EMQAL: ERASMUS MUNDUS MASTER IN QUALITY IN ANALYTICAL LABORATORIES

MIQUEL ESTEBAN* AND ÁNGELS SAHUQUILLO+

Departament de Química Analítica, Facultat de Química, Universitat de Barcelona (UB), Martí i Franqués 1-11, 08028 Barcelona, Catalonia, Spain.

This manuscript is dedicated to the memory of Prof. Ramon Companyó (1951-2014). His efforts, enthusiasm and humanity have been crucial for EMQAL project.

ABSTRACT

The Erasmus Mundus Master in Quality in Analytical Laboratories (EMQAL) is a two-year Joint Master Degree. The course is funded by the European Commission through the Erasmus Mundus Programme, providing a number of attractive scholarships for European and non-European students. EMQAL prepares professionals for analytical laboratories, focusing on laboratory management and quality systems, along with complementing their technical knowledge. The EMQAL aims at training students in the most relevant issues concerning quality systems and management in analytical laboratories, and to become an expert in: Quality management, Analytical methods and Data Analysis. EMQAL promotes mobility. The students will attend one academic year of lectures in one of the European universities of the EMQAL consortium, and a 12 months master thesis at other European university, with the possibility to spend three-months in one of the non-EU partners. The language of instruction and examination is English. Further information is available at www.emqal.org.

INTRODUCTION

The Erasmus Mundus Programme (EMP), which is at present integrated inside the Erasmus+ Programme 2014-2020, was created by EU in 2004 to promote the cooperation between EU and non-EU higher education institutions (HEI) and the mobility of students. Main objective is the mobility of the most brilliant non-EU students towards European HEI. EMP represents the enhancement of the Erasmus Programme beyond Europe. The Erasmus Programme was created in 1987, and it is still active. It has been a huge academic and sociologic success in Europe. The name of the Programme is in honour of Desiderius Erasmus Roterodamus (1466 – 1536), known as Erasmus of Rotterdam, or simply Erasmus. He was a Dutch Renaissance humanist, Catholic priest, social critic, teacher, and theologian. Erasmus performed his academic career, as student and professor, in many universities around Europe. The chief centres of Erasmus’s activity were Paris, Leuven, England, and Basel. He was selected as an example of intellectual activity beyond borders.

EMP supports Erasmus Mundus Master Courses (EMMCs) that are selected by means of a very exhaustive selection process. EMQAL was chosen inside EMP by the first time at 2007 Application Call and reselected at 2012 for five more editions. The 7th EMQAL edition has started in the academic year 2014-2015.

Aims of EMQAL

EMQAL prepares professionals and scientists for analytical laboratories, focusing on laboratory management and quality systems, along with complementing their scientific and technical knowledge.

Analytical laboratories play a critical role in all aspects of modern society: in public health, in medicine, in the environment and even in trade. Analytical laboratories are called to provide information that makes the basis for decisions. There is a growing need to assure the quality and reliability of analytical laboratories in all countries of the world.

EMQAL project was born as an initiative of the University of Algarve, and in particular of Prof. Isabel Cavaco. EMQAL has been the pioneer project in European Higher Education for Quality in Analytical Laboratories.

Main figures in EMQAL

EMQAL is offered by a Consortium constituted by a number of partners, five European and three non-European Universities (Table 1), and ca. 20 associated partners (Table 2) including private companies, official laboratories, research institutes, national bodies and associations, as well as non-European universities in Brazil, Chile and India.

The program duration is 2 years (120 ECTS, European Credits) consisting of a 1 year taught course (60 ECTS) and 1 year of research project and thesis (60 ECTS).

First academic year (60 ECTS)

The taught course is made of stand-alone modules of 2 ECTS, which corresponds to ca. 50 hours of workload by a standard student. A typical module of theoretical classes corresponds to 10 hours of lecturer’s classes. In some cases, if some practical work is included in the module, the student-lecturer contact time (classes) can be enlarged to ca. 15 hours. The classes are concentrated in 4 – 5 days, because of the mobility of the lecturer from his/her own university to the host one. The rest of student’s time, until the named 50 hours, is required for study, preparation of exam, assignments to pass the module, etc.

