techniques were used and each had its particular benefits and its limitations. The Easley technique brought out the structure of the individual correspondence units. One of its limitations, however, is that the categories and units chosen are to be those the researcher thinks will provide the most useful and relevant information for the analysis, so the results depend upon the researcher's decisions. The key word analysis of the consumer reports allowed the qualitative replies made by the students on the free response reports to be codified and hence quantitatively analysed, and provided information about the students' opinions on the written materials. When the results of the content and the key word analyses were taken together, they provided important and valuable insights concerning the structure of the correspondence units. The key word technique suffers a limitation similar to that described for the Easley technique since the descriptive profiles of the units require the researcher to decide on the level of consensus which will be taken to indicate agreement amongst the students. Different thresholds may give different results.

However, almost all the information obtained about the written ESP materials came from the intrinsic evaluation and it alone provided a basis for their modification and improvement.

The Context Evaluation

The performance evaluation provided detailed information on how successful the ESP programme was in meeting its specified aims and objectives, for example, to do with teacher competence and performance. The context evaluation, in addition to providing information about the planned and expected outcomes also identified a number of unplanned outcomes of the programme. Amongst these were the improvements in head teachers' attitudes to implementing science curricula, and in the Ministry's attitude to the use of alternative programmes such as ESP. Neither had been foreseen and were identified only by the context evaluation, as were the students' criticisms of the central organization and the writers' and supervisors' concern about the role played by local tutors. The context evaluation, therefore, provided valuable information on how the ESP programme was perceived by the different groups and levels of people who had participated in or had knowledge of it, and brought to light the unexpected and unforeseen outcomes which were identified by no other evaluation method or technique.

Performance Evaluation

The ability of teachers to perform the role for which ESP trained them, namely to teach science in secondary schools in Guyana, was measured twice. The norm-referenced method demonstrated that the teachers trained via ESP were as competent as teachers who were already accepted as such by the Guyanese education authorities, and so legitimizes the distance-teaching approach used. However, it was only the criterion-referenced evaluation that showed the ESP teachers to be actually competent. One crucial point with the approach, however, was that in order to judge whether or not a teacher was competent, a clear definition of what did nor did not constitute competent behaviour was needed. A working basis for the ESP evaluation was created by asking a panel of local educators to provide clear statements on what behaviour they considered should be accepted as displaying competent performance on the CSA tests that were to be used. The criteria for judging the competence of ESP teachers were based, therefore, on the level of performance a panel of science educators considered was adequate.

As well as using two evaluation methods the performance evaluation of ESP also used a number of different techniques, each of which had particular benefits for the evaluation and each of which had certain constraints or limitations.

Supervisors' Assessments

The supervisors' ratings provided a measure of the teacher's overall teaching performance based on the direct observation of experienced science educators. There are a number of disadvantages with using supervisors' ratings as a measure of teaching performance. Because they are generally based on high inference measures of performance there is always some doubt about the extent to which the grades awarded are independent of the school and the environment.

Self-image Questionnaires

The self-image questionnaire investigated the effect of the ESP programme as perceived by its "primary products", namely the teachers, and provides a highly reliable measure of a teacher's self-image with a K_r 20 internal reliability of 0.94 which compares favourably with those reported by Crowther (1978) for self-image in biology teaching (0.95) and for self-image in physical science teaching (0.96). The major limitation of using a self-image questionnaire is that the technique assumes teachers' self-images to be valid measures of their teaching ability. As noted in Chapter Eight there is evidence which suggests that they are. Other evidence, however, suggests that a teacher's self-image may be affected by age and teaching experience (Shavelson, Hubner and Stanton 1976). The results obtained in the ESP study suggest that age may have influenced the teachers' self-image ratings. Self-image ratings of the combined ESP and LDC teachers were calculated according to age and are shown in Table 10.5 below.

