

generalize about Africa, yet huge differences exist among countries and institutions. Many uncertainties and deficiencies exist in higher education, which remains elitist and selective in the admission of students. The rising demand for access to higher education is prompting reconsideration of the university's role in Africa. However, the outcome may ultimately be dependent on political decisions by local governments.



Status of Chemical Education in Africa

The African university environment has changed since the 1960s, a decade described by Dr. B. M. Abegaz as one of hope, euphoria, and romanticism. By the 1970s, expectations had been somewhat reduced, stung by a wave of military coups and the growing politicization of higher education. In the 1980s, disillusionment and decline were the norm. Overcrowding in the universities led to a growing pessimism among students and faculty, along with an overall decrease in quality. The 1990s have seen new hope for successful change and transformation of higher education. However, this is accompanied by increased "donor fatigue" among external agencies and nations.

Prof. John Bradley, Chair of IUPAC's Committee on the Teaching of Chemistry, provided a statistical overview of education of Africa. He noted that the population of Africa was 778 million in 1998 and will grow to 930 million by the year 2005. 236 million (36%) of the current African population are of primary and secondary school age (6–17 years). Prof. Bradley added that the adult illiteracy rate in Africa is 40%, due partly to the fact that public expenditures for education are very low on average, about 6% of the GNP. Nevertheless, numbers of students have increased substantially since 1980 with enrollment ratios in tertiary education currently at 6%, in secondary education 32%, and in primary education 72%. In natural sciences and engineering, the percent of enrolled students varies according to country between 11% and 34%. The number of science students per 10,000 inhabitants is approximately one-tenth that found in Latin America and one-fiftieth that of the United States.

Prof. Bradley observed that many African university professors must undertake supplementary nonaca-

demic jobs to augment meager incomes. There is a chronic shortage of textbooks, virtually all of which must be imported from outside the continent. Laboratories are often cancelled because of a shortage of reagents.

Prof. E. M. R. Kiremire reported on the dire situation facing higher education in Zambia, typical of African countries. Tremendous inflation, exacerbated by a lack of government support and political instability, have caused serious problems. Prof. Kiremire noted that 300 lecturers left Zambia during the 1980s and, unfortunately, for every two professors lost, only one professor was recruited. The age profile of the scientists remaining behind is not encouraging. Some 40% of the university staff are over 50 years of age.

Prof. Kiremire urged that the educational system must concentrate on student study skills and motivation, conditions of service for teachers, improvement of teaching aids, and infrastructure. There is a great need for information technology and library development. Journals published since 1975 are lacking in Zambia, as are textbooks and, especially, computers. There is a need to strengthen basic research and development in Africa to help provide relevance for chemical education. Basic political support with no strings attached needs to be developed for chemical research and education.

Prof. T. T. Mokoena of Botswana reminded the participants that one of the greatest challenges to chemical education in Africa is to make chemistry understandable to the poor. It is extremely important, he said, that the educational system have a clear understanding of the educational environment from which students come and a plan for where the graduates will go.

Prof. Mokoena suggested that undergraduate chemistry programs in Africa suffer from a lack of goals and objectives, overcrowded and authoritarian undergraduate curricula, general scarcity of modern resources, "tunnel vision" caused by undue emphasis

on subdisciplines, too many “drudgery hours”, and lack of regular assessments. He urged that African universities and nations do more strategic planning, carried out in a way that strikes a responsive chord among the people. Educational programs, he said, need to be directed toward acceptable goals.

According to Prof. Mokoena, there is a need to provide high-quality, relevant programs with clearly defined aims and objectives. The programs should emphasize mastery of the use of instrumentation, reduce staff and student time spent in rote learning, and provide for the needs of majors as well as general interest or preprofessional students. The programs should especially include project-based teaching and work experience assignments. There also should be opportunity for distance learners and adults to study chemistry. The structure of the program should prepare students for conventional and applied course options.

The Role of the Chemical Industry in Ensuring Sustainable Development in Africa

Dr. M. Booth, a member of IUPAC's Committee on Chemistry and Industry (COCI) outlined operations of the chemical industry in sub-Saharan Africa. He explained that from a global perspective the chemical industry in Africa is small, operating mainly in South Africa, Zimbabwe, Ghana, Zambia, Nigeria, and Egypt.

The primary manufacturing sectors are explosives, fertilizers, insecticides, petrochemicals, and polymers. Management practice standards, e.g., the Responsible Care program, are applied in the areas of health and safety, storage and distribution, transportation, waste management and pollution control, community awareness and emergency response, and product stewardship.

Dr. Booth noted that the firm AECI has recently opened new explosives factories in two African countries. These new enterprises have created new jobs for chemical professionals. It will be important to educate and hire as many Africans as possible for these new jobs, rather than to import personnel from elsewhere.

Dr. Booth suggested that ways need to be developed to improve the image of chemistry through government, industry, and societal activities. Government must provide clear, unambiguous policies, implementable legislation, and fair enforcement. Industry must care for the health and safety of the workers, be mindful of product stewardship, and be ready to communicate hazards. Consumers must learn to read and understand cautionary labels, use chemicals as directed, and dispose of waste chemicals safely.

Special challenges for Africa lie in existing international legal obligations and treaties, poor ambient environmental quality, development of sustainable consumption and cleaner production, and finding eco-efficient uses of natural resources.

Existing international agreements regulating movement of hazardous waste across international boundaries are a challenge to African countries. No national legislation on the subject exists in South Africa or in Africa generally. Moreover, additions to the Montreal Protocol are making it increasingly difficult for economically disadvantaged nations to conform. African countries are having difficulty implementing the Protocol on Informed Consent (PIC) Convention on the use of pesticides, the Protocol on Pesticides (POP) Convention norms regarding organic pesticides, and standards for compliance to global climate change rules. Africa is one of the most economically vulnerable regions, and therefore it is least able to deal with new or established regulations. African industry needs to participate more in the setting of international protocols.

Africa must move its orientation in environmental practices from environmental protection to sustainable development. This shift in orientation will require careful environmental stewardship, social development, and economic growth. A priority goal will be to begin to eliminate poverty through the fulfillment of basic household needs, such as provision of safe water supplies. This problem can be addressed through sustainable consumption, i.e., through minimization of waste and recycling of chemical materials.

Dr. Booth noted that it is important to share expertise and experience to develop uniquely African solutions to support African industrial development. The challenges in Africa will require replacement of obsolete chemical processes with new, “green” technology. According to one estimate, there is much room for growth since the African economy is on average only about 20% technology driven.

Prof. L. Diop of Senegal reminded the participants that Africa has plenty of natural resources, e.g., coal, minerals, and diamonds. He noted that, even though the image of chemistry has suffered because of pollutants coming from industry, and the field inherits a lot of the blame for pollution resulting from the generation of energy, the chemical industry is nevertheless at the very heart of development. Prof. Diop suggested that Africa should concentrate on small technology for local consumption as a way of building grass-roots markets. Also, Africa should look as an example to the efforts made by Asia in the 1960s. Greater cooperation is needed in setting up joint regional research and production centers. The participants agreed that it is as important in Africa as it is in other regions of the world to publicize the positive aspects of chemistry.