During a week the student can attend one or two modules, maximum. After one month of finishing the classes, the student must provide the assignments or the exam, depending on the characteristics of the module.

The modules are distributed into three blocks of modules concerning: i) quality management (QM), ii) analytical methods (AM), and iii) data analysis (DA). Among the 30 modules (60 ECTS) selected by the student, at least 5 of each block must be chosen. Out of this, the student has the freedom to select the modules according to his/her field of interest.

Students are allowed to build their study plan according to their own interests and needs. Classes take place in one of the European Universities of the consortium and are lectured by lecturers from all the partner institutions and specialists from public agencies, private companies, etc. The Host University rotates every year (Table 3).

Table 4 shows an example of the list of modules offered to the students. This list can suffer some slight changes year to year, but most of the modules are offered every year.

Second academic year (60 ECTS)

In the second year each student moves to an EU-university of the Consortium located in a different country to complete a research master thesis project (1 year) or two EU-universities (6 months each), but for an unique research and thesis project. Part of the research project (a maximum of 3 months) can be done in one of the non-European institutions of the Consortium in Brazil, Chile, China or Russia. Research projects are proposed each year by the partner institutions in the fields of laboratory accreditation, quality management, analytical methods and data analysis. These theses are integrated in on-going research projects in the Universities of the Consortium and may be offered in collaboration with public agencies and private companies (Associated Partners).

As an example, Table 6 summarizes the research master thesis projects selected by students of 2013-15 EMQAL edition.

At the end of the two-years EMMC, students will be awarded a joint diploma with a joint diploma supplement, when national (changing) regulations allow it.
EMQAL is an excellent Master Course as proved by the selection as EMQAL and three other EMMCs were selected by the Action 3 Erasmus Mundus Programme (EMP). As a consequence, EMP provides a number of attractive scholarships for European and non-European students. Characteristics of these scholarships are summarized in Table 7. The number of studentships is fixed by the European Commission through the Erasmus Mundus Programme (EMP). As a consequence, EMP provides a number of attractive scholarships for European and non-European students. Characteristics of these scholarships are summarized in Table 7. The number of studentships is fixed by the Education, Audiovisual and Culture Executive Agency (EACEA) at Brussels and changes year to year.

The Selection criteria for these studentships follow the general rules of EMP. All eligible candidates to EMQAL are evaluated and ranked according to the following criteria:

A. Academic Excellence: Quality of previous qualifications - evaluates the academic curriculum of the candidate: previous degrees, post-graduate courses, specialization courses, scientific publications.
B. Proficiency in languages of the consortium, particularly English.
C. Motivation and Potential - measures the benefit to the candidate from the Master.
D. Suitability - match between the candidate’s profile and the Master. Appropriate professional experience is evaluated.
E. Recommendations - based on the confidential evaluation of the candidate by two referees.

Each criterion A-E is scored 0-5. Only very high quality candidates, with all criteria above 3.5, are accepted to the course. The scores for all criteria are summed, and candidates are ranked by order of merit according to their global score (17.5-25.0).

This evaluation is made by a Selection Committee composed by representatives from each of the EU-partner universities in EMQAL. The results are published in the website as a pre-selection list of candidates to EMQAL. The pre-selection is sent to the EACEA, who will give the final approval of the candidates selected for Erasmus Mundus studentships.

Eligible candidates (not awarded by one of the restricted number of EM scholarships) can obtain an Admission Letter to EMQAL in order to apply for national or private grants programmes.

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### Table 4: Modules proposed in the 2013-14 academic year at UB (6th EMQAL Edition).

