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Strategy for globalization of chemical education based on the Internet*

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Abstract: It is likely that in the age of globalization, chemical education cannot be unaffected by this trend. The essential prerequisite for globalization would be a common curriculum. It has long been assumed that a common curriculum is technically impossible because of the difficulty involved in the dissemination of information. There is now a realistic possibility that this difficulty will be substantially reduced, if not eliminated, by use of the Internet. Difficulties involved in the translation of text will also be reduced by the use of accurate and low-cost translation software. Under such circumstances, what is urgently needed is the establishment of teaching materials translation centers around the world.

INTRODUCTION

The IUPAC-sponsored 14th International Conference on Chemical Education (ICCE) was held in Brisbane in the south hemisphere summer of 1996. On this occasion, we organized a half-day symposium entitled, "Is There Unique Asian Chemical Education?" [1]. The purpose of that symposium was as follows:

> Chemistry is, in principle, an "international" phenomenon in the sense that everyone in the world uses the same basic chemistry laws, the same atomic weights, and the same chemical symbols and equations. If chemistry is not international, then there is no reason why an organization such as IUPAC should exist. On the other hand, education cannot be fully international since education is, in general, entrenched within one's culture. Culture, in turn, is deeply influenced by the history, politics, economy, sociology, and tradition of each country.

To provide an example of national vs. international differences in education, the way in which chemistry is taught in relation to environmental issues is necessarily local (*national*) depending on the particular situation of each country (e.g., the extent of development of the chemical industry). From the viewpoint of conservation of Earth and of the human race, chemical education concerning environmental issues should be uniform and international. The content of teaching, i.e., the courses of study of chemistry, may be different from country to country since the economies and the extent of industrialization among countries are so different.

From a number of lectures delivered at this symposium, we learned that there is some general agreement that chemical education can be internationalized, or should be internationalized at least to

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some extent. There may be many opinions as to what is the internationalization of education. We thought, however, that internationalization should not be a mere exchange of people and information. Internationalization should correspond to a standard shared by all people. If this criterion is applied to chemical education, a common curriculum would be this standard. It is anticipated that there are many difficulties to be overcome in achieving internationalization of chemical education in this context.

The most significant problem to be circumvented is that of language: there are some 4,000 languages in everyday use around the world. If internationalization of chemical education were to be achieved by the use of one language, this would prove hopeless. At a professional level, English may be, in the future, the global language by which at least almost all written (nonverbal) information is exchanged. Even at the tertiary education level, however, use of a language other than the mother tongue is not practical except for a few countries where, mostly for historical reasons, a foreign language is widely used.

As far as primary and secondary education is concerned, it is simply impossible to unify the education of children under one global language. There are many countries where more than one language is widely used, and yet it is impossible to unify the education of children in those countries under just one of the mother languages. How would it be possible therefore to unify education on a global scale into one foreign language (e.g., English)?

A second serious problem is the cost of dissemination of information (textbooks and other teaching materials) when education of this sort is to be practiced on a large (e.g., international) scale. One typical example is the small pamphlet *International Newsletter on Chemical Education* [2]. The publication of this small pamphlet was originally started in 1974 by the IUPAC Committee on Teaching of Chemistry (CTC). As far as we know, the money necessary for the publication (and dissemination) of the pamphlet initially came from UNESCO. As has been the case with many other projects, UNESCO withdrew its support for this publication owing to a budget cut, and for some ten years or so IUPAC's CTC had a particularly difficult time maintaining production of the publication.

It turned out soon, however, that the real problem associated with its continuing production was not only the cost of publication (editing and printing); from the beginning, there was no remuneration for contributors, and editors worked on a volunteer basis. The real problem was associated with dissemination of the publication—or postage costs. For proper distribution of such a pamphlet, you would need to send it to individual chemists or chemistry teachers, for which the cost of postage would be prohibitive, particularly given that most destinations are foreign countries. In effect, a certain number of pamphlets were sent in bulk to chemical societies, where they most likely ended up being buried among many other documents and pamphlets. The last printed issue of the pamphlet was dated 1997.