Table 10.5

Relationship Between Age and Self-image of ESP and LDC Science Teachers

	Under 21	21 to 23	23 to 25	25+
n	4	16	11	12
Mean	329	302	296	295
s.d.	24.9	33.8	23.3	42.9

Although the differences were not statistically significant (at the 5% level) the older the teachers the lower was their self-image. Crowther and Preece (1979) have reported that self-image in science teaching is sex related, with female teachers having lower self-images than male teachers. In this study, however, there was no significant difference in the self-image ratings of male and female teachers.

Interviews with Head Teachers

Head teachers' opinions were collected on fifteen of the sixteen teachers completed the CSA test. Comparative statements were also collected from head teachers in those schools which had both ESP and LDC trained science teachers. The interview technique allowed the head teachers' answers to be probed by the interviewer. The interviews gave information in a number of areas which was not obtained by any of the other techniques. This included the better lesson preparation and class control of the ESP teachers and the hesitancy of some of the LDC teachers towards teaching fourth and fifth form classes. There are limitations and problems associated with using the interview technique on this occasion.

In order to interview the head teachers the researcher had to travel to the schools where they taught and since ESP is a distance-teaching project the schools were widely separated geographically. The interviews, therefore, were time consuming and involved extensive travel throughout Guyana. There was also the problem of assessing how accurately the head teachers' replies represented their true opinions. The interviews were held in private and the heads were told of the researcher's "independent" status at an overseas university, but the researcher's previous position as an officer of the Ministry of Education may have influenced the replies they gave. However, the interviews provided information which was not obtained with any of the other techniques and also gave valuable background information which helped with the interpretation of data obtained from other sources.

Pupils' Reports

Unlike rating scales which restrict responses to expected behaviour, the free response reports used for ESP meant that the pupils described the features and characteristics of the teachers which they felt were important. The key word analysis ensured that these qualitative replies could be codified and quantitative comparisons made between different pupils' opinions of their teachers. There is a weakness with using content analysis of pupils' reports as an evaluation technique. Pupils' rating scales or questionnaires collect the views of a large number of pupils about a particular item. In free response surveys, however, only the views of those who choose to write about that topic are collected. Another risk with using pupils' opinions as an evaluation technique is that research evidence suggests that they may be influenced by such factors as the teacher's age, physical attractiveness and sex (Strumph and Freedman 1979, Goebal and Cashen 1979) and as reported in Chapter Eight, in the ESP study there did appear to be a relationship between teacher's age and the number of pupils who reported on his or her kindness.

In spite of its limitations, the analysis of pupils' scripts can provide important and useful information about a teacher's teaching performance. In the ESP study, it was only the analysis of pupils' reports that identified the significant difference in the classroom "kindness" of the ESP and LDC teachers.

The Criterion Sampling Evaluation

Criterion Sampling is a relatively new technique and prior to the current UNESCO metaevaluation has not been used to evaluate a complete educational programme. The ESP study has identified a number of advantages and limitations of the technique.

1. The other performance evaluation techniques used in the study were norm-referenced and compared the performance of a group of ESP teachers with the norm of the LDC teachers. The main benefit of the CSA evaluation was that instead of giving such comparative data it gave both direct and independent measures of the teachers' competence.

2. In common with written tests, CSA can evaluate teachers from different schools and different environments under controlled conditions. CSA, however, has a major advantage over written tests in that with CSA the teachers are tested on their performance of a sample of the skills and tasks which are required for their everyday jobs.

3. In Guyana, as in many developing countries, the traditional and accepted way of assessing a teacher's performance is to use supervisors' ratings of classroom teaching. These ratings are normally based on indirect and high inference measures of performance. CSA has the advantage that it gives direct and low inference measures of teaching ability.

Limitations of CSA as Presently Structured

As well as noting a number of strengths of the CSA approach the ESP evaluation also identified a number of limitations to the approach, at least as currently perceived.

1. CSA testing is relatively expensive and time consuming, both to develop and to carry out. Other evaluation techniques, such as written examinations, ratings, questionnaires and interviews, involve some expense at the development stage but are relatively cheap to carry out. Criterion Sampling, since it depends upon students being tested under standardized conditions required that the ESP students be brought to a central testing area. Distance-teaching, as its name implies, involves students being taught in geographically isolated areas. To bring a body of students from the rural and interior areas of a developing country to a central location is expensive, yet was necessary for the CSA evaluation of ESP.

2. Because it is time consuming, the number of items or skills examined in a CSA test will be smaller than in a conventional test. For ESP only six of the thirty-six skills rated as being important by the science educators could be tested in the time available.

3. The CSA test used in ESP evaluated the teachers' performance on one specific occasion. CSA assessment assumes that a teacher's performance on the day of the test will be typical of his or her everyday performance. However, there is evidence from the ESP study that this is not always the case (see UNESCO Institute Report page 49 section 3).

4. The CSA approach provides information about a narrow range of teaching behaviours and misses information that is needed for a comprehensive evaluation of a curriculum project. For example, the CSA evaluation did not provide information on the teachers' willingness to remain in rural areas, neither did it identify the difficulties which students had encountered in the correspondence units, nor the concern felt by supervisors and writers about the role played by the local tutors.

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General Conclusions

In spite of the fact that the distance-teaching approach to teacher education has been used in many countries their evaluation has been largely "circumstantial" and "anecdotal". Jenkins (1980) in noting the need for "firm" evidence about the performance of teachers trained via distance teaching also warned that,

> "it will remain difficult to convince the cynics that teacher training at a distance is anything more than an ad hoc second best alternative to college".

The evaluation of The Emergency Science Programme in Guyana that forms the basis of this thesis has provided the first full and complete evaluation of a distance-teaching project for teacher education. One of the findings is that teachers trained via a distance-teaching approach can teach as competently as those trained via a college programme. A second finding is that the distance-teaching approach had a number of advantages over college based training. In particular, the distance teaching trained teachers were more content to remain in the rural areas where they were most needed, and, because of its in-service nature, the distance-teaching programme was able to recruit many highly qualified trainees who were unable or unwilling to attend the residential course at the college.

The evaluation also measured the criterion performance of ESP teachers and found that ESP teachers were competent to teach science in Guyana. The study has shown, therefore, not only that teachers trained via a distance-teaching approach can teach as effectively as those trained via a college-based approach but also that those trained via the distance-teaching approach can in fact do the job for which they were trained, which in this case is to teach science in secondary schools.

The evaluation also highlighted the need for regular face-to-face tuition within a distance-teaching programme, and the importance of incorporating self-evaluation exercises into correspondence materials. Both have implications not only for the ESP programme but for distance-teaching programmes in general.

A number of different evaluation methods and techniques were used in the study. No single method or technique provided an adequate or comprehensive evaluation and the results obtained from the different methods and techniques clearly demonstrate the need for using a pluralistic strategy in curriculum evaluation. Such a strategy should, however, maintain a balance between quantitative data and qualitative opinion. The study has shown that this is achieved by incorporating intrinsic, contextual and performance techniques into the evaluation.

In the ESP study the teacher's self-image and the head teachers' opinions correlated most consistently with other measures of teaching performance, while pupils' free response reports correlated least consistently with other measures. There is no satisfactory single measure of teaching performance. Indeed there are two ways in which this can be measured, one based on norm-referenced measurement, the other on criterion-referenced measurement. The feasibility of the Criterion Sampling Approach to evaluation was investigated in the study and CSA was found to be a reliable and valid technique for evaluating teaching performance, though relatively expensive and time consuming. It is valuable in that it assesses teaching competence under standardized conditions.

Teacher training institutions in many developing countries have been unable to keep pace with the demands of their rapidly expanding education systems. As the number of school pupils continues to escalate the need for trained teachers will continue to grow. Traditional training programme have failed to meet the demand in the past and are unlikely to meet future needs. A partial solution, as many countries have discovered, is to use distance teaching to train teachers. This evaluation of The Emergency Science Programme in Guyana provides evidence that distance teaching offers a viable alternative and supplement to college-based teacher training.

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