**Quality Management (QM) - 23 modules**
- QM001 - Quality Management
- QM0011 European Quality Policy and Infrastructures
- QM0012 Introduction to Quality Management
- QM0013 Laboratory Quality Systems: ISO/IEC 17025
- QM0014 HACCP and ISO 22000
- QM0015 Good Laboratory Practice
- QM0016 Laboratory Quality Systems: ISO 15189

**QM02 - Management**
- QM0022 Human Resources
- QM0023 Managing Installations, Equipment and Consumables
- QM0024 Quality Systems Documentation
- QM0025 Laboratory Information Management Systems (LIMS)
- QM0026 Risk assessment

**QM03 - Traceability**
- QM0032 Calibration and Verification
- QM0033 Laboratory Audits (EN ISO 19011)

**QM07 - Safety**
- QM0070 Safety and REACH regulations

**QM08 - Postgraduate skills**
- QM0082 IT Tools
- QM0083 Laboratory Skills
- QM0084 Fieldwork Skills: practical implementation of quality management Systems
- QM0085 Research Skills
- QM0086 Language course - Intensive Spanish course

**Data Analysis (DA) - 13 modules**

**DA01 - Basic Statistics**
- DA0011 Measuring variability and Error Propagation
- DA0012 Regression Analysis
- DA0013 Statistical Decision and Analysis of Variance
- DA0022 Uncertainty measurement
- DA0023 Introduction to Uncertainty Measurement
- DA0024 Uncertainty Measurement in Chemical Tests
- DA0025 Uncertainty Estimation in Clinical Analysis

**DA03 - Chemometrics**
- DA0031 Experimental Design and Optimization
- DA0032 Pattern Recognition and Classification
- DA0033 Fundamentals of Multivariate data analysis
- DA0034 Latent Variable Regression Techniques
- DA0035 Process Analysis: modeling and non-linear parameter fitting
- DA0036 Multivariate Analysis of Metabonomic and Proteomic Spectral Profiles
- DA0037 Curve Resolution

**Analytical Methods (AM) - 34 modules**

**AM01 - Natural Water Analysis**
- AM0011 Water Directive and CEN Standards
- AM0012 Water - Sampling and general characterization
- AM0013 Water - Metal Analysis
- AM0014 Water - Analysis of Organic Components
- AM0015 Water - Microbiological Analysis

**AM02 - Food Analysis**
- AM0021 Foods – Sample treatment
- AM0022 Functional Foods Analysis
- AM0023 Foods - Microbiological analysis
- AM0024 Determination of toxic substances migration from the packaging to food

**AM03 - Clinical Analysis**
- AM0031 in Vitro Directive and CEN Standards
- AM0032 Medical Microbiology

**AM05 - Environmental Analysis**
- AM0050 Trace Metal Water Speciation
- AM0051 Soil and Sediment Analysis
- AM0052 Environmental samples monitoring

**AM07 - Biochemical Analysis**
- AM0070 Immunnoassays

**AM08 - Sampling**
- AM0080 Design of Sample Strategies and sampling techniques

**AM09 - Advanced Techniques of Analysis**
- AM0090 Molecular Spectroscopy
- AM0091 Vibrational Spectroscopy
- AM0092 Quantitative IR Spectroscopy
- AM0093 Atomic Spectroscopy
- AM0094 Mass spectrometry
- AM0095 Hyphenated techniques
- AM0096 Introduction to the Electroanalytical techniques
- AM0097 Automated methods of analysis
- AM0098 Gas Chromatography
- AM0099 Liquid Chromatography
- AM00910 Extraction Methods in Analytical Chemistry
- AM00911 Quality Parameters and Optimization in Chromatography
- AM00912 Application of Nanomaterials in the Analytical Laboratory
- AM00913 The practice of Capillary Electrophoresis: optimization and method development
- AM00914 Green Analytical Chemistry

### Table 5: Learning Outcomes.

1. Design, implement and manage a Quality System in any given testing or calibration analytical laboratory;
2. Develop and evaluate a quality control scheme for any given type of measurement;
3. Fully understand, both at theoretical and practical level, a set of advanced analytical techniques;
4. Research, develop and validate new techniques and methods of analysis;
5. Plan a validation program for a given method of analysis;
6. Identify critical aspects in a given method of analysis
7. Estimate the uncertainty for a given analytical result;
8. Develop Reference Materials;
9. Organize and evaluate Collaborative Studies;
10. Fully understand the current state of worldwide standardization and comparability of analytical results.

