The Curriculum Integration in Chemical Engineering Courses in Brazil

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Abstract - *The correct structuring of the chemical engineering course curriculum is important to the students to become, already during the course, problem solvers. It is a great mistake to think that the students need to attend to all the disciplines of the course to have the necessary background for the resolution of technical problems.*

According to Felder [1], the whole fundamental mathematics and the scientific background of the graduation course should be supplied in a " just-in-time " basis, that is to say, immediately after the need have been created for the resolution of real problems.

Failure to recognize relationships among concepts in different courses hinders the students in two ways, first each instructor must teach concepts from scratch and second, students do not apply interdisciplinary approaches to problem-solving, as it was shown by Froyd and Winkel [2].

Traditionally, all engineering courses of the Country were influenced by the convention of the modulate teaching, the curricula were always organized according to preset patterns, without a sequence that propitiates a narrow linkage among related subjects. Even in the cases where some linkage attempts could be seen, they were generally frustrated, since they were not more than a sequence of discipline titles done without a deep content analysis of each one.

In order to investigate the current situation of the Chemical Engineering courses in Brazil, a survey will be accomplished to show what has been done, up to now, regarding curricular integration and interdisciplinarity in the 44 Chemical Engineering courses offered in Brazil, so that it will possible to define the curricular structure, the concern level regarding the subject interdisciplinarity and what was already made in Brazil towards curriculum integration programs.

This work is the first step to propose a curriculum integrated program to the Chemical Engineering courses in Brazil.

Introduction

The correct structuring of the chemical engineering course curriculum is of great importance so that the students become, already along the course, “problem solvers”. It is a great mistake to think that the students need to attend for all the disciplines of the course to have the necessary background for the resolution of technical problems. Some teachers have the illusion that , once known the tools, the students will get to use them with dexterity; it is fundamental that those tools are not supplied isolated, but always accompanied of the applications they are destined in the graduation courses. According to Felder [1], the whole fundamental mathematics and the scientific background of the graduation course should be supplied in a “just-in-time” basis, that is to say, immediately after the need to real problems resolution have been created.

It existed, until today, in the traditional engineering courses of the Country a certain concern lack with the integration of the disciplines, influenced by the tradition of the modulate teaching, the curricula was always organized according to preset patterns, without a sequence that propitiates a narrow linkage among the approached subjects. Even in the cases where some linkage attempts can be seen, they are generally frustrated, since they are no more than a simple sequence of discipline titles made without a deep analysis of each one contents.

Flaws in the detection of the existent relationships among the disciplines leads the students not to apply interdisciplinar solutions to problems, as it was shown by Froyd and Winkel [2], this fact is very serious to the students’ professional life, since some of them will reach a general vision of the science, but so many other will become limited professionals.

The discipline integration will be defined, in this work, as the search of conceptual connections among the disciplines and the proposal of better methodologies of connectivity among those disciplines.

The proposal of this work is the execution of a curricular analysis of a course of Chemical Engineering with establishment of the existent connections among the disciplines and assembly of a plan for curricular integration involving some teachers, in order to create a team of integrated teaching. A group of disciplines will be selected to take part of a curricular integration pilot project. The results of the actions will be collected basing on researches and statistical data taken before and after the execution of the project.

Motivation Of The Work

During the first months of the performance of the author of this work as Graduation Coordinator in the Chemical Engineering College of Lorena (Faenquil), it was possible to analyze the curricula of the Chemical Engineering course and to detect that there are many common points among the disciplines, a lot of times some subjects are intimately connected but that is not clearly shown to the students, owed mainly to a flaw in the planning of the course as a whole; trying to detect whether the problem is general or restricted to the ambit of Faenquil, it was made contact with several course coordinators in the country and it was verified that a general concern exists with relationship to the problem.

According to Zenor [3], the fundamental idea of the assembly of a curricula is that many topics covered by the basic cycles of the engineering courses should be intimately tied up. The courses that teaches those topics should present a coherent picture of mathematical tools, physical and engineering applications, in such way that the inter-relationships are clearly revealed to the students.

To exemplify the problems of curricular descontinuity, let us look to the classic case of Physics discipline that treats the definition of speed with Integral concepts before the students have seen this topic in the discipline of Calculus, or still the case of the disciplines of General Chemistry and Experimental General Chemistry that treats a lot of times identical topics with different approaches, subtracting to the student the opportunity to have a wide vision of the subject that it is being taught, or moreover, the complicated cases of the basic cycle disciplines that are very simplistic with subjects that should be deepened, just as the case of treating in the first semesters the Pressure with a simple state equation and suddenly, in a semester ahead to present it to the student with the complicated equation of Stokes. All descontinuity types causes barriers to the students which only can be transposed after a long time, sometimes, years after undergraduation. Eliminating such descontinuities means, essentially, to eliminate the intellectual barriers.

The assembly of the teaching plan should not be seen as the end of a long bureaucratic day between teachers and departments, but as the result of a consent among the teachers of the several involved disciplines. For this reason, it should count with the teachers' participation in the planning of the courses of a same discipline, this phase seeks mainly the difference elimination in one discipline that is taught by several teachers. Finally, according to established approaches, to plan the courses in such a way that the curricular connections are evident to the students' eyes.

