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A NEW CHEMISTRY CURRICULUM IN A NEWLY FOUNDED UNIVERSITY: DESIGN UNDER CONSTRAINTS

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ABSTRACT: This presentation will discuss the difficulties and challenges involved in setting-up a new chemistry curriculum, in a newly-founded University, in a country where no university existed prior to its establishment. Parameters that influenced choices made, included space (especially laboratories) limitations, staffing problems leading to the use of visiting staff, the need for frequent reorganisation of the course (moving courses from one semester to the next) depending on the availability of visiting staff, and the likely employment of future graduates. [*Chem. Educ. Res. Pract. Eur.*: 2000, 1, 295-302]

KEY WORDS: *new chemistry department; course development; course structure; postgraduate degree programme*

INTRODUCTION

The Republic of Cyprus was established as a sovereign state in 1960, after several decades as a British colony, and prior to that after 300 years under Ottoman rule. The population of the island consists of a majority (82%) of Greeks and a sizable minority (18%) of Turks, plus small numbers of Armenians, Maronites, Latins, etc. The Cyprus Constitution recognising the cultural and religious differences of the two larger communities (Greek and Turkish), gave jurisdiction on educational and religious matters to the so-called community assemblies. Thus, the pre-existing arrangement of separate schools (primary and secondary) for Greek-Cypriot and Turkish-Cypriot children continued after independence. After several discussions which ensued regarding the setting-up of a university (or universities) either by one or the other community or bi-communally, it was decided that no university was necessary on the island, and its youth was encouraged to look elsewhere for post-secondary education. Thousands of young Cypriots have been educated in Greek, Turkish or British universities, but also in those in several other countries.

The thinking on this issue by the government of the Republic of Cyprus changed after the events in 1974, which led to the continuing occupation by Turkey of a large portion of the island. As early as 1976, a committee was set-up to report on the question of setting-up a 'University of Cyprus'. Whilst that and several subsequent reports concluded that such an institution should be established, no action was taken. A new advisory committee (the so-called preparatory committee) was established in 1988. It produced a report as a result of

which legislation was introduced in the House of Representatives which was voted unanimously into law in 1989. Thus, in 1991 the first members of academic and administrative staff were appointed, and the University admitted its first students in September 1992.

The University of Cyprus was established by the internationally-recognised Government and not by the Greek-Cypriot community, and therefore has two languages of instruction, Greek and Turkish. Members of both communities (as well as others) are welcome to attend provided they can fulfill the entrance requirements. The reality is, however, that the vast majority of students are Greek-Cypriots, and only a handful are Turkish-Cypriots: this is not the wish of either the University or the Government, but is the consequence of the currently existing complete separation of the two communities. The University was founded in response to the growing intellectual needs of the Cypriot people, and is well placed to fulfil the numerous aspirations of the country. The University is the only such institution in the island, but several tertiary colleges do operate, some governmental, but also several privately owned, but none recognised by the Government as universities. Admission to the University is highly sought, as it is evidenced by the number and calibre of its applicants. The ratio of candidates to admissions is 10 to 1. Admission is through examinations organised by the Cyprus Ministry of Education and Culture.

The main objectives of the University of Cyprus are twofold: the promotion of scholarship and education through teaching and research, and the enhancement of the cultural, social and economic development of Cyprus. In this context, the University believes that education must provide more than simply accumulation of knowledge. It must also encourage the active participation of students in the process of learning, and the acquisition of those values necessary for responsible and active involvement in the community. The University sets high standards for all branches of scholarship.

THE ESTABLISHMENT OF THE DEPARTMENT

Cyprus is a small country (island) with no heavy or primary chemical industry. Any industry that does exist, consists mainly of small family owned companies producing products such as pharmaceuticals, agrochemicals, fertilisers, food and beverages, cosmetics, plastics, paints, household cleaning goods etc., from imported raw materials. Little or no formulation is involved in the process, and certainly no synthesis. However, most of the industry is chemical in nature. In addition to the above, there is also a refinery, but also cement and bricks manufacturers, etc. Cyprus was known in antiquity for its copper mines (the Latin name *cuprum* comes from the Greek name for Cyprus) as well as iron, gold and silver mines, but little mining activity is still running. Chemists are mainly employed in industry, biochemical laboratories (blood analysis etc.), government laboratories, and education. In contrast to physics, mathematics and biology, few chemists are employed in education, the majority being employed in other fields.

Given the obvious importance of chemistry for the Cypriot economy but also for education, it was chosen to be among the first topics to be offered by the newly-founded University. However, cost considerations led to the decision of pairing chemistry with physics (and probably biology) into a unitary department, which was called the 'Department of Natural Sciences'.