Note: These competencies can be attained in different environments, for example in the context of a clinical laboratory, or a laboratory for drinking water quality control. Students can obtain these competencies by taking 30 modules, chosen from a large set of modules that are offered in the master.

### Table 6: Research master thesis projects in course (2014-2015).

- GC/MS validation method for analysis of Chlorinated hydrocarbons in underground water (UAlg).
- DRIFT and DR-UV/vis spectroscopy methods for studying the interaction of vanadium compounds with cellulose (UAlg).
- Metal Complexes as therapeutic drugs (UAlg / CQE).
- Analysis of organic contaminants in water intended for human consumption – analysis by GC-TOFMS with different sample preparation techniques (LLE, SPE and SPME) (UAlg / EPAL).
- Pharmacogenetics analysis of drug metabolizing enzymes as risk factors for breast cancer (UAlg).
- Pharmacogenetics analysis of drug metabolizing enzymes as risk factors for colorectal cancer (UAlg).
- Interlaboratory comparisons in the analysis of new reference materials (UAlg / GUT).
- Raman spectroscopy studies of polychlorinated biphenyls (PCBs) effects on phospholipid liposomes (UiB / Inst. Marine Research).
- Development of extraction methods for the analysis of chemical composition from the different parts of citrus fruits (UiB / UCA).
- Analytical study of the compounds from different woods employed in the ageing of wines (UiB / UCA).
- An investigation of the chemistry involved in adding water to whisky (UiB...
Impact of omega 3 and omega 6 polyunsaturated fatty acids on the production of cyclo- and lipo- oxygenase mediated metabolites in fish cell culture experiments (NIFES / UiB).

Comparison of new methods for determination of phenolics in vegetables (GUT / UCA).

New analytical methods for bioactive components in foods (GUT / UCA).

Food additives analysis (GUT/USP (Brasil). BCE: Bergen University College. Faculty of Engineering (Norway); CQE: Centro de Química Estrutural (Portugal); CSU: Central South University (China); EPAL: Empresa Pública de Aguas Livres de Lisboa (Portugal); GUT: Gdansk University of Technology (Poland); IMR: Institute for Marine Research (Norway); NIFES: National Institute of Nutrition and Seafood Research (Norway); UAlg: University of Algarve (Portugal); UiB: University of Bergen (Norway); UCA: University of Cadiz (Spain); USP: Universidade de Sao Paulo (Brasil).

Table 7: Details on the EM studentships.

**Payment of the participation costs for the whole EMQAL programme**

- Including the tuition fees and the full insurance coverage

**Contribution to subsistence costs** ($1000/€/month for the entire duration of the EMQAL study programme; 24 months).

Contribution to subsistence costs will not be given to the scholarship holders for the JMD (study / research / placement / thesis preparation) periods spent in their country of residence.

**Contribution to the travel and installation costs:**

- 1.000€ per year per scholarship holder resident of a Programme Country (see NOTES) for travel costs.
- 2.000€ per year for travel costs + 1.000€ for installation costs for scholarship holder resident of a Partner Country (see NOTES) whose location is situated at less than 4.000 km from the JMD coordinating HEI (University of Barcelona).
- 3.000€ per year for travel costs + 1.000€ for installation costs for scholarship holder resident of a Partner Country whose location is situated at 4.000 km or more from the JMD coordinating HEI (University of Barcelona).

**NOTES:**

**PROGRAMME COUNTRIES**

- Member States of the European Union (EU)
- Non EU Programme Countries: former Yugoslav Republic of Macedonia, Iceland, Liechtenstein, Norway, Switzerland, Turkey

**PARTNER COUNTRIES**

- The rest of countries (for more information consult Part B of the Erasmus+ Programme Guide).