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The development and implementation of a pilot internal evaluation procedure for postgraduate engineering courses

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ABSTRACT: New technologies have a vital role in a nation's development. Critical new technologies include information, telecommunications, genetics and advanced materials. University education in these crucial technology areas must be kept up-to-date to facilitate overall national development, particularly at the postgraduate level. In the article, the authors present a self-evaluation methodology on a specific postgraduate engineering course in the critical technological area of advanced materials. The methodology developed has been based on total quality management (TQM) procedures that have been introduced in the higher education sector in Greece.

INTRODUCTION

It is well know that new technologies play an important role in the development of a nation. Among such new technologies, those of information, telecommunications, genetics and advanced materials are considered to be the most critical.

University education in these critical technology areas, especially at the postgraduate level where research takes place, plays a significant role in the overall development of a nation. In this sense, the content of the educational services offered has to keep up-to-date with the most recent technological developments, and to be of a sufficiently high standard. For this reason, the quality of the offered education needs to be constantly monitored and improved.

In recent years, the advanced materials sector has emerged as a high technology area, having serious effects on the competitiveness, growth, employment, trade patterns and location of manufacturing activities. This view has been widely accepted in both industrialised and industrialising countries. Indeed, in many countries, education and research in advanced materials studies have been singled out as a national priority.

It this article, the authors seek to present a methodology by which to evaluate and improve the quality of the educational services offered in Greece, specifically in the field of advanced materials at the postgraduate level.

HISTORICAL BACKGROUND AND CURRENT STATUS OF THE MATERIALS SECTOR IN GREECE

In the period from 1900 to 1940, the Greek mining and materials sector was characterised by the mining and export of raw materials or semi-processed minerals of low added value.

In the period from 1950 to 1975, a rapid growth rate was observed, mainly in the metallurgical sector, dominated by foreign capital and by large industrial units producing mainly Al_2O_3, primary Al, flat steel products and reinforcing steel bars for the construction sector. The ceramic materials sector developed around traditional ceramics, structural, clay products, and white ware ceramics directly related to household and construction activities. The cement industry, on the other hand, developed the offering of high quality products with strong export orientations, while the advanced ceramics sector was non-existent.

Over the last five years, the Greek economy has grown at an annual rate of around 4%, mainly due to big infrastructure projects undertaken for the 2004 Olympic Games and the regional funds given to Greece by the European Union (EU). As a consequence of this, the metallic materials sector has shown satisfactory growth rates with the demand for iron and steel products to increase at an average annual rate of 11% over the last ten years. The Al industry has also been performing very well in two main areas, namely: Al extruded products for the construction sector and Al rolled products mainly for packaging.

EDUCATIONAL SERVICES IN THE AREA OF MATERIALS TECHNOLOGY

Formal education in the area of materials science and engineering at the university undergraduate level exists at four universities in Greece. The National Technical University of Athens offers a degree in metallurgy and mining. Three new departments in the area of Materials Science at the regional Universities of Creta, Ioannina and Patras, respectively, have been initiated during the last three years. At the postgraduate level, few national universities offer specialisation and postgraduate courses in the area of materials.

There is a great interest by various stakeholders (government, industry and universities) to improve the quality of educational services in the area of materials science and engineering. A recent market analysis was conducted in order to evaluate the demand that exists in various industrial sectors in Greece in the area of materials; this produced very interesting results.

In this article, the authors discuss these aspects and propose specific actions to improve the educational environment in the industrially critical area of materials technology taking into consideration the industry's view regarding their needs and knowledge requirements.

Concerning the postgraduate teaching in the area of *Processes and Technology of Advanced Materials*, the evaluation method developed aims to improve the teaching process and the appropriate preparation of graduate students for the specific demands of the labour market.

EVALUATION OF EDUCATIONAL QUALITY IN GREECE

According to a report on educational policy in Greece by the Organisation for Economic Co-operation and Development (OECD), the evaluation of higher education can be carried out by the specific use of performance indicators so that there is a guarantee for high-level services at the university level [1]. The report proposes the creation of an evaluation technique that will include an assessment to be carried out by students and an in-depth examination of the contents in every subject. By doing so, universities are put in the position to develop their own self-evaluation procedures and improve their performance.

This framework takes into consideration the experiences of other universities that have implemented in their structures total quality management systems and quality assurance systems [2-5]. The authors have designed a methodology of internal evaluation of a postgraduate course. This methodology is based on international standards [6][7]. The target of this is the improvement of the course's level and effectiveness and the contribution towards the implementation of the methodology in other postgraduate courses.

The specific objectives of the procedure are to introduce a self-assessment process that will enable a continuous evaluation and guarantee a high standard at postgraduate level education. This study is focused in the course of *Processes and Technology of Advanced Materials* offered by the Engineering School at the Aristotle University of Thessaloniki in Thessaloniki, Greece.

METHODOLOGY

The evaluation process was based on the assumption that every *party* of the postgraduate course (students, teachers and staff) should participate in the evaluation process and should be committed to contribute with their suggestions and actions to improving the course [2-5]. The data utilised was based on information provided through questionnaires, interviews, discussions and tests.

More specifically, the data was based on questionnaires that were given to students, interviews with both students and teaching staff, discussions on a personal as well as group basis with all parties involved. Moreover, students tests on knowledge and skills acquired throughout the course gave a thorough insight concerning the teaching-learning process [2-8]. Additionally, an in-depth assessment of the curriculum content was attempted.

The information obtained was analysed and classified in terms of three qualitative aspects, namely:

1. The inputs of the educational system;
2. The process of teaching-learning;
3. The output of the educational system.

A self-evaluation model was developed based on the three above-mentioned aspects, as listed in Table 1.

