Bull.Chem.Soc.Ethiop.,2(2), 89-96 (1988).

FEATURE ARTICLE

SOME THOUGHTS TOWARDS IMPROVING CHEMICAL EDUCATION IN ETHIOPIA

Theodros Solomon
Department of Chemistry, Addis Ababa University
P.O. Box 1176, Addis Ababa, Ethiopia

(Received September 7, 1988)

INTRODUCTION

This article will focus on tertiary level chemical education in Ethiopia, excluding the diploma programmes at post-secondary-school higher education institutions. Its main concern is on B.Sc. level chemical education which is offered in only two universities in the country - Addis Ababa and Asmara. The experience gained in the Addis Ababa University (AAU) will form the basis for the subsequent discussions, although some of the situations described could equally well be applicable to Asmara University also. Much of what follows is not so much a statement of fact, explaining what chemical education in Ethiopia is like, as much as a hint of what can and should be done to improve chemical education in Ethiopia. On another level it might also be regarded as a constructive self-criticism of existing situations at AAU and what directions must be taken in future, or what alternatives need to be explored, to raise the level of chemical education in the Country.

Objectives of chemical education in Ethiopia. The existing curriculum at the Addis Ababa University (as well as at Asmara University) is designed to meet the national need for chemistry teachers at the secondary school level, as well as to meet the needs of local industries and research institutions for the required manpower in this discipline. This dual objective has, for the past several years, led to a situation whereby the former has dominated the general structure of the degree programme, but the latter has dictated the course contents. To clarify this, the degree programme requires 18 credits of pedagogical science courses for all chemistry students, and 53 credits of chemistry courses. However, in very few, if any, of the chemistry courses is any seriuos consideration given to the relevance or need of subject matter content to future high school requirements. Nor is there any provision for adding, in the degree programme, topics that are dealt with in the high school curriculum. Thus, although some aspects of environmental chemistry, chemistry and agriculture, and chemistry and society are dealt with in the secondary school chemistry curriculum, our graduates are not adequately exposed to these topics in their university education. On the other hand, those going to industry and research institutions are loaded with pedagogical science courses when they could (and should) be exposed to further basic as well as applied (industrial) chemistry.

A step in the right direction has recently been taken by revising the B.Sc. programme at AAU. Beginning in the 1988/89 academic year, chemistry majors will be divided into two groups: the first group will follow more or less the present programme (described above) and will follow a career in education upon graduation, whereas the second group will take more chemistry course (inculding more industrial chemistry) instead of pedagogical science courses. The splitting of the programme into two, each with its own specific objectives, is a welcome step. However even though this division may be to the benefit of the second group of students, a significant departure from the existing chemistry programme, addressed specifically to future secondary school teachers, has still not yet been taken. This is a serious drawback and needs to be rectified in future. Regarding the curriculum for the second group and its relevance to industries or research institutions, the situation is slightly better in that the industrial chemistry courses are biased towards local processes and a gradually closer link is being established between University and Industry through the recently launched cooperation agreement.

Educational technology in the teaching of chemistry. In this section an attempt is made to discuss the status of educational technology in the teaching of chemistry in Ethiopia and what can be done in this regard. By educational technology is here meant the use of instructional or teaching aids such as films, casettes, videotapes, computers, TV programmes, etc. It would not be an exaggeration to state in Ethiopia today, as Rao did during the 1975 International Symposium on "**Educational Technology in the Teaching of Chemistry**" that *"educational technology is hardly making a beginning in developing countries. In many of the countries, the blackboard is the only device available"* (1). Although this was stated some thirteen years ago, it is a sad truth that it is still applicable today in Ethiopia since none of the above, to any significant extent, is being used in AAU for the teaching of chemistry. Of course, one may ask *"Is the educational technology that is valuable for countries in, say, Western Europe and North America, equally valuable to a developing country such as Ethiopia?"* This is a valid question, especially in view of the following consideration. University education in Ethiopia is given in English language. However, the level of comprehension of spoken English by the students is not very high. In fact this language problem is an important contributing factor to the very poor performance of students at the freshman level. This was also very clearly stated by Berhan Sishah at the Panel Discussion on "**Characteristics and problems of chemical education in Ethiopia**" during the 5th Annual Congress of the Chemical Society of Ethiopia held August 12-13, 1988. Thus, for some of the educational technologies mentioned above to be valuable, the capabilities of the students as well as cultural backgrounds have to be taken into serious consideration. On the other hand, considering the very large number of students attending the introductory chemistry course at AAU (approx. 1500), the development by the Department of videotaped cassette programmes is not as farfetched as it may seem. Considering that the recording of video films in private and public occasions is now widely practiced in Addis Ababa, it should not be too difficult to develop lecture, as well as laboratory video programmes for the teaching of chemistry. The experiences of others (2,3) could help in this regard. This is suggested not because of any reluctance to use hardware that someone else has developed (4), but because curricula are bound to be different from one country to another and so also would accompanying textbooks or laboratory manuals. Furthermore, it would have the advantage of not only being appropriate to the particular audience intended, but also of involving the Department as an active participant in the development and use of education technology.

