The European Dimension of Higher Education. A Project for Teaching Mathematics in Romanian Technical Universities

BRANDUSA PREPELITA-RAILEANU
University Politehnica of Bucharest
Department of Communication in Modern Languages
Splaiul Independentei 313, 060042 Bucharest
ROMANIA
brandusaraileanu@yahoo.com

Abstract: The paper focuses on new aspects of teaching and learning mathematics as a vector for society modernization and effectiveness of European integration. It deals with the project developed under the patronage of the Romanian Ministry of Education, Research and Innovation, POSDRU/56/1.2/S/32768, project entitled The Training of University Teachers and Students in the Field of Using Modern Tools to Teach-Learn-Assess for the Mathematical Subjects in Order to Acquire Important Professional and Practical Skills for the Labour Market.

The paper emphasizes that teaching and learning of mathematics are built up based on modern educational methods which generally define the educational process: obtaining basic knowledge, developing the tactical and strategic thinking. It is highlighted that education through mathematics represents an extra proof that, from the educational point of view, Romania is already in line with the European trends. In conclusion, it is pointed out that the study of mathematics means an investment with profound implications for the future of the Romanian society, an engine for national development.

Key–Words: mathematics, curricula, technical education, teaching, learning, assessment, training programs, syllabus

1 Introduction

The rapid expansion of higher education and its growing cost are focusing attention in many European countries on issues of quality, relevance and efficiency. The modernization of Europe’s universities is a necessity. Member States of European Union are urged to free up their substantial reservoir of knowledge, talent and energy with immediate, in-depth and coordinated change: from the way in which higher education systems are regulated and managed, to the ways in which universities are governed. The aim is to increase universities’ contribution to the Lisbon Agenda for more growth, and more and better jobs [3]. Romanian universities have enormous potential, much of which unfortunately goes untapped because of various rigidities.

Reviews of Romanian policies for education are most prominent among a range of activities that lead to analyses of education policy development and implementation in response to or anticipation of wider economic and social trends and developments. There is involvement of Ministries as well as professional groups, researchers and others, in formulating and carrying out the work and in discussing the findings.

The aim is to improve the understanding of issues, implications for education policies and experience with the range of national policy options and strategies.

Educational work is a key element for both human capital formation and the promotion of democratic values. Therefore it has been identified as one of the priorities of the project launched late last year by the Ministry of Education, Research and Innovation.

2 An European Project-Evaluation for Teaching Mathematical Subjects

Funded by the European Social Fund, the project entitled The Training of University Teachers and Students in the Field of Using Modern Tools to Teach-Learn-Assess for the Mathematical Subjects in Order to Acquire Important Professional and Practical Skills for the Labour Market aims to adapt the study programs of mathematical disciplines to the labor market demands and the creation of mechanisms and
tools to extend learning opportunities.
The project covers a period of 36 months contributing directly to the general objective of Sector Operational Program of Human Resources Development - POSDRU and entered in the field of intervention 1.2 *Quality in higher education.* The project is implemented by the Ministry of Education, Research and Innovation in collaboration with The Red Point, Agency OSC, Polytechnic University of Bucharest, University of Bucharest, University of Civil Engineering of Bucharest, University of Pitesti, Technical University Gheorghe Asachi of Iassy, West University of Timisoara, University of Galati, Technical University of Cluj-Napoca and University of Alba-Iulia.

Each of the universities participating in this project will create one training center for teachers and students involved in increasing the quality of Mathematical education in Romania and in developing best practice in national and international level.

The specific objectives of the project are:

- Assessment of educational needs, of teachers’ and students’ aims related to the use of mathematics in higher education, masters and doctorates;
- Analysis of the effectiveness and relevance of current curricula at the level of performance and efficiency to develop knowledge and skills for students who study mathematical subjects at university;
- Development and harmonization of university curricula of mathematical disciplines, according to the demands of the labor market;
- Development and implementation of a training program for teachers and students interested in partner universities based on the development and harmonization of curricula;
- Creation of 9 training centers for teachers and students involved in increasing the quality of mathematical education in Romania and in developing best practice at national and international level;
- Creation of a resource base of innovative, modern and functional teach-learn-assess for the mathematical subjects in universities;
- Fostering cooperation and communication between students;
- Using new knowledge and skills in the labor market.

3 **The Role and the Place of Mathematics in Technical Education**

We emphasize at the outset that learning mathematics is a very important role for most of the qualifications offered by higher education because mathematics established theoretically and scientifically methods which are applied in different fields. One of the most convincing examples is the mathematical statistics operating with representations of different aspects of reality and say to those who can be counted, measured or quantified. Statistics is to describe, to make predictions and to give credibility to observational data. The statistical methods are used in industry, economy, administration, agriculture, biology, sociology, ecology, medicine, sports.