At that time, we could not be so optimistic in our attempt to internationalize, or in modern terminology, globalize, chemical education. It seemed that the idea did not have a rosy future.

AN ATTEMPT FOR STANDARDIZATION OF CHEMISTRY CURRICULA

In spite of the problems associated with dissemination of relevant literature, we initiated a plan to standardize chemistry curricula. One of us (Y.T.) proposed, as a member of IUPAC Commission III.2 (Physical Organic Chemistry), to the Commission a feasibility study to survey the possibility of a common curriculum/textbook in elementary organic chemistry, and if possible, in general chemistry. Though the Commission could not accept to do the task by itself, it did undertake to support us in our attempt to continue the effort. Side by side with this proposal, we also made a proposal to IUPAC's CTC on the occasion of the IUPAC General Assembly 1993. Here is the relevant part of our proposal to CTC.

> Proposal 2: Standardization of College/University Chemistry Curriculum
>
> It appears that the chemistry curriculum for senior high school is standardized in some countries. In Japan the government issues the so-called "The Course of Study", being a set of guidelines for the scope and limitation of teaching chemistry (and all other subjects)

for all stages of primary and secondary education. This is a regulation by law, and hence the curriculum for elementary, junior, and senior high schools in Japan is highly standardized.

There are, however, considerable differences in the scope and method of teaching chemistry in different countries. Nevertheless, we do have a reasonable understanding of what is going on in other countries, which is due almost entirely to the activity of the CTC.

On the other hand, we know almost nothing about the uniformity of curricula of college/university chemistry courses. The situation is even worse if we take graduate schools into consideration.

We wish to know the chemistry curriculum (if any) at each level of tertiary education in other countries. The information would be helpful should we wish to modify our present curriculum. At present there is some argument in Japan calling for an innovative chemistry curriculum so that a rapid response can be made to society's changing attitudes to chemistry. A typical example of such attitudinal changes include awareness of environmental issues. To know of the prevailing situation in other countries would be of great help to us in Japan, and we believe that this should apply to every country.

We would like to propose the organizing of a working party to examine the feasibility of surveying chemistry curricula at:

- Undergraduate level—chemistry for non-science/technology students
- Undergraduate level—chemistry major and as a major in related fields
- Graduate level—chemistry major and as a major in related fields

This survey could form the basis of the starting point for standardization of chemistry curricula at all levels in ALL COUNTRIES.

At the time it was advanced, there was little support for this proposal. The general response was that the curriculum is a matter for nations or for national chemistry organizations and not that of an international organization and so no special steps were taken by the CTC.

In parallel with this proposal, we carried out a survey to ascertain the situation in various countries in relation to the standardization of chemistry curricula. We sent questionnaires to 46 national representatives and members of the CTC, and received 19 replies. The questions and the replies are summarized as follows (Table 1).

Table 1 Results of the survey.
Question: Does your country have a standard curriculum for chemical (or science) education?
Answers:

Level	Yes	No
Elementary school level	12	7
Middle and high school level	16	3
University education (1st and 2nd year) level	4	15
University education (3rd and 4th year) level	3	16
University education (graduate level)	2	17

The results of the survey are self-explanatory. The common curriculum is popular among primary and secondary education, but is not popular in tertiary education in general. It is clear that there is room for considering a common curriculum for university education. The comments attached to the replies were various. Some thought that the idea of a common curriculum was impractical and inappropriate, while others gave their support to the idea.

ATTEMPT AT GLOBALIZATION OF CHEMICAL EDUCATION VIA THE INTERNET

The development and popularization of software to be used in preparing good teaching materials was also rapid. This new software included Hypertext Markup Language (HTML), Common Gateway Interface (CGI), Java, and Virtual Reality Modeling Language (VRML) techniques on the World Wide Web. Information and software stored on computers connected to the servers could be easily accessed using Web browsers and could be applied effectively to chemical education on a worldwide basis.