Objectives

Some objectives of this work are outlined as follows:

General objectives:

To assemble data on the curricular structure and regarding what has been done in the chemical engineering courses with relationship to the interdisciplinarity in Brazil;

To propose forms of increasing the chemical engineers' capacity in presenting interdisciplinar solutions to daily engineering problems;

To contribute for the improvement of the teaching of the Chemical Engineering, through a deep study of the curricula of the courses;

To propose methods that seek a larger curricular integration, involving the specific disciplines of professional formation and the ones of general formation, that is to say, embracing the whole curricula;

To generate, through the extrapolation of the results, a methodology of curricular integration that is possible to be applied in any Chemical Engineering course.

Description Of The Proposed Work

1st Phase

Choose of the disciplines that will participate of a preliminary study regarding the effects of the interdisciplinarity programs. Example: Physics, Chemistry and Calculus for the basic cycle. (See Figure 1 and Figure 2)

At the same time with the previous item, it will be accomplished an assay on what has been done in Brazilian Chemical Engineering courses regarding interdisciplinarity: it will be made a research among all the course coordinators of the 44 offered courses in the country and, by means of the answers to a standard questionnaire previously elaborated, it will be possible to define the curricular structure, the concern level regarding the subject interdisciplinarity and what has already been made in the country towards the disciplinary integration.

In a first semester students of a group in which no curricular integration is being applied will be accompanied and a group of teachers interested in the formation of Interdisciplinar Teaching Group will be set up, initially, only teachers of the disciplines chosen to take part of the work will take part of the group.

After the study of the program of the chosen disciplines the strategies to be adopted for the integration will be studied. The selection and evaluation of the methods of descontinuities elimination and of curricular integration will be done based on the existent literature (scarce) and in

the experiences accomplished in another universities (some of them not published), without discarding the use of totally innovative proposals.

2nd Phase

Once mounted the action strategy, it will be applied.

A questionnaire-test will be prepared to be applied the two student groups mentioned above, seeking to measure the level of the students' interdisciplinar vision, in order to compare the effect of the integration actions adopted.

It will be elaborated a method to measure the connectivity degree among the disciplines, opening the possibility of numeric comparison among the connectivity and the statistical data about the groups involved in the research.

The evaluation of the methods cannot proceed, in this case, the most rigorous scientific patterns of the exact sciences; once it is a work done with people, it must be taken into consideration the inherent subjectivity to any human process. Therefore, what is proposed is not the comparison of the behavior of a same sample to two different perturbations, because of the evident impossibility while dealing with "human sample" in a material way without loosing the concepts of the ethics, but the proposal is to analyze the consequences of the actions in the educational process as a whole, that is to say, the evaluation of the effects of the executed actions will be made basing on statistical data taken from two different groups, one without any action and another with the adopted integration methods. Although there is the risk of working with different profile groups, this is the only way to evaluate the work, because once chosen a group of disciplines for the work, it forms a singular group (by the students involved with those disciplines), and no more actions are possible over the same group, since after one semester these students will be attending to other disciplines. The impossibility of using the same groups in the two phases of the proposed work may affect the results evaluation, that is why some care should be taken for guaranteeing a minimum of trust, for example:

In the two analyzed semesters, it is evident that one should choose the same group of disciplines and to work just with the students common to that group. This won't be difficult, once, at the school where the assay will take place , the first semester has induced application, that is to say, all the students enroll in a same group of disciplines;

The same group of teachers will be working in the two proposed semesters to avoid that gets up the hypothesis that differences in the didactic capacities among teachers can generate errors in the results;

A narrow accompaniment of the group should be made during the whole period of tests, seeking to detect every order of events inside and out of class, such accompaniment has for objective to detect facts that could interfere in the results and should be taken into consideration in the judgement and interpretation of the results and they can influence from a simple path correction to the complete invalidation of the semester.

Some comparisons between the groups involved in the work will be made based on the following data:

- distribution of notes of the disciplines;
- index of reproof of the groups;
- number of abandons;
- number of reproofs without final exam;
- number of approvals without final exam;
- number of reproofs with final exam.

With the assay about of the structure of the Chemical Engineering courses in Brazil and with the results of this preliminary research it will be possible to set up a coherent methodology of curricular integration with the peculiarities of each different group of disciplines. The proposal is, once analyzed the general structure of the Brazilian courses, to set up a possible methodology of being applied to any course, that is to say, a widespread methodology.

References

1) FELDER, R. M.; Bernold, L. E.; Burniston, E. E.; Dail, P. R.; Gastineau, J.E., *"An Integrated First-Year Engineering Curriculum"*, Annual ASEE Conference Proceedings, 1996.
2) FROYD, J. E., WINKEL, B. J., "*A New Integrated First-Year Core Curriculum in Engineering, Mathmatics, And Science: A Proposal*", Frontiers in Education Conference Proceedings, IEEE 1988.
3) ZENOR, P. et al. "*A Interdisciplinary Approach to the Pre-Engineering Curriculum*", em fase de publicação, 1997.

SITUATION 1 – 1st semester of 98

Figure 1 - Situation on the first semester proposed on the study

SITUATION 2 – 1st semester 99

PHISICS

Figure 2 - Situation on the second semester proposed on the study