Regarding computers and other microelectronic devices it is necessary to note that *"the high technology revolution is here to stay"* (5). Computers are now used not only for processing data, but also for interfacing with laboratory equipment and for data acquisition and storage, for simulating experiments, etc. Nowadays, one cannot afford to leave out computers in the teaching of chemistry, especially in view of the fact that they are, relatively speaking, not as expensive as imagined. They are within the grasp of chemistry departments of many developing countries. The fact that computers as such have, however, until very recently, not neen very common at AAU, means that teaching chemistry by the use of computers - computer assisted instruction (CAI) -is still not only not practiced, but is also a totally new concept to some staff members of the Department. There are now innumerable CAI programmes in all branches of chemistry. Even by 1975, the few examples quoted by Kornhauser (6) should serve an indication of how extensively this technology had spread through university education in chemistry. That computers and CAI feature prominently in the teaching of chemistry can also be appreciated from the "**Computer Series**" column which has been regularly appearing in the **Journal of Chemical Education** since 1979 (7). There have appeared numerous articles in this series that merit serious considerations and study by the Chemistry Departments at the Universities in Ethiopia (taking into account the shortcomings of CAI mentioned by Kornauser (6)) in order that the ever-widening gap between the developed and developing countries does not reflect itself also glaringly in the teaching of chemistry.

There is also, to a large degree, a certain lack of awareness of other educational methods such as programmed learning (8,9), the Keller Plan or self-paced instruction (10). That the Department of Chemistry at AAU has been producing graduates for careers in education for the past several years without applying such educational technologies as those mentioned above is sad; it would, however, be inexcusable if the same trend were to continue, now that a curriculum has been revised that addresses itself specifically to future chemical educators.

The use of educational technology is in general a must if one is to improve instruction. That it is worthwhile and beneficial has been arrived at through a study, the findings of which were presented at the ACS 1982 Symposium on "**What can science educators teach chemists about teaching chemistry**" (11). Since the aim of using educational technology is to improve instruction, one must be involved in the different attempts being made towards this goal.

Other trends in the teaching of chemistry. Lecture demonstrations can be used to enhance the learning of chemical principles, illustrate scientific concepts and stimulate interest. Such techniques have rarely been used in the teaching of chemistry at AAU; in fact, demonstrations are the exception rather than the rule in lecture courses. This is an area in which academic staff members can be involved in without great difficulty. Several examples can already be found in the **"Tested demonstrations"** column of the Journal of Chemical Education. That this exercise is looked at with great seriousness and importance can be gathered from the opportunity that the ACS Biennial Conference on Chemical Education regularly provides for demonstrations and hands-on activities. See, for example, reference (12). In an address to the 7th Biennial Conference on Chemical Education, among the challenges that Shakhashiri issued to the participants was the following (13): *"Every month during the coming academic year, do at least one more lecture demonstration than you have been doing. Display chemical phenomena and illustrate principles. Use each demonstration as a vehicle to teach and not as a magic trick".* Staff members of the Chemistry Department, AAU would do well to take up this challenge. Maybe the Chemical Society of Ethiopia can take a lead in this reagrd by arranging in future demonstrations during its annual congresses.

The use of microscale techniques in the laboratory - especially in organic chemistry - is another trend that seems to be quite popular. Pavlik dealt with this topic in a Chemical Society of Ethiopia (CSE) publication (14). That this trend is taken up by many laboratories and will continue to be popular is indicated by Schumm's prediction (15): *"Microorganic Lab is the wave of the future".*

Considering the fact that microscale techniques lead to: improved laboratory safety, lower costs, improved student laboratory techniques and greater experimental variety (14), it behooves the Department to consider and adapt such techniques in its laboratory exercises.

