

A BRAZILIAN WAY TO IMPROVE THE CHEMICAL ENGINEERING EDUCATION

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Abstract

Since 1989, the Brazilian Chemical Engineering academic Community has periodically (every two years) held national meetings to discuss a variety of teaching aspects. The event, named ENBEQ (abbreviation in Portuguese of "The Brazilian Meeting on Teaching of Chemical Engineering") is attended by all Brazilian schools of Chemical Engineering, and in the end of each Meeting, a set of recommendations has been generated through consensual and collective decisions. As the implementation of these recommendations has been carried out freely and spontaneously, the observed benefits are significant and have been resulted in effective improvements in quality of Chemical Engineering Education. In order to share this successful and unprecedented Brazilian experience with all those involved in the Education of future professionals, we present a brief exposition of these meetings: its history, general premises, basic schedule, its decision making process, its results and new perspectives.

ENBEQ'S History

The I ENBEQ was carried out in 1982 at UNICAMP - Campinas State University, and was accomplished only through Panels involving professors, engineers of some companies and representatives of governmental agencies related to financial support in research and a representative of the Brazilian Education Ministry. During this event, Prof. d'Ávila presented a preliminary evaluation of the 36 existing Chemical Engineering undergraduate courses. In the end of his presentation, Prof. d'Ávila suggested that the Chemical Engineering Education should provide for the students the development of creativity, as well as recommended that the undergraduate curricula should provide a global and general Education, instead of specific information. Also it was pointed

out that the education techniques should involve computer applications and activities in Chemical Engineering Laboratories.

As results of this Meeting, it was decided to extend the discussion to the necessary minimum curriculum to the Chemical Engineering courses in Brazil, and to carry out a survey on the qualification of the teachers as well as the operational conditions of these courses. The II ENBEQ was only held in 1988, and was attended by a number of participants, among which were professors of public and private institutions, some engineers of the industrial sector and a representative of governmental agencies of financial support in research. This event was accomplished through six Work Teams, that discussed six different subjects, being one in each Work Team. The discussion in each Work Team had been initiated through reports elaborated before the event, and in the end of the Meeting all the participants, in a Plenary Meeting had appreciated the Work Teams' conclusions.

As one of the results of the II ENBEQ, it was verified that there was urgent necessity to correct some distortions in Brazilian Chemical Engineering courses and only after this it was possible to update them. It was also decided to carry out a real survey on the 39 existing courses, and the results should be presented in the III ENBEQ. In this occasion it was also determined that the next event would be held in 1989 and from that, the Meeting would be carried out biennially. In 1989, III ENBEQ was accomplished with a Basic Schedule that prevails nowadays, and will be described in this contribution. The accomplishment of the III Meeting was a landmark in the ENBEQs' history. It was attended by 92 participants, involving representative of industrial sector, of Chemical Engineering's associations, of governmental agencies of financial support in research and representatives (lecturer) of 32 of the 39 existing undergraduate courses.

In the III ENBEQ, the participation of Prof. Levenspiel, of Oregon State University, was very important, as in his Conference he pointed

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perspectives to Chemical Engineering Education, based in a previous presentation of a retrospect about all the development of Chemical Engineering in the world.

This III Meeting, as mentioned before, was a landmark in the ENBEQ's history, since in this event the ENBEQ's fundamental premises were established, and they prevail nowadays. These premises are also presented in this contribution.

During this event, the participants formed seven Work Teams to discuss the teaching of specific disciplines and other general topics related to Chemical Engineering Education.

As a resolution of the III Meeting, the IV ENBEQ was held in 1991, and lecturers from Chemical Engineering Department of Federal University of Minas Gerais organized it.

The IV ENBEQ was attended by around 100 participants, amongst which were lecturers from 31 of the 39 existing undergraduate courses. During this Meeting the Evaluation of Operational Conditions of Brazilian Chemical Engineering Courses was presented, like in the previous Meeting, but during the III ENBEQ, a list of the Results of Actions developed between 1989 and 1991 was also presented.