However both in school education and in university there is a loss of interest in mathematical education. This decrease in interest has several causes. The mathematics is often regarded as a difficult and abstract discipline, accessible to restricted categories of people. That is why we refer to this project that follows an increase in quality of mathematical education. In the conference which marked the launch of the project, referring to this issue, Prof. Constantin Udriste, Dean of the Faculty of Applied Sciences (Polytechnic University of Bucharest) emphasized that in many real-life situations lack of ability is confused with lack of confidence for a more detailed discussion on confidence in learning [6]. Obviously in the rare cases when the mathematical ability is close to zero this cannot always be compensated for by hard work. Another factor which can contribute to the result of learning mathematics is the students’ orientation to learning. For example, students with personal or intrinsic academic orientation, who enjoy exploring new and challenging discipline are expected to get better results in mathematics than students with a vocational or social orientation.

It should not be taken for granted that engineering students understand the need to study mathematics in the first place. ‘When, after the first few lectures of the course, the professor asks the students to complete feedback forms, and about 55% of the students complained that the course was too academic, something in teaching is wrong’, Professor Constantin Udriste said [6]. He continued saying that this general mood is coming from the idea: we are mostly not academics.
but practical engineers; we forget what we are told but never forget what we see or discover for ourselves! It is clear that the professor made at least two mistakes in designing the course. Firstly, the theory was indeed not properly balanced with practical applications. Secondly, the need for the theoretical part was not well explained at the beginning of the course. The professor had to put things right in order to complete the course successfully. There are obvious natural limits to the depth of the mathematical analysis. If we do not set these limits we can, in theory, end up studying topology (the foundations of mathematics) ad infinitum. Our brain may be working very hard, but its direct contribution to the science of engineering would be negligible. On the other hand, there are not so many objects that can be physically touched in modern engineering. For example, one cannot touch the boundary layer of a supersonic aircraft or the inside of a working internal combustion engine. In order to study them one needs to describe them as abstract concepts in terms of mathematical equations. This means that mathematics is indispensable for the engineering community, but the depth of its study is bound to be limited.

4 Mathematics between Tradition and Present

In spite of all criticism of formal lectures they still remain the main teaching method used for teaching mathematics at university. Formal lectures alone are not particularly effective in teaching mathematics because of a number of reasons. Mathematical courses are built in such a way that if a student misses a key concept at the beginning of the lecture, the rest of the lecture can be lost for him/her. Besides, every student has his/her own pace of acquiring mathematical knowledge. The pace of the lecture can be too slow for some students and too quick for others. Finally, formal lectures can deprive students from using their initiative, encouraging surface/atomistic rather than deep/holistic learning. The obvious way of overcoming many of these problems is to give students motivation although in practical terms this can often be difficult to achieve. Many teachers, participants in the project have stressed various methods of teaching - learning mathematics. These may include compulsory reading of the recommended textbooks, detailed handouts, small group teaching and formative assessment. Recommending a particular book as complementary reading often proves to be inefficient. Many students ignore this recommendation and try to base their learning exclusively on the lecture notes. Others start reading but become stuck somewhere and eventually drop the book altogether. It seems that the most efficient way ahead is to link specific sections of the recommended book with the corresponding parts of the course. This can be explicitly indicated in handouts as compulsory reading for a particular topic. Part of the lecture time can be spent on giving an overview of the book material and highlighting the most important concepts. 'I adopted this approach, prof. Udriste continued, and it was well received by the majority of students. The main problem with this reading was unavailability of books in the library and their high cost for students in the bookshops’[6].

In these conditions, the project we refer aims to achieve a high European level in learning - teaching mathematics. Here are some of the project activities:

- developing awareness of the need to harmonize activities curricula for mathematics and related disciplines in the context inter/multidisciplinary;
- the implementation of the harmonization of curricula at the partner universities in the project;
- identifying opportunities in the labor market that require mathematical applications;
- creating the infrastructure of centers;
- developing teaching-learning-assessing resources;
- develop a portal that allows the support of the communication strategy;
- facilitate the creation of innovative resources and dissemination of innovative electronic resources;
- carrying out practical placements in the labor market.

5 Teaching and Learning Strategies

The objectives mentioned above have a high degree of generality and complexity. They are linked to the acquiring of certain skills and attitudes that are specific to the respective subject, objectives that are pursued along several years of study.