The *inputs* to the system include each student's profile, student-teacher ratios and administrative and technical support, as well as the course content itself.

The teaching-learning *process* has been assessed through tests applied to students, as well as logistical support for teaching purposes.

The *output* of the educational process has been assessed through an examination of the labour market demand. This was provided via questionnaires given to industries in the specific field and an assessment of a graduate's opportunities in the labour market.

Student Profile

The majority of the ex-postgraduate students were male (73%) and came from the Thessaloniki area (89%) where they had studied their undergraduate studies.

The age range of the ex-students was between 28 and 32 years old.

Assessment of the Postgraduate Course from the Ex-Student's Viewpoint

Most students (88.9%) responded that the teachers and staff substantially helped them during the course of their studies and that the course responded to the academic expectations of the students.

Contribution of the Postgraduate Course in Their Professional Career

It has been widely recognised by most ext-postgraduate students that the course, *Processes and Technology of Advanced Materials*, deals with a critical and rapidly developing scientific area, and that it responds to the needs of modern Greek and international industries.

However, the completion of the course did not prove to be a determinant in their subsequent incorporation in the labour market. The knowledge acquired in the course has not contributed to their actual job requirements since only a small percentage of them found placement in a relevant field.

The Process of Teaching and Learning

The questionnaire applied to students and ex-students helped to assess the quality and content of the course from the point of view of the receptors. They assessed the level of academic

Table 1: Aspects considered in the development of the self-evaluation model.

Aspects of Quality	Indicators	Criteria
1. Input	1.1.Student profiles	Gender, age, geographical origin, previous education, qualifications, professional experience, aspirations
	1.2. Teaching staff	Qualifications, professional experience, self-development on teaching
	1.3. Administrative and technical staff	Number of staff/number of students, contribution of staff to good operation of the course, general organisation of the course
	1.4. Physical facilities	State of workshops, laboratories, classrooms, library
	1.5. Intentions and planning of the course as expressed in studying guide of the postgraduate degree course	Context of the course, aims and objectives, structure, content, teaching methods, criteria for assessment
2. Process of teaching and learning	2.1. Forms of teaching utilised in the acquisition and transfer of knowledge	Scope of lectures, organisation of seminars, practical work, etc
	2.2. Students' assessments	Means of assessment (multiple choice, open questions, entrance test of prior knowledge and skills of students compared to middle and final test), ways of assessment (sectionals, finals)
3. Outputs	3.1. Survey of ex-students' destinations	Main destinations in industry or continuation of studies
	3.2. Graduate destinations	Degree of similarity with the context of the course
	3.3. Examination results	Comparison with examination results of previous students
	3.4. Employers' views of graduates	Sufficient enough for the demands of the labour market, degree of practicability of acquired knowledge and skills
	3.5. Reports from external examiner, inspectors and professional bodies	Emphasis on the strengths and weaknesses of the course Comparison of the results to the conclusions of the self-evaluation model

support and communication with the teaching staff. In relation to the taught courses, they assessed whether the different subjects overlapped, the availability of reading material and laboratory equipment, the participation of students in the teaching-learning process and the examination procedure.

Proposals were devised to improve the course. They were based on ISO 9001 standards. The response of the teaching staff regarding students' proposals related to the content of the courses was also assessed.

More specifically,

- Most ex-students chose the specific postgraduate course for career purposes due to the fact that it was a new and critical field in Greece (89%).
- The specific contribution of the postgraduate course in their subsequent professional career generally shows that the expected outcome did not materialise. In fact, 29% of the graduates mentioned that the specific course did not help them to find employment, whereas the same percentage stated that it marginally helped. Only 18% affirmed that the specific course had substantially contributed to their employment placement. In terms of the knowledge acquired, only 30% considered that the specific course had substantially contributed to their actual job demands.

Outputs of the System

Based on the survey of ex-students' destinations, job placement and degree of relevance with the content of the course, the authors have reached conclusions concerning the strong and weak points of the course.

The strong points are as follows:

- The course provides new knowledge in a critical technological area;
- The course generally responds to the needs of the Greek and EU industries;
- The course content responds to the academic expectations of the students.

The weak points are as follows:

- The course did not have enough liaisons with potential employers;
- The course did not offer sufficient information about future employment opportunities.

Based on a survey made on 300 industries in relation to the employment of engineers in the field of materials engineering, interesting conclusions were reached. The questionnaire was answered by 207 general managers in the industrial sector in Greece. The objective of the questionnaire was to determine if there is a need for the creation of a degree in materials engineering in Greek universities and, if yes, to foresee the future of materials engineers. The questionnaire had both multiple choices and open questions.

The level of employment demand for metallurgical, ceramic and materials engineers is expected to increase faster than any other engineering specialisation for the decades following the year 2000. It is envisaged that the majority of the market demand will be a result of the need to replace engineers who have moved to other fields.

Most of the metallurgical engineers, ceramic engineers and materials engineers will be needed by manufacturing industries

in order to develop new applications, products and processes. For example, metallurgical engineers will be needed in the future to develop new methods to recycle waste materials and low quality minerals, since the level of high quality minerals are expected to decrease. More materials engineers and ceramic engineers will be needed in order to develop advanced materials and products.

CONCLUSIONS

There is a great need and market demand in Greece to offer high quality postgraduate education in the area of the processing and technology of advanced materials. The developed internal evaluation procedure proved to be capable of assessing the quality of the offered postgraduate course in this area. It involved all the concerned parties (students, teachers and industry) and was efficient in pinpointing the strengths and weaknesses of the teaching process.

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