During the IV ENBEQ, seven Work Teams had continued the discussion of subjects considered in the III ENBEQ, and some papers related to Chemical Engineering Education were also presented.

In the end of the IV ENBEQ, it was determined that the two following Meetings would be carried out at the same place (in an attempt to become a traditional ENBEQ Meetings place), and would occur in 1993 and 1995, being organized respectively by the Chemical Engineering College of UNICAMP and by the Chemical Engineering Department of Federal University of Santa Catarina, respectively.

The V ENBEQ was held in 1995, with an innovation: a central theme - "Formation vs. Information" - as one of the topics discussed in all activities developed during the Meeting. In this occasion the subjects discussed in the Work Teams were revised to include some more general ones, and a Suggested Minimum Guideline was provided to initiate the discussion in each Work Team.

During the V ENBEQ, the participation of Prof. Richard M. Felder and of Prof. Rebecca Brent were very valuable, as they conducted a small version of a workshop named "Effective Teaching: the Workshop". In this workshop, amongst other subjects, they presented the Different Learning and Teaching Styles. A comparison of them shows that in many situations these styles are exactly antagonistic, and despite of a great teacher's persistence, the result is a low learning efficiency.

It is important to stand out that Prof. Felder is Professor of Chemical Engineering at North Carolina State University (NCSU) since 1969, and he was selected as one of five "**Outstanding Engineering Education of the Century**" by the Southeastern

Section of the American Society for Engineering Education in 1993. Prof. Brent is Professor of Education at East Carolina University, and they have developed joint works.

V ENBEQ was attended by 143 participants, with lecturers of 37 of the 45 existing courses in Brazil, and some undergraduate and graduate students. Two of the General Resolutions decided in the end of the Meeting are outstanding: there will be no paper's presentation in the Meeting just to have more available time to work in teams; the students will attend to ENBEQ, being one for each Work Team. In the end of the V ENBEQ it had been defined the schools that will organize ENBEQ up to 2001.

The VI ENBEQ, organized by the Chemical Engineering Department of Federal University of Santa Catarina, was hold in 1995. This Meeting was attended by 156 participants, and the landmark of this VI ENBEQ is the high positive results obtained. They are consequences of some continuous work and actions accomplished throughout all the time since the beginning of the ENBEQs' history. Some Work Teams proposed their own dissolution, recognizing that there was no teaching distortion in the disciplines they had been discussing since III ENBEQ, therefore there was no reason to go on working in the subject.

In the end of the VI ENBEQ it was also decided to make some changes in the ENBEQ's structure and in the subjects to be discussed in the next ENBEQ, to include topics like inter and multi disciplinary and emergent teaching methodology.

In 1997, the VII ENBEQ was held in another place, at a hotel in Caxambu, a small city of Minas Gerais State. The discussions in Work Teams had been more privileged with the definition of Thematic Areas. In this new structure each small Work Team has been part of a Thematic Area, and each one has to discuss a specific subject related to its Thematic Area. In a second stage, there is a discussion in a larger Work Team, involving all small Work Teams related to a Thematic Area. This latter discussion begins with the results presented by small Work Teams. This new structure provides better conditions to have more deep discussions, and the proposed recommendations are based on better justifications.

ENBEQ's General Premises

The ENBEQ'S fundamental general premises had been established in 1989 during the III ENBEQ, as already mentioned, and they have prevailed nowadays. The main characteristics of these general premises are described bellow.

The ENBEQ does not aim to make all Brazilian Chemical Engineering Courses to have exactly the same curriculum. The diversification as well as the specific characteristics of each course are not only recognized but are also stimulated. The effort to guarantee the best quality teaching in each course is the main ENBEQ's purpose, and the common

effort is to assure, for all Brazilian Chemical Engineers, a minimum set of knowledge to allow them to develop safe and recognized professional activities.

The ENBEQs' results are of two types: Recommendations and Actions, and both of them have been generated through consensual and collective decisions, in the end of each ENBEQ. The Recommendations are only suggested and their implementation has been carried out freely and spontaneously. Therefore each Brazilian Chemical Engineering school decides which of those recommendations will be implemented and when and how it will be accomplished.