The Department of Natural Sciences accepted its first students in 1993 into its Physics degree programme. The first Chemistry undergraduates were admitted in 1994. The delay in admitting students to the Department was due to the time needed for setting up laboratories

necessary for undergraduate instruction. It was decided to admit students into the Physics programme ahead of Chemistry, because the number of physicists in the academic staff was higher than the number of chemists. The initial number of academic staff when the degree programmes were first ran, was six for physics and five for chemistry. The current so-called 'steady state' is ten members of academic staff in physics, and eight in chemistry, with a further two chemistry positions vacant at the moment, but which will be filled soon.

THE BASIC UNIVERSITY RULES

It is important to set out the basic rules that govern teaching at the University of Cyprus, to the extent that they impinge upon the design of the Chemistry Degree Course. The University of Cyprus has adopted the semester system. Degree courses are of four years (eight semesters) length, and students can only be enrolled for a maximum of six years. Autumn semesters are of 13 weeks duration, and spring semesters of 14. At the end of each semester there is an additional examination period. Each course (set of lectures, seminars, laboratory sessions, etc.) has a number of credit units (3 to 4), and students have to collect 120 of those for a degree. One credit unit, represents roughly one contact hour. It is expected that each member of academic staff will teach about 3 courses per academic year. 12 to 15 credit units in the curriculum represent free university electives not from the main field of study of the students. These rules put a maximum on the course load of the student, and present a constraint on course content.

Each course is assessed separately, using at least two different appraisal methods, one being an obligatory final examination. A final examination may not be necessary for a laboratory based course. The final degree mark and classification is obtained by the weighted average of all courses taken, the weight of each being the course credit.

FACTORS AFFECTING COURSE DEVELOPMENT

It is important to appreciate that the first chemistry undergraduates were admitted into the Department of Natural Sciences at a time when only a small number of academic staff were in place (three of the five appointed). This number was sufficient for the first year of operation (1994-1995), but in subsequent years, it was necessary to attract good quality visiting staff to cover the teaching needs, whilst in the meantime more staff were recruited.

The starting point for the design of the degree course was obviously similar courses at universities in Europe and the United States with which the academic staff were familiar. Detailed course descriptions and course syllabi were obtained. Special attention was paid to chemistry degree courses in Greek universities, given the cultural, linguistic and other similarities as well as the geographical proximity of Cyprus and Greece.

Students from Greece gain entrance to the University via the nationwide entrance examinations for the Greek universities. Given that, it is necessary for the curricula of the University of Cyprus to be not too dissimilar from those of the Greek universities.

However, the Cyprus environment (cultural, academic, industrial, financial, etc.) is unique, and thus various other factors have been taken into account in designing the course, and are described below.

The vast majority of students at the University of Cyprus have gone through the Greek-Cypriot school system. A smaller number (*ca* 10%) have come from mainland Greece, and there is only a handful of 'foreign' students. The medium of instruction is Greek, and

therefore the University does not easily attract students from other countries, whose mother tongue is not Greek.

The chemistry curriculum in secondary schools has to be taken into account, since it defines the level of the first year students. Students come to University with good backgrounds in mathematics and physics, but less so in chemistry. Further, the final year curriculum in Cyprus *lyceums* is devoted wholly to organic chemistry.

Space (especially laboratories) limitations are very severe, and combined with the small number of teaching staff available, defines the upper limit of possible contact hours. Laboratories are small in size, with limited storage space. Thus, even a class of 30 (a typical size), has to be broken into two groups, therefore doubling the number of contact hours.

As mentioned above, the academic staff establishment for chemistry is ten, but two positions are vacant and one newly appointed lecturer has not yet taken up his position. Vacancies will be filled with visiting professors. The small number of staff, and the changing faces, has influenced curriculum development. There is need for frequent reorganisation of the course (moving courses from one semester to the next) depending on the availability of visiting staff.

The small number of students per semester is another limiting factor as to the course curriculum. The number of students determines to a large extent the number of academic staff, through use of a 'full-time equivalent' equation. Thus, a number of 25 students per year, gives the number of ten academic staff. The problem arises with the need to offer advanced chemistry electives to final year students. These are necessary in order to broaden their horizons and familiarise them with the more advanced aspects of the subject. However, the limited number of staff and the impossibility (and impracticality) of teaching classes as small as three to five students put a limit to the number of electives.