In order to achieve the established objectives several types of learning activities can be organized. The syllabus offers at least one example of such activities for each objective. The examples of learning activities are conceived so that they start from the concrete experience of the students to be included into didactic strategies appropriate for the various learning contexts. Here are some of them suggested by Professor Udriste [6]. Some students spent a year working with software packages and were very confident...
in using them. Others had no idea about these packages at all. Any centralized tuition of this group of students, via asking them to perform operations with the code simultaneously, would have been inappropriate. Instead, the professor prepared detailed handouts, describing the tasks expected to be performed by the students, and allowed them to work at their own pace. The professor stayed in class during the whole period of students’ work but he intervened in this work only when he was asked to do so. When several students were seeking for help simultaneously, then the professor was helped by other students who possessed knowledge of the subject. There were no general breaks during the three hours session, but the students were allowed to leave the room and to return at any time provided that they did not produce noise. At the end of the work they prepared the reports which were individually assessed. Since this approach to teaching was not traditionally used, students were asked for their feedback comments. The questionnaires were anonymous, but from the following discussions with students an impression was gained that the unhelpful verdict was made by the most experienced students who thought that they did not gain much of this laboratory. In the future, the professor plans to use the same approach to teaching second year students when their computer experience is about at the same level. Also he plans to introduce more advanced tasks as options to challenge the strongest students.

The curricular reference standards are criteria to be observed for the assessment of the quality of the learning process. They are synthetic statements that are apt to indicate the extent to which the curricular objectives are achieved by the students. In concrete terms, the standards represent the specification of performance targets related to the knowledge, skills and behaviors established by the curriculum. In this context, the general skills have the role of orienting the student after having studied the respective subject. Thus, at the level of each curricular area, the objectives and the strategic and methodological dominants of the curriculum are centered both around the interests of the society and on the interests of the beneficiary of the educational activity, the student. The aptitude for active social integration, combined with a set of personalized attitudes and values, that will enable the graduates to participate in the life of an open and democratic society.

For attaining the goals of Romanian educational system, a student-centered educational process has become a compulsory curricular orientation and consequently the application of certain teaching and learning strategies and of certain methods that should accomplish this aim has become equally impending [5]. The syllabuses for all levels and for all types of learning, also include strategic elements that are meant to serve the goal of forming a new educational profile of the student. Thus, at the level of each curricular area, the objectives and the strategic and methodological dominants of the curriculum are centered both around the interests of the society and on the interests of the beneficiary of the educational activity, the student. Rendering the contents flexible and adapting them to the concrete level of development of the learning activities, are indicative of an approach focused on how well, when and why we learn, what we learn, and the later utility of what has been learnt at the course. The curricular performance standards are criteria for the assessment of the quality of the learning process. They are synthetic statements that are apt to indicate the extent to which the curricular objectives are achieved by the students. In concrete terms, the standards represent the specification of performance targets related to the knowledge, skills and behaviors established by the curriculum.

The curricular performance standards make the connection between the curriculum and assessment. On their basis the levels of performance will be established, as well as the items that are needed for the assessment tests.

The teaching of mathematics educational system in Romania - just like the other European systems - is facing some general requirements whose direction is imposed by the economic, social, political and cultural development, both at a national and international level. The Romanian National Curriculum was devised taking into account the expectations that society has in these conditions from university and which university, in its turn, presents to the young generation during the educational and learning process [4].

These exigencies can be thus summarized:

- The aptitude for thinking critically and divergently which is likely to help the students make good use in different circumstances of the knowledge and skills they have acquired;
- The motivation and capacity to positively react to change, as a premise of personal development;
- The aptitude for active social integration, combined with a set of personalized attitudes and values, that will enable the graduates to participate in the life of an open and democratic society.

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students should be constantly pursued. These orienta-
tions have materialized, on the one hand, in the man-
ner in which contents have been organized, and, on
the other hand, in the types of activities that are meant
to be carried on together with the students for attaining
the curricular goals. Among the didactic methods
that the activities mentioned in the syllabuses and the
use of the new textbooks favor, maybe the most im-
portant are those leading to a new type of communi-
cation between the teacher and the student and among
students during classes. In order to answer the chal-
enges of the future, the Romanian teacher will have
to become a facilitator of the learning process, en-
couraging individual development and increasing the
opportunities of the student for group and self-study.
Besides the planning activities he will have to orga-
nize the group involved in the learning process and
become flexible enough to be able to face unfore-
seen and even temporary situations of conflict. The
teacher will have the opportunity to go beyond the nar-
row, protected framework of the classroom and start to
work together with his colleagues. An integrated cur-
ricular approach, which is gradually built and results
from cooperation during work and from a team spirit
will facilitate the introduction and acquisition more
and more easily transferable. In order to apply the
formal curriculum, an important role must be played
by teacher training.