The Actions are composed of activities to be developed in the two years between two successive Meetings, such as to use a questionnaire to obtain information about the characteristics of Chemical Engineering Laboratories in the undergraduate courses, the accomplishment of a specific meeting related to the teaching of a specific discipline, the accomplishment of workshops to discuss emergent teaching methodologies, the production of materials such as film explaining what Chemical Engineering is, etc. Therefore the developed Actions generate information and data and sometimes provides better conditions to implement the recommendations.

ENBEQ's Basic Schedule

Since the accomplishment of the III ENBEQ, the basic schedule of the event has included at least one Conference, the Presentation of Evaluation of Operational Conditions of Brazilian Chemical Engineering Courses and the Results of Actions developed since previous ENBEQ, and at least one Discussion involving participants of industrial sector. These activities are developed during the first day of the Meeting, and the last one has been carried out in the evening.

All the ENBEQ's second day has been dedicated to the discussions in Work Teams, and in this evening the Work Teams' Coordinators have a meeting to remove the coincident proposals and to prepare the guideline of the Plenary Meeting, which has been carried out in the morning of the third day of the event.

The Evaluation of Operational Conditions of Brazilian Chemical Engineering Courses is composed by data obtained through a detailed questionnaire, which is sent to the Courses' Coordinators in the beginning of the year of the ENBEQ's accomplishment. This questionnaire requests quantitative and qualitative teachers' and students' staffs data; some details of course's curriculum, such as number of credits, curriculum's changes and their results, implementation of ENBEQs' Recommendations and the observed results, characteristics of Chemical Engineers graduated in each school; the facilities available for undergraduate teaching, including laboratories, libraries and its books and journals, computational facilities, etc.

All the data collected through this questionnaire are published in the ENBEQ's Proceedings, constituting a valuable literature that allows to observe the courses' evolution along the time. As these data have been presented in the first day of each Meeting, all the participants can have a good and general updated situation of the Brazilian Chemical Engineering courses.

The presentation of the Results of the previous ENBEQ allows to all participants to know what went on in the previous Meeting and which were the important subjects at that time. The Actions developed in the last two years and the obtained results are also topics of this presentation.

The Conference's subject is usually related to the central theme of the Meeting, which is an updated subject of great interest, such as the National Courses' Evaluation in 1993.

The Discussion involving representatives of the industrial sector aims to detect which skills and knowledge are necessary for Chemical Engineers in an industrial career, being a feedback of industrial sector.

Therefore at the end of the first day of each Meeting, all the participants have a good general view of the situation of Chemical Engineering Education in Brazil, although some of them have not attended to the previous ENBEQ. Moreover, this general view constitutes an important contribution to the discussions in Work Teams, which is scheduled for the second day of the Meeting.

The activities in the Work Teams begin with a brief exposition of the discussions carried out in the previous ENBEQ, afterwards the developed actions and their results are evaluated.

The discussion can then continue with the subjects of the Suggested Minimum Guideline, and the work is finished with a Report that summarizes the discussions, presents Recommendations and indicates Actions to be developed in the two following years. This report must then be presented by the Work Team's Coordinator in the Coordinators' Meeting, which is scheduled for the evening of the ENBEQ's second day.

In the morning of the third day, during the Plenary Meeting, the Work Team's Coordinator also presents the Work Team's report.

The subjects discussed in Work Teams (WT) during the VI ENBEQ had been: WT1 - Basic Disciplines, WT2 - Process-Design Disciplines, WT3 - Critical Disciplines: Mass Transfer, Reactors and Kinetic and Processes Control, WT4 - Disciplines with Specific Features: Experimental Disciplines, Apprenticeship and Undergraduate Designs, WT5 - Unit Operations and Thermodynamics, WT6 - Teaching Evaluation, WT7 - Graduate Courses and WT8 - Computer Science Applications. Some of these subjects had been discussed in Work Teams during the III ENBEQ and had persisted until the accomplishment of the VI Meeting, others had been formed along the time during the ENBEQs, and

specifically the WT5 is already the result of the union of two Work Teams.

All the participants attend the Plenary Meeting in the morning of the third day of each ENBEQ. In this Plenary Meeting all the Recommendations and the Actions to be developed in the following two years are decided in a consensual manner. The decisions are based on the Work Teams' Reporters presented by the Work Team's Coordinators. Some General Resolutions are also decided.

Results

The periodic ENBEQ's accomplishment has contributed significantly in curricular realizations of Brazilian Chemical Engineering Courses. Moreover it has kept the lecturers constantly involved with Chemical Engineering Education and it has been a way to provide appropriated conditions to exchange teaching experiences.

Many changes in Chemical Engineering curriculum of some schools had been made using the ENBEQs' Recommendations. The Evaluation of Operational Conditions of Brazilian Chemical Engineering Courses published in the V ENBEQ's Proceedings reveals many details of this results.

Since 1982, during the I ENBEQ, it had been recommended that the education techniques should make intensive use of Chemical Engineering Laboratories, and in next ENBEQs, this recommendation has been kept and improved, such as, when it was recommended "hands-on" laboratories instead of demonstrative ones. As a result of this ENBEQ's Recommendation, in 1993, four Chemical Engineering schools had affirmed to have established this kind of laboratories.

After many discussions and evaluations, many of the others Work Teams, that had discussed disciplines' teaching, reported suggestions of bibliography and text-books, some of which has been adopted by many schools.

The Evaluation of Operational Conditions of Brazilian Chemical Engineering Courses, carried out during the III ENBEQ, allowed the identification of disciplines whose teaching was in critical situation, disciplines whose contents were misrepresented or less than the minimum necessary, or even though disciplines or subjects that were not taught. To solve these problems, some Work Teams was specifically constituted to discuss them, and these Work Teams remained until the accomplishment of the VI ENBEQ.

As a result of the Actions and Discussions, during the V ENBEQ, five schools had no longer affirmed to have implanted or given more emphasis to Mass Transfer teaching, the discipline whose teaching was considered to be the more critical one. The discussions related to Thermodynamics teaching, carried out in the same Work Team, had generated even though regional meeting to discuss exclusively the teaching of this discipline.

Several other results, amongst which the reduction of the time spent in classroom to privilege the extra-classroom works and the inclusion of a discipline related to Introduction to Chemical Engineering in the first or second semester of the courses, aiming to decrease the evasion, also had been told and are published in the Proceedings of the V ENBEQ.

However, the most relevant result is what happened with some disciplines whose teaching had been considered critical until the accomplishment of the VI ENBEQ. During this Meeting it was recognized that most of the problems related to the teaching of these disciplines had been solved. Therefore the discussion specially related to the teaching problems of these disciplines was not necessary anymore.

In this VI ENBEQ, some of the Work Teams that have been discussing these problems proposed their self dissolution and/or their association to others Work Teams aiming to discuss the inter disciplinary.

The results reported here are only some examples of the improvements in Chemical Engineering Education obtained through the ENBEQs. To have a complete notion of ENBEQs' effect on Brazilian Chemical Engineering Courses, it is recommended to read the ENBEQs' Proceedings listed in the end of this contribution.

ENBEQ's Perspectives

The last ENBEQ, carried out in 1997, had new structure and schedule, involving discussions in small Work Groups and in bigger ones related to Thematic Areas. This new structure increases the time dedicated to work in teams to one day and a half. As the topics discussed in this Meeting included more general subjects such as multi and inter disciplinary as well as emergent teaching methodologies, it is expected that such discussions open a new phase in Brazilian Chemical Engineering Education.

Conclusions

Considering the highly positive results of "The Brazilian Meeting on Teaching of Chemical Engineering" - ENBEQ and also that it is a spontaneous initiative of professors of Chemical Engineering in Brazil, and as we are aware of the ENBEQ is an unprecedented Brazilian experience, we have concluded that it must be divulged and shared with all involved in the Education of future professionals, to stimulate similar initiatives in other areas.

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