THE CHEMISTRY DEGREE COURSE

In order to make the running of the Chemistry Degree Course possible during the first few years of operation (academic years 1994-5, 1995-6, and 1996-7), the first two semesters were joint with the Physics Degree Course. Students were admitted to the common first year, and only declared their choice of chemistry or physics, at the end of the second semester. In each of the two semesters, students took one chemistry course (inorganic in the first and physical chemistry in the second), one physics course, and the corresponding laboratory classes in the two subjects. In addition, courses were taken in mathematics from the Department of Mathematics and Statistics, and in computer science from the Department of Computer Science. In addition, a course in mathematical methods for natural sciences was offered by the Department of Natural Sciences. It soon became apparent that this regime did not prepare the students well for the second and subsequent years of the Chemistry Degree Course. Therefore, for the academic years 1997-8 and 1998-9, only the first semester was common with the Physics Course. Students declared a choice between chemistry and physics during the first week of the first semester. Students joining the University in September 1999 will have declared their choice of degree at the time of enrolling for the entrance examinations.

Table 1 shows the current Chemistry Degree structure. All courses are compulsory. In the final year, students choose courses from a list of chemistry electives as shown in Table 1. In addition, as described above, students have to take four university electives of their choice, chosen from courses offered by departments in at least two faculties. The Course is divided into two sections: core chemistry during the first five semesters, and advanced chemistry in

TABLE 1. *Chemistry degree course (120 credits plus 2 courses -6 units- of foreign language).*

1st Year			
NAT 111	General Physics I	NAT 281	Analytical Chemistry I
NAT 511	Laboratory Physics I	NAT 552	Analytical Chemistry Lab
NAT 151	Inorganic Chemistry I	NAT 271	Organic Chemistry I
NAT 551	General Chemistry Lab	MAS 002	Mathematics II
MAS 001	Mathematics I	EPL 001	Computer Science
2nd Year			
NAT 161	Physical Chemistry I	NAT 262	Physical Chemistry II
NAT 282	Analytical Chemistry II	NAT 252	Inorganic Chemistry II
NAT 553	Organic Chem. Lab I	NAT 272	Organic Chemistry II
NAT 554	Physical Chemistry Lab I	NAT 555	Inorganic Chemistry Lab
University Elective		NAT 556	Organic Chemistry Lab II
		University Elective	
3rd Year			
NAT 363	Physical Chemistry III	NAT 353	Inorganic Chemistry III
NAT 391	Biochemistry I	NAT 392	Food Chemistry
NAT 273	Organic Chemistry III	NAT 393	Chemical Technology I
NAT 557	Physical Chem. Lab II	NAT 392	Biochemistry II
University Elective		University Elective	
4th Year			
NAT 451	Project I	NAT 452	Project II
NAT 558	Food Chemistry Lab	NAT	Chemistry Electives
NAT 394	Chemical Technology II	NAT	Chemistry Electives
NAT	Chemistry Electives	NAT	Chemistry Electives

Chemistry Electives for the 4th Year: Catalysis / Polymers / Surface Chemistry / Organometallic Chemistry / Stereochemistry

the final three semesters. Courses taken in this last part include special topics such as chemical technology, food science and biochemistry, advanced chemistry electives (e.g. organometallic, polymers, surface chemistry, catalysis, advanced, etc.), and a two-semester-long final year project.

The choice of advanced courses was dictated by local needs for specialised chemical knowledge, and the special interests of the academic staff. From an examination of Table 1, it is apparent that no pedagogical courses are included. Those graduates who wish to become secondary school teachers upon graduation, have to undergo a teachers training programme organised jointly by the Department of Education of this University, and the Ministry of Education and Culture. It is also possible for students to take relevant courses as some of their university electives.

Final Year Project

The final year project has a special role to play in the Degree Course. Students work under the close supervision of a member of the academic staff of the Department, concentrating on a specialised topic, which they choose from a list. While carrying out the

project, the student learns to search and study the relevant literature, to present seminars to his/her fellow students in a clear and concise way, and to record and report conclusions. The projects can be experimental, theoretical or computational in nature. Whereas the final year project work does not have to be original, the Department expects the more capable students to be involved in the research programmes of their supervisors.

For chemistry undergraduates the final year project is a compulsory part of the curriculum, as it is a vehicle for introducing the students to advanced topics of modern chemistry. It also allows them to work independently, to learn to use library and other sources of information, as well as giving them a flavour of what 'real chemistry' is like. The most important aspect of the final year project is that it allows students to work on open-ended problems. In addition, it provides students with valuable additional laboratory experience.

POSTGRADUATE DEGREE PROGRAMME

The Department of Natural Sciences has already awarded one *doctoral* (Ph.D.) and one *magister scientia* (M.Sc.) postgraduate degrees. A small number of postgraduate research students were admitted in various University departments on an *ad hoc* basis in anticipation of formulating proper rules. These are now in hand, and therefore a Postgraduate Degree Course in chemistry is already running, with approximately 12 students enrolled. The Degree Course includes courses which are compulsory for all postgraduate students, whether they carry out research or not.

