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CURRICULUM GUIDELINES FOR UNDERGRADUATE COURSES IN BRAZILIAN HIGHER EDUCATION: A VIEW OF THE PROCESS IN MATHEMATICS AND ENGINEERING

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INTRODUCTION

Curriculum guidelines for undergraduate courses, in Brazilian universities[1], which are at present being examined by the National Council of Education (Conselho Nacional de Educação), raise a lot of questions about the changes that will be necessary to adapt those courses to these new orientations.

In this paper, we present the outlines of these proposals, exemplifying them with two undergraduate courses — mathematics and engineering — and we express our concerns about the possible modifications. We believe that to elaborate some proposals which can affect the curriculum structure is not enough, because it is necessary that professors stop being just mathematicians or engineers who teach in classes to become mathematics or engineering educators, contributing to reduce the gap between the current teaching process and the necessities of our society.

The Brazilian educational system has been presenting deeper structural modifications since 1996, when the National Educational Law for Basic Guidelines (Lei de Diretrizes e Bases-LDB) was passed. The law brought about several changes, such as permitting universities to elaborate the curricula of their own courses and programs, once appropriate general guidelines were respected.

Thus, from 1997 onwards, there was a call for proposals of new curriculum guidelines for undergraduate courses, to be presented by the universities and to be systematized later by the Expert Council (Comissão de Especialistas), in each area. As ruling principles, the guidelines propose, among other issues:

- to indicate study contents, avoiding the setting of specific subjects, with a pre-determined number of hours;
- to avoid unnecessary extension of the courses, reducing curricula and allowing a better relation among the subjects;

- to boost a solid general formation and specific abilities in the graduation area, stimulating independent study which leads to intellectual and professional autonomy;
- to encourage the use of experience acquired outside school, as well as practical training and other activities that could be included to establish the number of hours set.

The proposal of elaborating curriculum guidelines, according to the document of the Higher Education Office of the Brazilian Education Department (SESu-MEC), has objectives and goals that could be thus summarized:

- to give more autonomy to the universities in defining their own curricula;
- to propose a minimum number of hours which allow flexibility of the courses duration;
- to optimize the modular structure of courses, aiming at better learning progress;
- to guide practical training and other activities, as well as to stimulate universities to recognize abilities acquired outside undergraduate courses;
- to cooperate for the innovation and quality of the pedagogical project of each course, specially through orientations for assessing the teaching and learning process.

Starting with the discussions in universities and professional organizations, a great number of proposals was drawn up by the Expert Council, which is accessible at Internet for reference. New debates took place, the suggestions and criticisms of which were sent to the Education Department, to be analyzed by the National Council of Education, where they are till now, awaiting approval.

CURRICULUM GUIDELINES FOR MATHEMATICS

There are two kinds of mathematics courses in Brazilian universities, the bachelor and the teaching credential. The first one graduates professionals to do researches in mathematics and to be professors of higher education (in this case complemented by M.Sc. or Ph.D. degrees). Teaching credential courses form teachers for junior and senior high school.

Mathematics has applications in almost all fields of knowledge and the proficiencies developed in mathematics courses, such as logical thinking and the ability to solve problems, giving graduates in these courses many opportunities outside the academic environment. Thus, bachelor guidelines take it for granted that students have a strong formation in mathematical contents and are prepared to act in our changing society.

Consequently, proficiencies are required such as: expressing themselves with clarity and accuracy, both orally and in writing; working in multidisciplinary teams; identifying, formulating and solving applied mathematics problems; understanding, criticizing and using new technologies in solving problems.

Contents suggested are those traditionally studied in mathematics undergraduate courses, enriched by the knowledge of physics and computer usage, set to be studied in four years, with a minimum of 2000 hours of classes.

Math teaching credential courses, because of their special characteristics –– necessity of linking with different areas, such as Pedagogy and Psychology –– have not yet been drawn up in their final version of the curriculum guidelines proposal.

According to the Education Department and the experts in preparing teachers, it is necessary that the teaching credential courses have their own identity, instead of being just a supplement of the bachelor courses, as it has been up to now.

The temporary document version points out the fact that the professional graduates in teaching credential courses must consider society's contemporary requirements, which give new responsibilities to teachers and schools.
If modern education theories are focused on the student as constructor of his own knowledge, it is necessary to reshape the math teacher's role, so as to perform, among others, the following attributions: organizer, facilitator, mediator, stimulator and evaluator.
Therefore, it is necessary that graduates in teaching credential courses have a strong formation in specific contents of mathematics, associated with a pedagogical formation that enables them to critically keep in mind the teaching reality.
Thus, besides the proficiencies already mentioned in the bachelor curriculum proposal, the mathematics teacher should have, among others, the abilities of analyzing and selecting didactical materials and alternative methodological proposals; creating and adapting pedagogical methods; relating several mathematical areas to elaborate models, to solve problems and interpret data.
As to mathematical knowledge, it should have a basic core of traditional contents, linked with topics of computation, math history, physics, cognitive psychology, teaching methodology, didactics and teaching practice.
The duration of such courses is being debated. There is just the agreement of the obligation of at least 300 hours of teaching practice, according to the LDB.

CURRICULUM GUIDELINES FOR ENGINEERING

There is a great number of engineering courses in Brazilian universities and new specialties are created each year, to follow world trends and new market necessities. Nevertheless, curriculum guidelines for engineering do not make differences in courses and, according to the orientations of the SESu/MEC, future engineers should acquire, among others, proficiencies and abilities:

- to apply scientific, technological, mathematical and instrumental knowledge to engineering;
- to design and conduct experiments and interpret data;
- to efficiently communicate, orally, graphically and in writing;
- to act in multidisciplinary teams;
- to understand and apply ethic and professional responsibility;
- to evaluate the impact of activities developed in society and in the environment;
- to bring their knowledge up to date, autonomously and permanently.

However, the changes that must be made in current curricula, often depend on the modifications in teaching methodology, because there are essential capabilities for the future engineer to act in a global and competitive market that have not been developed through specific subjects. As examples, we can point out the proficiency to work in teams and the awareness of the necessity of continuos up dating.
Analyzing the future engineer's profile, presented in the curriculum guidelines, we can see that there is almost an identification with the attributes which those graduated in engineering courses must show, according to the U.S. Accreditation Board for Engineering and Technology (ABET). We see, then, that the Brazilian universities and the organizations of professionals and professors which presented their proposals to the elaboration of the

curriculum guidelines — The Federal Council of Engineering and Architecture (CONFEA) and the Brazilian Association of Engineering Teaching (ABENGE), among others — took into account world trends which demand professionals with capability to communicate and work in teams.

A requirement of the new LDB is related to the existence of a pedagogical project for each undergraduate course and the curriculum guidelines document also indicates the presuppositions that should regulate the working out of such projects. As for math courses, the new engineering curricula should foresee complementary activities, aiming at favoring student's gradual intellectual autonomy.

Besides, it is advised that the courses stimulate activities such as scientific initiation, technical visits, team work, prototype developments and other proposals that can foster cooperative, communicative and leadership attitudes.

In the proposal under examination, thirty five per cent of the number of the hours in the new engineering curriculum must be dedicated to a core of basic subjects which are not very different from those usually taught, including lab practice already traditionally fulfilled. Another fifteen per cent of the hours must be occupied with a set of professional subjects.

The remaining hours must be complemented with extensions and deepening of professional contents, as well as others which characterize each course, because each university has the possibility to allow flexibility in their engineering curricula to meet specific and/or regional necessities.

There is an estimate that the courses will occupy at least four years, with a minimum of 3000 hours of didactical activities, besides those hours dedicated to training, synthesis and complementary work. In each course, the university supervised training will have a minimum of 160 hours.

REGARDING TRENDS, PROBLEMS AND EXPECTATIONS IN ESTABLISHING THE NEW GUIDELINES

There are a lot of not yet fully defined questions in the proposals accessible on the web for mathematics courses. Thus, when the curriculum guidelines are established, adaptations will be necessary, especially in the number of set hours.

In the teaching credential courses, the changes will even be deeper, because they involve a new attitude of the future teacher, who has to give up their role of contents transmitter and help students build up their own knowledge.

This change of perspective has been outlined in Brazilian mathematical education since Piaget's ideas were presented, from the 70's onwards. Even though conflicting with the prevaling technical trend, Piaget's constructivism has been spread and blended with tendencies which are fully aware of the social and cultural aspects of mathematics teaching.

A great number of researches in problem solving, since the 80's, shows some foreign influences on Brazilian mathematics teaching processes: Polya's ideas, the studies about metacognition and Vergnaud's conceptions are examples of postulates incorporated, sometimes uncritically, to the theoretical foundation of curriculum proposals which emphasize problem solving as a favorite methodology.

Another influence on Brazilian math curricula is that of the Curriculum and Evaluation Standards for School Mathematics, from the United States. Their proposals are not directly used by teachers of junior and senior high schools, but are taken for granted by new

institutional proposals, as the National Curriculum Guidelines (Parâmetros Curriculares Nacionais-PCN), which bring some ideas from the Spanish curriculum reform, as pointed out by the presence of Spanish consultants in the team that elaborated the PCN.

Thinking of changes for engineering courses, there is the possibility of using curriculum flexibility to introduce studies about Science, Technology and Society (CTS studies), which, in spite of being broadly developed in many countries, are still unfamiliar to Brazilian curricula. In the American tradition, these studies give greater emphasis to technology and social consequences. In Europe, on the other hand, they are focused on social factors and on science, taking into account sociological, psychological and anthropological aspects.

Therefore, it is important that CTS studies should be blended with technical approaches which are prevalent in engineering teaching. Thus, including concerns about analyzing social aspects of science and technology should break the traditional attitude of transmitting contents, as well as bring a broader motivation to the learning process, developing in students critical abilities, so necessary to form responsible citizens in society.

However, indicating contents, suggesting new methodologies or proposing new approaches do not assure the quality of an undergraduate course, neither in mathematics, nor in engineering, specially because the change in teachers' attitudes will only take place once the corresponding change in their own professors' practice has begun.

This seems to be the biggest problem faced by universities: how are we to put a curriculum into practice without the corresponding changes in the staff ? Obviously we have vanguard centers in teaching math and engineering , distributed in many universities all over the main Brazilian capitals. Nevertheless, in a country that offers more than 250 math teaching credential courses and 270 engineering courses, it is a utopia to expect that the majority will be following the new proposals.

While the majority does not think about changes in a cohesive form, we'll still be fostering educational inequalities, which reinforce social discrimination in Brazil.

[1] Documents related to curriculum guidelines may be found at http://www.mec.gov.br/Sesu/diretriz.shtm