Cooperative Education. It is tempting to include in this section the general theme of University-Industry interaction in chemistry. This was the theme of a UNESCO-sponsored International Symposium held in Toronto, Canada, 4-7 December 1978. There, several papers relating to such interactions in developing countries were presented; see, for example, (16,17), for case studies in Nigeria and Malawi. In Ethiopia, as mentioned earlier, steps have been taken by both the AAU and the Ministry of Industry to collaborate in research, as well as to facilitate and formalize consultancy and other services. Such interactions in the field of chemistry was a topic for a plenary lecture given by Negussie Retta to the 3rd Congress of the Chemical Society of Ethiopia. Thus some preliminary steps have been taken to bridge the gap between University and Industry. What I would like to discuss, however, is cooperative education i.e. interaction as it pertains to the education of chemists offered by the university.

The aim of cooperative education is to relate teaching in chemistry to the real world of industrial chemistry by integrating the classroom training to productive work in industries (18). In typical cases, students spend several weeks or months in industry as part of their degree requirements. This may also be arranged during the summer vacations. They are supervised regularly while in industry and their work experience is carefully monitored and assessed. In some cases, the students are expected to write a report upon the completion of their industry experience. Among the benefits of such cooperative education, the following may be selected (18): *"For the student, an identification of academic, professional and communication deficiencies while there is still time to remedy them on returning to school....; for the employer, an opportunity to influence the quality and scope of academic coursework and the quality and preparation of graduates....for the University, an opportunity for market place assessment of the quality and appropriateness of course offerings and student preparation".*

Cooperative education has had a long history. Davies (19) points out that such a scheme began in the UK in 1840 at the University of Glasgow and at the present University of Strathclyde in 1880. Giessen et al (20) claim that Northeastern University has been a pioneer and a leader in cooperative education in the USA since the turn of the century. There have been reports about the initiation and status of cooperative education in many universities around the world; the following are only selected examples. University of Salford, UK (19), University of Victoria, Canada (21), University of Surrey, UK (22), Mississippi State University, USA (23). Also, through a tripartite exchange programme between the Swinbourne Institute of Technology (Australia), University of Surrey (UK), and the University of victoria (Canada), an international cooperative education scheme has been developed (24). The experiences of various universities running such programmes has largely been positive. A typical comment is that made by Kay (25): *"students are more mature, more confident about their goals, and more serious about their profession as they approach graduation".*
This issue of cooperative education is raised here to prompt the Department of Chemistry to start thinking of initiating such a scheme, especially now that the curriculum is revised and has been designed to produce chemists for industry.

Also, the number of students to follow this revised programme is expected to be low, thereby facilitating the running of a cooperative education scheme. Admittedly the number of chemical industries in the Country is low; however, with few students in a scheme as outlined above, much benefit for students, industries and the universities can be derived, and one must, after a very careful study, at least make a beginning. The recently launched AAU-Ministry of Industry cooperation agreement should thus cover a cooperation not only in research but also in education.

Regional and International Cooperation in Chemical Education. Education cannot flourish in isolation. A healthy interaction between chemical educators in various parts of the world is absolutely indispensable. Such interactions could be through participation in regional or international seminars, workshops, and conferences, as well as through newsletters, journals, the exchange of teaching materials, curricula, etc. (26). Parry (27) has dealt with this issue at length and discussed the possibilities of cooperation between a developed and developing country, or between two developing countries as well as cooperation promoted by international organizations. Two events in Ethiopia that herald a promising future in the area of regional or international cooperation are (a) the founding of the **Chemical Sociey of Ethiopia** in 1983 and the launching in 1987 of the **Bulletin of the Chemical Society of Ethiopia** and (b) the establishment in 1984 of the **Natural Products Research Network for Eastern and Central Africa (NAPRECA)**-with its headquarters at the Department of chemistry, AAU-and the launching of the **NAPRECA Newsletter** also in 1984. Through the **Bulletin** and the **NAPRECA Newsletter**, media have been created for chemists within and outside the Region to communicate and cooperate. Regional and international workshops conferences have been organized. Thus, if this trend continues, one forsees the possibilty of interacting professionally with chemists and chemical educators from the Region as well as from the developed countries. One hopes that it will not be long before, for example, African chemists not only are aware of the use of educational technology in the teaching of chemistry, but also participate actively in a Regional workshop to be held specifically for this purpose and then adopt whichever is relevant and appropriate in their home countries. It is heartening to note that **Chemical Education** can feature in the **Bulletin of the Chemical Society of Ethiopia** and it is hoped that this will encourage meaningful interaction with professionals abroad in this very important area where we seem to be lagging behind.