Our first course of action was the setting of the Asian Chemical Education Network (ACEN) which forms part of the activities of the Federation of Asian Chemical Societies (FACS; Asian version of IUPAC). According to our plan, ACEN would be more than a web page. ACEN was to consist of a notice board, useful teaching materials, and a database. The first item in the ACEN database [3] was the entire file of *Chemical Education in Japan, 2nd edition* [4] edited by us and published by the Chemical Society of Japan in 1994. This publication was originally published in conventional form as a 200-page booklet. It was, from the beginning, to be converted into a computer-readable form and to be stored in the database. In 1997, we published our second book, *Chemical Education in Asia/Pacific* [5] (Fig. 1), and all files for this publication were also placed in the ACEN database.

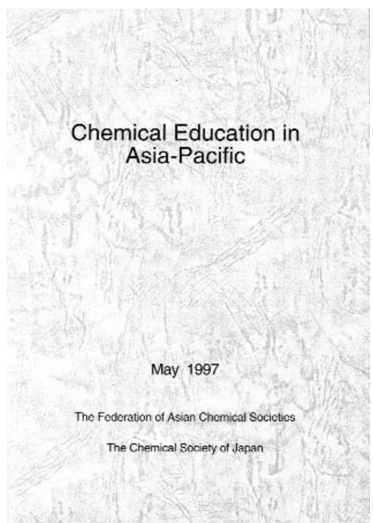

Fig. 1 *Chemical Education in Asia/Pacific*.

We noticed, however, that the dissemination of good teaching materials was not necessarily very effective even though the mode of dissemination via the Internet was available. It is true that good-quality teaching materials are produced in many parts of the world, but these are not necessarily used in other parts of the world. The reason for this is that there was no good center, or hub, for chemical education, to which good teaching materials were to be linked.

For this reason, we proposed to IUPAC's CTC to the effect that the CTC should take a more positive role along this line, the setup of a Worldwide Chemical Education Network (WCEN) [6,7] and the Virtual Chemical Education (VCE) [8] project. This proposal was made at the meeting of the CTC during the 39th IUPAC General Assembly held in Geneva, 1997, for which the approval and support of the

CTC to this project was immediately given. Furthermore, some CTC members and observers showed interest in participating in this project.

It must be added that the role of the VCE project is not only in the production of good teaching materials but also to support chemical educators to produce good teaching materials by themselves. MOLDA, *Molecular Modeling and Graphics Software* [9], generates 3D molecular structures in VRML for the creation of the teaching and learning materials in 3D graphics. The chemical structures can also be drawn for electronic publishing on the Web. This versatile software can be downloaded for free from the MOLDA Web site, which has already been accessed more than 90 000 times.

What we expect in future is that many projects similar to VCE will be initiated around the world. If these are linked to WCEN, then all chemical educators worldwide could have a well-equipped arsenal for teaching chemistry. This was our first attempt at such a project [10].

COMMON CURRICULA REVISITED

Meanwhile, the phenomenon of globalization is progressing in many aspects. There are now many large, multinational companies, and the movement of people as immigrants, students studying abroad, or as tourists, has dramatically increased over recent years. This means that there are many young, pre-college students moving from one country to another.

It is particularly difficult for such students because what they learn in one country is often different from that taught in another country. A common curriculum between countries, is therefore, desirable. Basically, a common curriculum is desirable at any stage of education, although to structure a common curriculum for primary and secondary education is difficult for reasons mentioned above. In this regards, general chemistry, introductory physical, inorganic, and organic chemistry courses for the first- and second-year university students would be most suitable for such attempts.

There actually appears to be signs that indicate that attaining such a goal is within the realms of feasibility. Particularly impressive is the activity of the European Chemistry Thematic Network (ECTN) [11], Core Chemistry Group, headed by Prof. P. E. Todesco of the University of Bologna, working for a common curriculum. Sixteen European countries are involved in this program. In 1997, the member chemists from 16 countries contributed a national report of physical and organic chemistry, and in 1998, other member chemists from the same 16 countries contributed national reports for analytical and inorganic chemistry. Each annual report provides details of subject matter taught, class hours for each topic, and finally, arrives at a CORE CHEMISTRY [12] (Fig. 2), being the "average" chemistry curriculum for one country.

Based on the collected information, ECTN published two reports, "Learning Objectives for Core Chemistry" [13], and "List of Topics" [14] (to be included in the course of study). Though they did not propose an obligatory syllabus, most European chemistry departments seem to agree with this content. They have proposed a test of the knowledge of students who have studied based on this list.

It must be admitted, however, that the general feeling in the chemical world towards a common curriculum is still one of indifference. It was mentioned that we previously made a proposal to IUPAC Commission III.2 (Physical Organic Chemistry) for a feasibility study of a common curriculum for introductory organic chemistry. In 1999, Prof. N. S. Nudelmann of the University of Buenos Aires, who belongs to the Commission III.2, became interested in this idea and she made a proposal asking for support from IUPAC as a project authorized by IUPAC.

The title of the project was "Internationalization of the Organic Chemistry Curriculum" [15] and its object was:

> "To propose and promulgate general recommendations for up-to-date university curricula in organic chemistry, without interfering with instructors' freedom to choose and present topics. An international curriculum will clarify the educational levels to be attained by students and thereby facilitate transferability of courses and exchange of students."

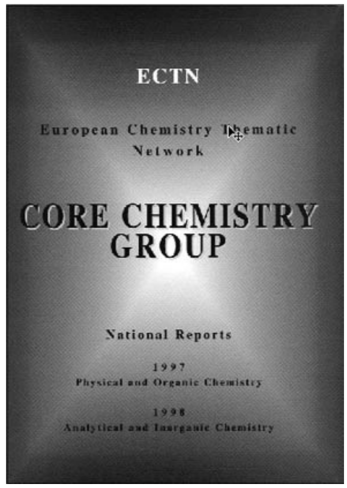

Fig. 2 Report of European Chemistry Thematic Network (ECTN), Core Chemistry Group.

The proposal was very careful to avoid possible objections against any regulation of individual curricula and explained the character of the project as follows:

> "We have no intention of imposing a uniform curriculum or of arguing over details of what must be covered. Our emphasis will be on concepts, not pieces of information. We will define what new material should be introduced and what can be deleted or reduced."

However, IUPAC decided not to support this proposal on basis of the *IUPAC Strategy for Educational Policy* [16] recently prepared by the Education Strategy Development Committee (ESDC) of IUPAC headed by Prof. P. W. Atkins of Oxford University. The Committee expressed their reason for rejection of the proposal as follows:

> "The Committee took the view that national needs were so disparate that it is impractical for IUPAC, and the CTC in particular, to attempt to impose a rigid framework, and that most national organizations were perfectly competent to identify the essential components of a chemical education and to identify their local needs. The committee recognized that courses driven by local requirements and specific local interests could be highly successful, and that it would be unwise and unwelcome for the Union to tread insensitively in this area. Furthermore, many national organizations already have in place apparatus for the identification and authentication of curricula, and the committee considered it inappropriate to add yet another layer to this pursuit."

This reflects the general policy of IUPAC that is expressed in the report [17].

We believe that globalization of chemical education and a common curriculum is a kind of inseparable pair, like the two sides of a sheet of paper. We would like to stress that a common curriculum for general or introductory chemistry courses at the university level is essential or a necessary step for globalization of chemical education. On the other hand, the attitude of IUPAC may be justified in view of their scale as an organization. It is usually difficult for such a huge organization to adapt quickly to new circumstances. Probably the input of a nongovernmental organization (NGO) type of body (i.e., by a small number of individuals) would be more suitable.

DIFFICULTIES ASSOCIATED WITH A COMMON CURRICULUM

Those who take a skeptical view of a common curriculum told us: "The preparation of a curriculum itself is not very difficult. The content of one introductory organic chemistry textbook is in fact much the same as another. There are hundreds or even thousands of introductory organic chemistry textbooks used in the world, and yet there is no confusion, no problem at all. This means that there is a kind of consensus as to what is basic organic chemistry. In fact, there exists in the chemical world a kind of invisible common curriculum for introductory chemistry."