A student to be eligible for a post-graduate degree whether at the M.Sc. or Ph.D. levels, must complete 30 credit units from post-graduate courses. In order to fulfill this obligation, the chemistry members of academic staff have agreed to offer four courses per annum instead of three, the fourth one at the postgraduate level.

The courses have been divided into two Sections, namely Section A which contains the theoretical modules, and Section B which contains laboratory-based modules. Students must take five courses from Section A and two courses from Section B, each worth four credit units. In addition, they must present a seminar based on an extended essay on a topic related but not the same as their research topic, equivalent to two credit units. In addition, while five of the seven postgraduate courses can be from the general area of the research topic of the student, two have to be from further afield. At the moment, the Department offers postgraduate courses in two areas, physical chemistry and organic-inorganic-biochemistry. Table 2 shows a list of postgraduate courses.

Candidates for the M.Sc. degree have in addition to undertake a project, and write a dissertation upon it. While the dissertation is not marked, successful completion of the project is a prerequisite for the award of the degree. For a student to become a Ph.D. candidate, he has to pass a qualifying examination based on the postgraduate courses he has taken. The M.Sc. or Ph.D. dissertations have to be defended during an oral examination. The minimum period of study for an MSc course is three semesters, and for Ph.D. three years.

CONCLUSIONS AND FUTURE DEVELOPMENTS

The University has approved the evolution of the Department of Natural Sciences, into separate Departments of Chemistry and Physics. In order for this to be implemented, the approval of the Cyprus House of Representatives is required. It is anticipated that approval will be given before the end of 1999.

TABLE 2. *Postgraduate degree programme in chemistry.* *

Section A	Section B
NAT 610 Physical Chemistry of Surfaces	NAT 700 Special Topics/Research
NAT 611 Physicochemical Methods of Inorganic Chemistry	Methods of Surface and Colloid Chemistry
NAT 612 Special Topics of Polymer Chemistry II (Physical Chemistry)	NAT 710 Methods of Characterisation of Organic Compounds
NAT 620 Stereochemistry of Enzymatic Reactions	NAT 720 Methods of Characterisation and Synthesis of Inorganic Compounds
NAT 621 Advanced Organic Synthesis	NAT 730 Special Topics/Research Methods of Biochemistry
NAT 622 Chemistry of Molecular Solids	NAT 740 Special Topics/Research Methods for Physicochemical Characterisation of Solid Surfaces
NAT 635 Dynamic Phenomena of Inorganic Complexes and Meta-enzymes	NAT 750 Special Topics/Research Methods for the Mechanistic Study of Catalytic Reactions
NAT 636 Group Theory	NAT 760 Special Topics/Research Methods for Polymer Characterisation
NAT 637 Zeolites	NAT 800 Seminar
NAT 640 Principles of Colloid Chemistry	
NAT 650 Molecular Mechanics and Methods of Molecular Simulations	
NAT 652 Thermodynamics and Statistical Mechanics	
NAT 660 Advanced Topics of Biochemistry	
NAT 661 Special Topics of Molecular Biology	
NAT 670 Heterogeneous Catalysis	
NAT 680 Environmental Technology	
NAT 681 Biochemical Engineering	
NAT 690 Special Topics of Polymer Chemistry I (Synthesis, Characterisation, Technology)	

* All courses carry four credit units, except NAT 800 which carries two.

Although the number of Chemistry academic staff (ten) has already reached the so-called steady state, it is anticipated that with the growth of the University, the Department of Chemistry will also grow. This will be especially true given that the University is planning the setting up of a Department of Biological Sciences within the Faculty of Pure and Applied Sciences, as well as new Faculties of Engineering, and of Medicine. The students in these departments will need instruction in chemistry, which will be provided by the Department of Chemistry, generating need for additional staff. As the Department increases in size, there will be further development in its research activities, also making possible new specialised postgraduate programmes. The possibility of joint courses (e.g. chemistry and environmental engineering, chemistry and computer science, chemistry and economics or management) is also being considered. New electives in chemistry are also being planned, with emphasis on important areas of chemistry that are not well-represented in the current restricted curriculum, such as environmental, pharmaceutical, clinical, theoretical chemistry, advanced synthesis, etc.

The setting up of a viable Department of Chemistry in the University of Cyprus was not an easy task. People who were in a position to take decisions, such as certain Government

ministers and officials, but also certain members of the Interim Governing Board (IGB) of the University did not consider that chemistry was of any relevance to the economy of Cyprus. The funds available for setting up laboratories both for teaching and research were limited, and the authorities had to be convinced that they were necessary. On at least two occasions, members of staff who were appointed did not choose to take up their position, thus increasing the workload on the rest, and delaying the growth of the Department (replacing a member of academic staff takes at least 12 months). Some other members of staff, chose to delay taking up their positions by as much as two academic years.

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