What else can be done to improve chemical education in Ethiopia ?. As mentioned eralier, a major problem for students in the Universities in Ethiopia at the moment is their poor language skills. Admittedly, education is given to students in a language (English) that is foreign to them. The fact that secondary school eduction is also in English does not necessarily imply that students have had adequate exposure to, and command of, spoken or written English language. I distinctly remember an instance a few years ago when, baffled by the lack of response from my freshman chemistry class, I prodded the students to ask questions. One bold student started to ask a question, could not phrase it meaningfully in English, and finally ended up by asking the question in a mixture of both English and Amharic. That was a clear indication that there was a very serious language deficiency, which obviously was affecting the performance of students in the classroom, as well as, evidently, during examinations. It is not too difficult to extrapolate and conclude that they also have difficulties in reading and understanding regular General Chemistry textbooks such as those by Slabaugh and Parsons (28), or Brady and Humiston (29), both of which have variously been used in the past in our first year classes. One may have to resort, in future, to instruction in the official local language. Preliminary steps have been taken in this direction by initially attempting to translate, from English into Amharic, chemistry terms for the high school curriculum (30). These terms have first to be popularized and tested before launching a further translation of more chemistry terms for the University curriculum. However, other than this step, the only alternative is to make very great effort, both in the secondary school and at least in the first two years in the University, to increase English language lessons and expose students to greater reading, listening and writing exercises. Only if our students can understand their lectures and assignments, are able to write clearly and concisely laboratory and other technical reports, are able to read without difficulty books and articles in journals, can we say that we are making headway in improving chemical education in the Country.

We are living in an age of burgeoning chemical information. Millen (31) briefly traces the growth of **Chemical Abstracts:** originally published in 1907, one million abstracts were accumulated by 1937; two million by 1955; three million by 1963; four million by 1968; and five million by 1971. At present, there are close to half a million abstracts in a single year. Graduates in chemistry from a developing country must carry an additional responsibility of not being able to afford the lack of aknowledge on how to find, in the literature, the information they require, since in most instances they have no senior person to call upon at their work stations. They must be well-read and well-informed. It is thus regrettable that the course that the Chemistry Department at AAU used to offer in the past on the use of the Chemical Literature has been abondoned. I believe that we should reinstate such a course. A formal course of instruction can be designed, as advocated by Gorin (32). Relevant approaches and viewpoints are also given by Wiggins (33), Hendrickson (34), and Allan (35), and it would be instructive to note these.

In view of the fact that energy, pollution, natural resources, health are some of mankind's pressing concerns, it is not difficult to appreciate the global importance of chemistry today. However, the public is unfortunately not aware of the enormous contributions that chemistry makes to life. This was stated by Newbold at the 9th International Conference on Chemical Education (ICCE) held in Sao Paulo, Brazil, 26-31 July, 1987 (36), where, in his paper on "**The importance of introducing chemistry to the citizen**", he makes suggestions on how chemists, chemical educators, chemical societies and the chemical industry can make effective use of the mass media to raise the awareness of the general public about chemistry and its contributions. Similarly, chemical topics of interest and concern to the general public are not adequately discussed in schools and in the universities. Thus one of the suggestions made by Newbold (37) is that links with local, everyday life and historical aspects be included, wherever possible, in secondary school and university chemistry courses. Millen (32) makes a similar suggestion regarding the emphasis to be given to social implications and technological applications. We should thus give serious considerations to relate our chemistry courses to general topics of public concern such as energy, environment, natural resources, new materials, etc.

I would like to conclude this article by advocating that it is high time that Chemical Education be considered here in Ethiopia as an important discipline in its own right which must be pursued and researched on seriously. Research in science education in general has emerged as a new interdisciplinary activity, as pointed out by deTorre (38) in his lecture on "**Science, Research, and Education**" at the 9th ICCE. In fact, one of the themes of the 9th ICCE was "**Research in learning applied to chemistry**", thereby emphasizing the current importance of carrying out research on chemical education. Chemical education as a discipline can be pursued upto the Ph.D. level (as evidenced by existing programmes in some universities in the USA and UK) and it should not be long before the Faculty of Education and the Department of Chemistry at AAU collaborate to start a joint venture in this important area.