We may be criticized then, with people asking: Why do you insist on setting up a common curriculum even though it, in fact, tacitly exists? This is the crucial point of our opinion. As we have already mentioned, to put something (i.e., a course) together is one thing, but to then disseminate it is a quite different matter. In the past, dissemination of a common curriculum was impossible because of the printing and distribution costs, even if we were to overlook the language problem.

The Internet will then, in principle, solve this problem under a rather bold assumption that at least in the near future everyone in the world can have a reasonable probability of having access to the Internet. This assumption may sound too optimistic if one considers the fact that there are so many people living in third-world countries. However, if you look at the scenario, now popular almost all over the world, that most young people have their own mobile phones, our assumption may not be so unrealistic. We should also mention the possibility of the use of next-generation cellular phones as a means of downloading teaching materials and class notes.

The next-generation cellular phone is expected to be capable of handling large files suitable for teaching materials, including multimedia files. If appropriate software and teaching materials suitable for the next-generation cellular phone can be developed, the phones will serve as an adequate supplement for personal computers in general. In fact, standard personal computers, desktop or note type or whatever, will be the main device for downloading teaching materials for self-study in the future. The next-generation cellular phone will, nevertheless, open a new era for education because of their more affordable cost. One of us (H.Y.), with the cooperation of Prof. Y. Honma of Niigata Womens' College, has already developed a system [18] with which one can receive teaching materials on chemistry (such as molecular structure information) by the *i*-mode cellular phone (Fig. 3). Such a system would work much more effectively when used with the next-generation cellular phones.

All in all, we can say that the means of dissemination of teaching materials, including common curricula, is now in a much better situation compared to that available to us five years ago. Though it is

Fig. 3 Downloading of chemical teaching materials containing molecular structure with an *i*-mode cellular phone.

difficult for us to make an accurate estimate of the availability of the Internet to a large percentage of the population and of new-generation cellular phone capabilities, we can be optimistic to some extent.

The remaining, and most difficult problem to overcome, therefore, is that of language.

HOW TO SOLVE THE LANGUAGE PROBLEM

The most significant consequence of globalization is, in our opinion, the fact that the world's population will have the opportunity to share in, or at least, become part of, a number of common standards. A common curriculum is one example. To have a common standard, it is essential for everyone to be able to have access to the same documents (papers, books, or other information). Without such access capabilities, it is difficult to envisage a common standard being achieved. It was once almost unachievable because such a policy requires that all people use the same language.

From experience, however, it is clear that a one-language policy is not at all practical. The mother tongue is much easier to use than any other language, and to study some subjects in a foreign language renders the task several times more difficult than if it were to be completed in the mother tongue. All Japanese children begin learning English at school from the age of 12, and spend considerable time and energy in learning English: three years in junior high school, another three years in senior high school, and at least two years in colleges. The outcome of this extensive education has proven to be rather poor mostly because of the lack of constant use of the language with native English speakers. There are some countries whose citizens tend to be good in foreign languages on the whole, while there are countries where the learning of foreign languages is not so good. Under such circumstances, a one-language policy is not at all practical.

What can be done then? The answer is translation! The only possible way to solve this problem is bi-directional translation; from English to the mother tongue and from the mother tongue to English. One may argue that translation is expensive and time-consuming. This is true, but as compared with the cost of printing and disseminating the translated materials, the cost pales into insignificance. Translation software is becoming more popular, and there are many examples of available software for bi-directional, multilingual translation. The most well-known one would be Babylon translator [19]. Most of the software, free or commercial, is for standard use, but there is some specifically designed for chemical materials. There is at least one form of software available in Japan that was originally designed for translating *Chemical Abstracts* [20]. The quality of the translation is far from perfect; however, if technical terms are properly provided, the results can be useful, in that it can convey the essential meaning of the sentences.

Though our knowledge is limited, such software is available in many countries. In fact, there are some scholars of humanities who operate a discussion site, "Language/Power" [21], in several languages including English, Japanese, Korean, Chinese, and many other foreign languages. All the discussions are machine-translated into other languages with the help of translation software without any amendment by humans (Fig. 4). The software is still in the early stages of development. Nevertheless, this attempt seems to foretell the outcome of globalization.

Compared with this multilingual attempt to solve language incompatibilities on a global scale, what we propose is much more "modest" approach. We propose the setting up of a VCE TRANSLATION CENTER, a kind of hub, in each country, that is involved in this common curriculum project. The necessary equipment to set up such a center is not considerable: a server, translation software (from English to mother language, and from mother language to English) and some manpower.

We have contacted with chemists in the countries given below. They are ready to cooperate with us should a grant be obtained: Argentina, China, Korea, Malaysia, Pakistan, the Philippines, Portugal, Russia, Sri Lanka, Taiwan, Thailand, and Vietnam.

Such a center definitely requires one or more key people who are sympathetic to the aims of this project. The key persons would be probably expected to work in a volunteer capacity, although part-time personnel should be paid. It is difficult to estimate the cost of such a project, but we have already

Moteki on Japan's Official Language Debate

Jonathan Lewis

[原文]

Hiromichi MOTEKI "Eigo Kôyôgo ka ron to wa nan datta no ka." *Chûô Kôron*, November 2000. pp.236-243.

Hiromichi MOTEKI is a representative director of Sekai Shuppan, which publishes the magazine Mangajin. The magazine helps Japanese to learn English. (An English version of Mangajin for learners of Japanese was discontinued in 1998.) In this short article, Moteki attacks the idea of making English Japan's second official language. That idea was mentioned in a report "Japan in the 21st Century," which was issued by an advisory committee to the late prime minister Keizô OBUCHI earlier this year. The idea has since been more actively proposed by Yôichi FUNABASHI, who was a member of that committee. The following paragraphs summarize Moteki's position.

Funabashi's proposal is essentially the same as the proposal made by the first minister of education in Meiji Japan, Arinori MORI (1847-1889). Faced with an urgent need to modernize in order to avoid colonization by Western countries, Mori had advocated that Japan adopt a simplified version of English as its official language.

The proposal seriously underestimates the time and effort that would be required to achieve its stated goals of English speaking levels in the Japanese population.

The proposal's use of Singapore as its model is also problematic. Singaporean government ministers have repeatedly lectured Japan on its need to improve its English or be left behind technologically and economically. These ministers do not seem to realize the extent of Japan's abilities in information

Moteki en el discusión del lenguaje oficial de Japón

Jonathan Lewis

[無修正の機械翻訳]

Ron de ka de Hiromichi MOTEKI " Eigo K4oy4ogo al datta nan del wa ningún ka. " *Ch4u4o K4oron* , noviembre 2000. pp.236-243

Hiromichi MOTEKI es director representativo de Sekai Shuppan, que publica el compartimiento Mangajin . El compartimiento ayuda a japonés a aprender inglés. (una versión inglesa de Mangajin para los principiantes del japonés fue continuada en 1998.) En este artículo corto, Moteki ataca la idea de hacer el lenguaje oficial de Japón inglés segundo. Esa idea fue mencionada en un informe " Japón en el 21ro siglo, " que fue publicado por un comité consultivo al último primer ministro Keiz4o OBUCHI anterior este año. La idea ha sido propuesta desde entonces más activamente por Y4oichi FUNABASHI, que era un miembro de ese comité. Los párrafos siguientes resumen la posición de Moteki.

La oferta de Funabashi es esencialmente igual que la oferta hizo por el primer ministro de la educación en Meiji Japón, Arinori MORI (1847-1889). Hecho frente con una necesidad urgente de modernizar para evitar la colonización por los países Western, Mori había abogado que Japón adopta una versión simplificada del inglés como su lenguaje oficial.