Besides restructuring the initial training programs
offered by the Universities, a central role in the Reform
of the Romanian education is played by the continu-
ous training of the teaching staff [2]. The two major
directions in the restructuring of teacher training have
been, during the last two years the decentralizing of
the training offer and the increase in its quality.
The modernization of Romanian education will be-
come convincing when the reform will materialize in
the change of the didactic approach in class. This pro-
cess of modernization will have to materialize in the
formal curricular innovation (planning, syllabuses),
elective textbooks, educational tools, the generalized
access to the informational system and the new modal-
ities of information that represent new quality sup-
ports in the coherent application of certain new didac-
tic methods and strategies for which teachers need to
be trained.

6 Summative versus Formative Assessment

The reference to the dynamics and current necessities
as well as to the projected aims of the Romanian edu-
cational system, which are generated by the evolution
of society and are specified in official documents of
educational policy will take into account several con-
ditions:
- the level, the variety and the complexity of the stu-
dent’s educational interests;
- the rhythm of continuous multiplication of the do-
main of knowledge;
- the requirements of shaping the student’s personality
in a changing world.

As a result, the project we have referred in this pa-
per aims to build key competencies of mathematics,
creating skills that each individual needs for personal
development, social inclusion and insertion in the la-
bor market. Under the circumstances required some
basic principles regarding both learning and teaching
are to be stated. Principles regarding learning:

- Students learn in different ways and rhythms.
- Learning presupposes continuous investigations,
effort and self-discipline.
- Learning develops attitudes and skills and con-
tributes to the acquisition of knowledge.
- Learning must start from relevant aspects for the
personal development of the student and for its
inclusion in social life
- Learning can be carried out through self-study
and group activities.

Principles regarding teaching:

- Teaching must generate and stimulate the stu-
dents’ motivation for permanent learning.
- The teachers must create various learning oppor-
tunities, that should facilitate the intended goals’
achievement.
- The teachers must discover and stimulate the stu-
dents’ interests and skills.
- Teaching does not only mean transmitting
knowledge, but conveying moral, behavioral and
attitudinal values as well.
- Teaching must facilitate the transmission of in-
formation and skills from one domain of study to
another.
- Teaching must be carried out in context relating
learning activity to everyday life.

The success of the mathematics teaching can be esti-
mated by some form of assessment. The traditional
assessment, via examinations, may be not particularly
informative, since the students have a right not to take
the mathematically demanding questions. More information about the students’ knowledge could be obtained via self-assessment rather than external assessment. The main restriction of this method is that it has to be applied to a group of students as a whole rather than to individual students. One cannot expect honest answers from the students unless the feedback forms are anonymous.

The main problem with assessments in Romanian technical universities, pointed Professor Udriste, is that they are in most cases summative rather than formative. Students sometimes have little or no idea of why they receive a particular mark. Moreover, they often do not have clear understanding of what is expected from them at the exams. ‘I have attempted to overcome these problems by introducing spot tests for my first year students’, professor said. There were three spot tests during the term. Most of them were suggested during the last 20 minutes of the lectures. Students were asked to solve a problem in class and hand the solution over to me for assessment. They were allowed to use books and any notes, but they were not allowed to communicate between themselves. Sometimes the suggested problems were taken from their homework. This, as well as the fact that spot tests were offered without warning, was intended to encourage students to work consistently during the term rather than just before the exams. If students missed spot tests without good reason then they received zero mark. The averaged mark for the spot tests contributed to the final mark for the subject. The main benefit in the spot tests was not in this mark, but in the individual comments that professor made in students’ papers. In these comments he explained in detail what was wrong and how this could be improved. The aim was to justify each individual mark using the same marking principles as in actual exams’ [6]. Along with this example here are some principles regarding the assessment:

- Assessment is an essential dimension of the curricular process and an actual classroom activity.
- Assessment must combine the use of a wide variety of methods.
- Assessment must be a regulating process that informs the educational agents about the quality of teaching/learning activity.
- Assessment must lead the students to a correct self-evaluation and a continuous improvement of their performance.
- Assessment is based on curricular performance standards, oriented towards the abilities of the student at the end of his/her educational years when he/she is to enter social life.

7 Conclusion

This paper is a plea for a thorough study of mathematical disciplines as part of the curricula of the degree specializations, Masters and PhD. It highlights the contribution of mathematical education to ensure the quality of graduates and to increase performance in the relevant scientific research to various fields of knowledge.

‘Knowledge and innovation are the engines of sustainable growth in Europe today, and universities are crucial for achieving the goals set out by the European Council’, Ján Figel - European Commissioner for Education, Training, Culture and Multilingualism said [1].

The Romanian project to which we have referred - The Training of University Teachers and Students in the Field of Using Modern Tools to Teach-Learn-Assess for the Mathematical Subjects in Order to Acquire Important Professional and Practical Skills for the Labour Market is an answer to the invitation of the European Council that invited national decision makers to set out measures that would enable universities to play a full role in the Lisbon strategy.

References: