

- A grave problem the Philippines shares with the rest of the have-nots in the world.

## EDUCATION FOR SCIENTIFIC PROFESSIONS IN THE POOR COUNTRIES

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The poor countries need three types of persons trained scientifically beyond the high-school level: technicians, basic scientists, and professionals. By professionals we mean those trained in agriculture, medicine, dentistry, veterinary science, engineering, architecture and similar arts. Such courses of education have this in common, that they borrow materials from a number of basic sciences, which they use as a foundation for specialized work. This raises a number of problems, to which this paper is devoted.

The capacity of a country to absorb university graduates is an index of its development. If we take graduates in all subjects, including the humanities, the absorptive capacity measured

in terms of the annual intake of graduates seems to range from as low as 20 to as high as 3,000 per million inhabitants. Frederick H. Harbison has recently assessed the absorptive capacity of Nigeria at 50 million; in recent guesses for the West Indies, I have been using a figure of 300 per million. The concept of absorptive capacity is not a precise one however. As the number of graduates increases, the possession of a degree becomes a condition for jobs for which it was not previously required, for example, in agricultural extension, dentistry, or teaching in high schools. Also, the gap between the salaries of graduates and non-graduates diminishes as graduates become available for more types of

jobs. In other words, the absorptive capacity increases *pari passu* with the supply of graduates and cannot be determined independently. It may still be possible to produce from historical or contemporary data a curve relating the absorption of graduates per million inhabitants to the per-capita national income, but this has not yet been done.

All one can say at present is that, in the sense there are vacant jobs, in nearly every poor country, there is a shortage of persons trained in the scientific professions. This is all one needs to say. Most poor countries could substantially increase their output of professionals without any danger of the supply exceeding the absorptive capacity during the next two decades.

In the United States a number of universities consider that professional courses should be undertaken only after a student has already acquired a first degree. This can be defended on two grounds: the student needs to have a good general education before embarking on a scientific profession. The first ground is empha-

sized, rather than the second, though the second may be included in the first.

In Great Britain the professions we are dealing with can all be studied for a first degree. Before entering the university, however, the student will usually be required to have specialized in science in the high school, as evidenced by his having passed certain science subjects (specified separately for each profession) at the Advanced Level (formerly the Higher School Artificate), equivalent to or slightly beyond what a junior college in California requires. In short, whether professional courses should be postgraduate or not depends on the university requirements for enrolling—in basic science, which in turn depend on the standard reached in the high schools. The high schools in Great Britain teach two years more of science than a public high school in New York City does, and as this is the level of university entrance, professional courses may be taught as training for first degrees.

The poor countries vary widely in the standards to

which their high schools aspire. In Africa the British and the French have sought to establish standards at their metropolitan levels, and, in so far as they have succeeded, most of Africa should be able to follow the British or French patterns. In some other countries (for example, Egypt or India), in which the numbers of high-school students have swollen more rapidly than funds or trained teachers have, high-school standards are lower, and both entrance and exit levels into and out of universities are substantially lower than in Western Europe. Faced with low standards of entry, the universities in such countries must either lower the professional standard or else lengthen the course (of which the extreme form is to make the professional course postgraduate).

The question as to whether there should be less basic science is a difficult problem. A number of arguments point toward reducing the amount of basic science in professional courses in the poor countries. The students have less practical work in their backgrounds than do

the students of rich countries, and therefore they need more time for this aspect. They have less practical experience because in their societies it is offensive for a middle-class person to do manual work instead of employing a servant to do it for him. (This is a form of share-the-wealth which custom has decreed in areas that do not have social insurance.) Students also have less experience with mechanical devices, since they do not live in a mechanical civilization and therefore do not become familiar with mechanical devices from an early age, as do children in the rich countries. Consequently, more time is needed in their professional training to accustom them to using their hands.

Because technicians are not as well trained and not as reliable as in the rich countries, professionals have to spend more time supervising them; the professionals must be able to show their technicians just what to do. This also means relatively more time for practical work. Since professionals are scarce and therefore work in greater isolation from one

another, each must have more of all-round competence. For example, an engineer sent to look after public works in an isolated rural area should be able to turn his hand to civil, mechanical, and electrical tasks, hence he must be given relatively more "know-how" of the various sides of his profession, and he has relatively less time for basic science. The same argument tells in general against providing opportunities for specialization in the undergraduate professional course. Most universities require the student to familiarize himself with every aspect of his profession (if we count civil, mechanical, and electrical engineering as three separate professions) and to postpone specialization until postgraduate courses. A medical student is not allowed to choose between pediatrics and surgery. In the rich countries, however, there are some exceptions: an agricultural student may choose between, say, chemistry and entomology, and an electrical engineer may choose between power generation and electronics. Specialization usually in-

volves more basic science. It is arguable, therefore, that universities in the poor countries should be less willing to permit specialization at the undergraduate level.

In some professions the need of using local materials for teaching purposes increases the factual burden of the course and thus reduces the time available for theoretical principles. This situation occurs wherever the local material has to be an auxiliary to, not merely a substitute for, the material used in teaching in temperate countries. For example, the medical student in the tropics has to know about all the diseases that occur in temperate zones, since these also occur in the tropics, and in addition he has to know about tropical diseases. In adapting any syllabus for use in a poor country, one has to decide how much of the factual framework taught elsewhere can be scrapped in favor of local conditions and how much must be retained. In some cases the result must be a net increase in the facts to be studied.

The professional must learn more social science in

the poor countries, since social change is occurring more rapidly there than in the rich countries, and therefore the professional is more deeply involved. His own work is one of the important forces causing social change. Moreover, his status in society is continuously being affected by the changes taking place. Some room, therefore, should be found in his course for instruction in the sociology of change. One cannot class this problem with other aspects of general education and dismiss it by saying, "This should be done in the high schools before the student reaches the universities." Students of high-school age are not ripe for sociology.

So much for the arguments for reducing courses in basic science. A strong case can also be made for maintaining the amount of basic science taught. This argument would begin with the premise that the professional is isolated and consequently needs to be able to turn his hand to many things. To do this, he must have a sound training in basic principles rather than a superficial training in techniques. In

his isolation he will meet many new problems which can be solved only by taking thought and by returning to basic principles. He needs both more science and more technique, and if one has to be sacrificed, it is not obvious that it is the science that should be curtailed.

The correct answer to our question is probably this: if the professional standard is to be as high in the poor as in the rich countries, professional courses should be a year or so longer in the poor ones, to allow for an inferior background in high schools, the need for more practical work, an increase in the syllabus because of the incorporation of local materials, and the need for a greater emphasis on social studies. But should the professional standard be as high in the poor as in the rich countries? There are several arguments for a lower standard. Even in the rich countries most professionals are overtrained for the work they actually have to do. University syllabuses tend to be framed with an eye on the student who will become a university teacher or research worker, whereas

the great majority go into jobs they could do just as well with a year less of academic training. The poor countries need proportionately even fewer research workers, and separate provisions can be made for their training. To maintain equal standards requires a longer and correspondingly more expensive training in the poor countries, which they can afford. Many such nations have abandoned the attempt to maintain equal professional standards, even if they once tried to do so. Given the great shortage of professionals, especially in rural areas, such a nation is better off with four three-quarters trained professionals than with the three fully trained.

Although many countries have abandoned the attempt, many others still strive to maintain their professional standards at European levels, not only out of national pride but also for other reasons. The routine portion of professionals' work is usually passed over to technicians, whose numbers can be multiplied more easily. This practice makes it all the

more important that the relatively small number of professionals who supervise technicians should be thoroughly trained.

The psychological effects of inferior standards are bad. A poor country is likely to employ a number of well-trained foreign professionals, and it is embarrassing if its own professionals are admittedly of inferior quality. This is especially true when the better paid or more responsible jobs are held only by people with foreign qualifications. The local universities are downgraded in the public eye, and students try to go abroad for education rather than to their home institutions. The latter are discouraged and find it hard to recruit or keep good staffs. This further reduces their quality by adversely affecting their capacity to do useful research. For such reasons, a number of countries have abandoned the inferior professional qualifications they previously offered (for example, Nigeria has dropped medicine, and Trinidad, agriculture) and have substituted qualifications intended to equal simi-

lar qualifications in Europe.

Although the great majority of the graduates of professional schools are required for jobs that demand competence but not brilliance, a significant number are needed to undertake fundamental research. The biological sciences and the professions based on them demand much more fundamental research than do the physical sciences. Whereas the physical structure of the earth is much the same in temperate as in tropical zones, the living organisms differ considerably. An engineer can transfer from a temperate to a tropical environment with only small adaptations; but an agriculturist has to spend a year or more relearning his job.

How fundamental is "fundamental"? Some research requires scientific training and imagination of the highest order; in the process, new scientific truths of universal application will be discovered. In the biological sciences it is hardly profitable to distinguish between pure science and research of the kind the poor countries need — for example, research in

animal and plant genetics, leading to the breeding of new useful types; human and animal physiology in hot climates; pests and diseases, animal, plant, and human; or plant and animal nutrition. Basic principles already worked out in temperate countries will be applied, but since the animals, the plants, the insects, and the microbes are different, the research has to start almost from scratch; it demands the highest qualities, and is likely to yield new universal principles.

The situation in the physical sciences is rather different. Here the main research task is to devote known principles to making inventories of economic resources: discovering minerals or underground water supplies; assessing soils; recording river flows and meteorological data. Such work demands professional competence rather than scientific imagination. The principal scope for fundamental research is in such fields as these: climatology; methods of combating the effects of torrential rain, earthquakes, or months of continuous sunshine on

such structures as roads, dams, and buildings; the utilization of local resources, such as crops, forests, building materials, sources of energy; the conversion of sea water; the invention of new engineering processes that use less capital. Some of this research (especially on the exploitation of materials) can be done in the laboratory in temperate countries, but virtually all the biological research, and nearly all that part of the physical research that is concerned with the effects of the local environment, have to be done on the spot.

There ought, therefore, to be a large number of fundamental research stations strung round the globe between the Tropics of Cancer and Capricorn. Actually there are very few such stations. The tropics are not yet adequately equipped even to make routine inventories of their resources; and they are far from coming to grips with fundamental research. It is not necessary that each country establish a battery of high-quality research stations. For example, there are now twenty countries in

West and Equatorial Africa between the ex-Belgian Congo and the Sahara Desert, but most of them have less than 2,000,000 inhabitants and could not support expensive research institutes. Asia fares better, having fewer and larger countries, of which several could maintain their own scientific establishments, as indeed India already does to a very considerable extent. It is true even of South-east Asia, however, as of Africa and Latin America, that the necessary stations for fundamental research will not be established on a substantial scale until groups of countries learn to combine for this purpose, with or without the United Nations or other international assistance. There have been some good beginnings, for example, sugar-cane breeding in the West Indies, cocoa research in West Africa, or rubber research in Malaya, as well as outstanding work on tropical diseases (done mainly in the laboratories of temperate countries). Nevertheless, an immense scope for expansion remains.

Since the professionals depend on basic science, their



research work depends on a supply of persons with a first-class training in science, whether educated in the professional or in the science schools, like the professional ones, mainly produce persons who need to be competent rather than brilliant. Most of their graduates go into high-school teaching or into routine jobs in commerce or administration. There is little manufacturing industry, and such as there is generally does not engage in research or else it conducts its research in parent establishments in the rich countries. The universities themselves are the largest market for highly trained scientists capable of good research. Nevertheless, every university science school is under pressure to do some research and keep up its standards, partly to make its own teaching lively, partly to contribute to knowledge, and partly because good scientists cannot be retained unless they are given opportunities for research. Many universities are therefore able to produce some men who, given further training, would do well in research.

In the professional schools, professors interested in research tend to feel badly handicapped by not having learned enough basic science in their own undergraduate days, and this prejudices them in favor of putting more and more basic science into the undergraduate syllabus, even at the cost of lengthening the course. This is hardly necessary, since the small number of professional men who go on to research can learn the extra basic science need during their postgraduate training.

What seems important is that, whereas the undergraduate course can be taught adequately in a professional school that has very little basic science, postgraduate training and research in professional subjects can be done adequately only in close association with strong science schools. Thus, while undergraduate teaching can be dispersed over a number of schools, postgraduate teaching must be concentrated in a small number of institutions in which both basic science and professional study are highly developed. It is all the better if these

postgraduate teaching institutions can be linked with the fundamental institutes.

Study in foreign countries has many attractions that study at home lacks. Standards are usually higher, the qualification carries more prestige, and its monetary value may exceed that conferred by the local school. Also, travel provides valuable experience. If the students go to foreign universities whose costs are met principally out of public funds and not out of students fees, it becomes much cheaper to send them abroad than to educate them at home. For example, for what it costs to run the University College of the West Indies, we could send one and a half times as many students to universities in Great Britain. This argument applies to small countries like the West Indies or Ghana, but not to large countries like India. Professional schools are especially costly to small nations, because they need a minimum complement of staff to teach each aspect of the course. For example, Nigeria has been advised that to run a veterinary school economically re-

quires an output of about seventy students a year, and she is finding this a stumbling block. The remedy would be for countries in this situation to group together to run professional schools; but this is not always politically possible.

On the other hand, the provision of professional schools at home has several advantages which may outweigh the higher cost. In so far as the syllabus is based on local materials and on research into local problems, what the student learns in the home university is more relevant to the job he will have to do. This is particularly important in the biological professions. The teachers do not merely teach: if doctors, they look after patients, inside and outside the hospital; if engineers, they do consulting work. The teachers play a part in the life of the community, they sit on boards and participate in private and public decision-making. If they are of adequate scientific caliber, they also carry on useful research of a kind worth paying for, even if there were no students. A large proportion

of students who do go abroad do not return home, and the cost of educating them, therefore, is lost to their country, except in so far as they make remittances.

A good compromise is to give students their first degree at home and then to send the better ones away for postgraduate training in

large, well-staffed and well-equipped institutes. As we have seen, however, the poor countries need a few of their own such institutes to do fundamental research into the problems of their regions. Where such institutes exist, a student can do effective postgraduate work there before he goes abroad.—*American Journal*.

## UNCHASTE

The NP is the old, divorced wife of the electorate — divorced for her infidelities. The LP is the brand-new current, and legal wife whom the electorate married, thinking it was pure and beautiful. The husband-electorate won't be any angrier to discover new evidence of infidelity of his old, divorced wife. But what flaming rage he will go into to discover that his pure and beautiful new wife has had some unchaste experiences before — and after the wedding. — Napoleon G. Rama in the *Free Press*.