La oferta subestima seriamente el tiempo y el esfuerzo que serían requeridos para alcanzar sus metas indicadas de niveles de discurso ingleses en la población japonesa.

El uso de la oferta de Singapur como su modelo es también problemático. Los ministros del gobierno de Singaporean han dado una conferencia en varias ocasiones Japón en su necesidad de mejorar su inglés o de ser ido detrás tecnológico y económicamente. Estos ministros no se parecen realizar el

Fig. 4 Discussion based on the machine-translation. Left side: original English transcript. Right side: Spanish machine-translated from English. No amendment by humans was done.

made applications to the Japanese government for grants to bring this proposal to fruition. At the moment, their response has not been overly promising. However, time is needed before such an adventurous project could be fully understood and supported by all involved, and so patience will be necessary.

It must be pointed out that the need for a translation center was also discussed at a meeting of UNESCO and IUPAC's CTC that was held in Budapest on the occasion of the 16^{th} ICCE in 2000. The report of the meeting [22] describes the idea of the satellite centers as below.

> "Global dissemination of information, especially electronic (Internet, CD) also has great potential value. It is comparatively inexpensive where the infrastructure exists. Language and culture are not catered for however, and local translation and adaptation are likely requirements.
>
> Hence whatever media, other than individual personal transmission, of informing chemistry teachers are considered (printed or electronic) the same local/national characteristics must be accommodated at some stage. This does not mean the global electronic dissemination in English has no value: it means its value is limited to a greater or lesser degree.
>
> Satellite centers may be conceptualized as a useful interface in this regard, especially in developing countries. These centers are envisaged as locations with the capacity and technology to take the global dissemination into the furthest reaches of the country by the most appropriate means."

We believe that the idea of translation centers should be considered seriously because we can now expect that a good deal of teaching materials will be produced and in some cases their translation is allowed, or rather, is encouraged.

A good example is found in the recent announcement from MIT [23], which states that:

> "MIT President Charles M. Vest has announced that the Massachusetts Institute of Technology will make the materials for nearly all its courses freely available on the Internet over the next ten years. He made the announcement about the new program, known as MIT OpenCourseWare (MITOCW), at a press conference at MIT on Wednesday, April 4.

> Professor Lerman noted the potential of OpenCourseWare to teach and to train students and young faculty in developing countries and said, 'We hope our materials will be translated. Developing countries need information, and they need to develop infrastructure and institutions.'"

It is clear that the supply of good teaching materials on the Internet will increase. As such, the role of translation centers will become increasingly important, for which we believe the setting up of translation centers deserves much more attention.

Side by side with the attempt to promote the translation center project, we have also attempted to produce good teaching material on the Internet in both English and Japanese. Some 15 years ago an introductory textbook on stereochemistry was published by one of us (Y. T.) in Japanese. The book has sold well, probably because it has been written in the so-called "Programmed Study" style and is therefore suitable for self-study. It occurred to us that if the whole book is digitized and placed in the VCE database, the material would be of some use for self-study or for college students as well as bench chemists. The Japanese version is nearly complete and has undergone some modernization (including animation), and can be accessed by anyone [24]. Now we are translating the material into English. We must note that prior to starting this attempt we asked the permission of the publisher. The publisher, Kodansha, which is one of the leading publishers in Japan, was sympathetic with the idea. They admitted that they have already covered their costs, and moreover, as there is little chance that the book will be translated into English, they allowed us to use the book as we wished.

Based on the belief that common reading is the essential factor for the globalization of chemical education, we have started another project for IUPAC's CTC, the publication of an electronic journal on chemistry for teachers, students, and citizens. The title of the journal is *Chemical Education International* [25], and the subtitle is *Matter, Life, and Environment*. This is formally the successor of the IUPAC's CTC publication, *International Newsletter on Chemical Education.* At the moment, the number of readers is limited, but the circulation is still better compared to that achieved with the pamphlet once published by CTC.

Now the blueprint has been made. We will continue our efforts to globalize chemical education via the Internet.

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