REFERENCES

1. C.N.R. Rao, J. Chem. Ed., **53**, 295 (1976).
2. G.P. Haight, Jr., J. Chem. Ed., **59**, 221 (1978).
3. A.R. Russel and B.L. Mitchell, J. Chem. Ed., **56**, 753 (1979).
4. R.C. Brasted, J. Chem. Ed., **53**, 296 (1976).
5. M. Gardner, J. Chem. Ed., **61**, 146 (1984).
6. A. Kornhauser, Proceedings of the International Symposium on Educational Technology in the Teaching of Chemistry, C.N.R. Rao, Ed., UNESCO, p. 107 (1975).
7. J.W. Moore and R.W. Collins, J. Chem. Ed., **56**, 140 (1979).
8. C.N.R. Rao, New Trends in Chemistry Teaching, Vol. IV, UNESCO, p. 75 (1975).
9. J.A. Young, Proceedings of the International Symposium on Educational Technology in the Teaching of Chemistry, C.N.R. Rao, Ed, UNESCO p. 93 (1975).
10. M.J. Frazer, Proceedings of the International Symposium on Educational Technology in the Teaching of Chemistry, C.N.R. Rao, Ed., UNESCO, p. 44 (1975).
11. J.A. Kulik, J. Chem. Ed., **60**, 957 (1983).
12. J.M. Daly, G.E. Farley, E. J. Hailmeir, J. Hill. Juergens, H.E. Outlow, J.C. Seydel, J.P. Williams, Report of Ninth Biennial Conference on Chemical Education, J. Chem. Ed., **64**, 103 (1987).
13. B.Z. Shakhashiri, J. Chem. Ed., **60**, 4 (1983).
14. J.W. Pavlik, CSE-Chemistry Newsletter, **2** (2), 12 (1985).
15. M. Schumm, J. Chem. Ed., **64**, 100 (1987).
16. D.E.U. Ekong, Proceedings of the International Symposium on University Industry Interactions in Chemistry, Toronto, Canada, 4-7 December 1978, UNESCO, p. 57.
17. C.C. Mjojo, Proceedings of the International Symposium on University Industry Interactions in Chemistry, Toronto, Canada, 4-7 December 1978, UNESCO, p. 262.
18. G. Davies and A.L. McClelland, J. Chem. Ed., **57**, 297 (1980).
19. L. Davies, J. Chem. Ed., **60**, 580 (1983).
20. B.C. Giessen, G, Davies, P.W. Le Quesne and K. Weiss, J. Chem. Ed., **53**, 149 (1976).
21. A. McAuley, J. Chem. Ed., **61**, 155 (1984).
22. R. A. Schultz, Proceedings of the International Symposium on University Industry Interactions in Chemistry, Toronto, Canada, 4-7 December, 1978, UNESCO, p. 88.
23. E. Grimley, L.L. Combs, and C.U. Pittman, Jr., J. Chem. Ed., **63**, 235 (1986).
24. R. L. Laslett, R.S. Reeve, R.A. Schultz, J. Chem. Ed., **62**, 131 (1985).
25. J. Gakay, J. Chem. Ed., **57**, 439 (1980).
26. M. Gardmer, J. Chem. Ed., **61**, 146 (1984).
27. R.W. Parry, New Trends in Chemistry Teaching, Vol. IV, UNESCO, 1975, p. 138.
28. W.H. Slabaugh and T.D. Parsons, General Chemistry, 2nd Ed., J. Wiley, (1971).
29. J. Brady and G.E. Humiston, General Chemistry. Principles and structure, 3rd Ed., J. Wiley (1983).
30. Yilma Kebede, Theodros Solomon, and Berhanu Abegaz, Amharic Dictionary of Chemistry Terms, Academy of Ehiopian Languages (1986).
31. D.J. Millen, Chemical Society Reviews, **5**(3), 253 (1976).
32. G. Gorin, J. Chem. Ed., **59**, 991 (1982).

33. G. Wiggins, J. Chem. Ed., **59**, 994 (1982).
34. W.A. Hendrickson, J. Chem. Ed., **59**, 997 (1982).
35. F.C. Allan, J. Chem. Ed., **59**, 999 (1982).
36. B.T. Newbold, International Newsletter on Chemical Education, **28**, 12 (1987).
37. L.E.C. de Torre, International Newsletter on Chemical Education **28**, 17 (1987).