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Pedagogia no Ensino Superior

**Building an Industry-Aware Master Curriculum in Engineering
– the Master in Embedded Systems**

João Carlos Cunha, J. Pedro Amaro, Luís Marques - Instituto Superior de
Engenharia de Coimbra, Portugal

**Preparing teachers for multiculturalism: Are we going beyond
the surface?**

Julia A. Spinthourakis - University of Patras, Greece

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BUILDING AN INDUSTRY- AWARE MASTER CURRICULUM IN ENGINEERING — THE MASTER IN EMBEDDED SYSTEMS

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ABSTRACT

The practice of engineering acts is based on a set of principles, knowledge and training that are traditionally lectured in higher education institutions. Most engineering education programs use a classical pedagogical approach based on passive transmission of information which is complemented with laboratory work and a final project implementation. Engineering educators, that originally had industrial background, have been replaced by full-time professors with little or no connection to industrial environment. Nevertheless, the majority of students will inevitably end up working in industrial environment, where different skills from those effectively trained at school are often required. This disengagement between polytechnics/universities and industry pushes the latter to endeavour internal training of graduates to complement formal education and provide them with proper skills for practicing engineering.

This paper presents a novel approach on the curriculum development of a master programme in Embedded System. This industry-aware programme was designed within a strong cooperation with the four most relevant companies of the region in this area, and supported on the Conceive, Design, Implement, Operate (CDIO) educational framework for engineering curricular planning and outcome-based assessment.

Keywords: embedded systems, CDIO, curriculum design, project-based learning

1. INTRODUCTION

The Bologna process brought new responsibilities to higher education institutions, which had to adapt the curricula, pedagogical approaches and degrees' organization, to face the challenges of being part of a European Higher Education Area: the system is now organized in three cycles (undergraduate, graduate and doctoral); the education system based on the transmission of knowledge changed towards a system based on the development of competences; the programmes are defined in terms of qualifications; the new credit system (European Credit Transfer System) measures the amount of student's work; students are submitted to continuous evaluation through written exams,

laboratory work, presentations, reports, etc. The goal of this major reform is to ensure a quality higher education system with a European dimension.

Regarding most educational areas, namely engineering, the institutions face another challenging responsibility, which consists in properly preparing graduates for the global job market. This is particularly relevant for a graduation cycle (master's level), as it implies advanced and specialised studies. Furthermore, in Portugal, the polytechnic institutions must assure that this specialization has a professional nature, which means that they must demonstrate employability of graduates. Academia-Industry cooperation is thus regarded as fundamental in such teaching and learning process, to prepare graduates for a competitive labour market economy in developed countries.

This cooperation is scarce and, when exists, is usually limited to internship programmes for last-year students or graduates, as learning outcomes and syllabus contents are typically of exclusive responsibility of academia members. This is current practice for programme definitions in Portugal, where the implementation of most engineering programmes lack the participation of industry partners. As a result, some companies have to develop their own education and training strategies, as is the example of itGrow (<http://www.itgrow.pt/>), a recent company that complements the formal high-level education of recent graduates with on-the-job training in information systems and software engineering.

A report from the Organisation for Economic Cooperation and Development (OECD) (Hasan, 2006) regarding the tertiary education in Portugal refers the general disengagement of the academia with the community and business. The results from this report were acknowledged by all partners in Portuguese academic and industrial community, recognizing the importance of cooperation by all stakeholders for the quality of the programmes, namely in Business and Engineering areas.

In this context, some Professors from the Engineering School of the Polytechnic Institute of Coimbra, Portugal (ISEC), with close contacts to local companies in joint research projects and consulting activities, became aware of the companies' difficulties in hiring qualified

people. These difficulties became especially relevant in some critical areas, where skilled professionals are scarce. One such area is the development and validation of embedded systems. The importance of this area is enhanced by the number and relevance of projects they actually develop that are funded by the European Framework Programmes or European Space Agency. This lack of qualified human resources regards not only technical aspects but also soft skills. This situation gave rise to the idea of building a master programme able to produce skilled engineers in the embedded systems area.

This paper addresses some educational approaches in curriculum development for graduation courses in engineering, with particular awareness of the industrial needs, in order to produce graduates with competences tailored to the labour market. In particular, the CDIO framework (Crawley, Malmqvist, Ostlund, & Brodeur, 2007), which is an initiative for engineering education adopted by universities around the world, is analysed. Then a case-study based on a recent proposal of a new Master's programme in Embedded Systems (MES) is presented. This work resulted from a very close cooperation between ISEC, and the most relevant companies of the region in this field: Critical Software S.A. (www.criticalsoftware.com), ISA – Intelligent Sensing Anywhere (www.isa.pt), Active Space Technologies (www.activespacetech.com) and WIT Software (www.wit-software.com). The core businesses of all of these companies are technological-based, and all of them have strong international cooperation, representing an important portion of Portuguese high-valued exports. A thorough work was made both by professors from ISEC and experts from these companies resulting in a strong commitment to the elaboration of a programme in embedded systems, fulfilling not only the companies' declared needs, but also maintaining a generic nature, welcoming future partners. This programme has been accepted by the Portuguese Ministry in August 2009.

2. BUILDING A CURRICULUM FOR AN ENGINEERING PROGRAMME

The second half of the 20th century was characterized by the omnipresence of technological gadgets that contributed in large amount to the lifestyle presented by modern societies. Engineering, in its several flavours, is to be mainly accountable for the widespread use of technology. These fast developments pose an enormous challenge to the engineering learning process, and therefore to its stakeholders.

When implementing an engineering programme of high-studies, developers face the dilemma of teaching the basic notions and skills together with an ever growing number of details demanded by technological development. Moreover, high education systems characterised by longer training times face an added challenge due to the time constraints of the Bologna framework. The need for a strong theoretical basis, linked to a solid implementation practice, is not easily matched with three-year programs of undergraduate studies. In this context, second cycle studies, used to lecture advanced subjects, also miss this implementation practice. As a consequence, classical engineering programs sometimes lack practical skills that are considered essential by industrial partners.

2.1. PROBLEM AND PROJECT BASED LEARNING

Problem and Project Based Learning approaches (Lehmann, Christensen, Du & Thranea, 2008; Mehmet, 2010; Mills & Treagust, 2003; Sridhara, 2005; Yusof, Aziz, Hamid, Hassan, Hassim, Hassan & NMA, 2004) are a potential solution to meet the Bologna process challenging requirements, allowing implementation skills to be introduced together with strong theoretical basics. Engineering training, using Problem-Based Learning (PBL) techniques, requires educators to define complex problems that should be solved in collaborative work. Educators are advised to propose work with a link to real world problems, enhancing this way student's motivation.

On the other hand, Project-Based Learning (PjBL) concept is associated with linking students' disciplinary knowledge to real-world problems while embedded in project environments. PjBL integrates engineering training with soft skills acquisition. Skills such as communication, management, time organization, research, self-evaluation and

group work, among others, should therefore be addressed in a PjBL environment.

Implementing engineering programme studies using PBL/PjBL can nevertheless become difficult due to organizational and cultural establishments. PBL and PjBL may substantially differ from classical programs being therefore failure prone. Projects are not measurable using standard assessment tools and rely on subjective criteria. Also what constitutes an acceptable project is not consensual. Projects may vary in depth of questions, learning goals and teacher tutoring.

2.2. CDIO

The CDIO initiative (Crawley et al., 2007) provides an organizational framework to implement engineering education curriculum based on a methodology of conceive, design, implement and operate systems and products. The CDIO initiative's goal is to approach teaching practices with companies' training and skill needs. Within CDIO, 12 standards are proposed as guidelines for educational programme definition and evaluation. The CDIO standards address programme philosophy, curriculum development, design-build experiences and workspaces, new methods of teaching and learning, faculty development, assessment and evaluation.

These guiding principles were developed in response to programme leaders, alumni, and industry partners in response to the lack of a tool that can provide accountability and comparability to their programmes. A council of founding university members supervises CDIO evolution and the acceptance of new members. The initial members are the Massachusetts Institute of Technology, from the USA, and the University of Chalmers, University of Linköping and the Swedish Royal Institute of Technology, from Sweden. These institutions were later joined by the Technical University of Denmark, the Queen's University, from Belfast, the USA Naval Academy, the Queen's University, from Ontario, Canada, and the University of Pretoria, South Africa. Currently more than 50 universities and polytechnics around the world have joined this initiative.

The twelve CDIO principles are defined as follows:

1. Engineering education must be accomplished in a context of product and system development. Engineers should be trained to

conceive, design, implement and operate systems and products.

2. Learning outcomes for personal and interpersonal skills, as well as product and system building skills must be defined. These definitions should be consistent with programme goals and validated by programme stakeholders.

3. Both technical and soft skills should be addressed in an integrated curriculum definition designed with interdisciplinary subjects. Detailed documentation on syllabus contents and learning outcomes are required to adopt CDIO principles.

4. There should be defined introductory courses to develop basic engineering skills and to introduce essential personal skills.

5. A curriculum should include two or more design-build experiences, one at a basic level and one at an advanced level. PBL/PjBL is seen as an essential step to conceive, design, implement and operate systems and products.

6. Laboratories and other spaces should support and encourage product and system building using hands-on approaches. Also disciplinary knowledge and social learning should be encouraged by workspace design.

7. Learning approaches should foster personal, interpersonal, and product and system building skills, altogether.

8. Passive transmission of information is deemphasised as active learning methods are applied. Students engage in thinking and problem solving activities. Students are encouraged in manipulating, applying, analyzing, and evaluating ideas.

9. Educator technical skills are better developed in contexts of professional engineering practice. Faculty scope can, nevertheless, vary according to programme resources and objectives. Cooperation with industrial partners in research and educational project development and professional leave of work in industry, are examples of competency enhancing faculty actions. Furthermore, hiring and promotion criteria include engineering practice, and specific professional development experiences at the polytechnic /university.

10. Faculty competence should be enhanced by providing integrated learning experiences (as stated in standard 8).

11. Assessment of student learning is the measure of the extent to which each student achieves specified learning outcomes. Instructors usually conduct this assessment within their respective courses.

12. Joining CDIO is done by implementing a system that is able to evaluate and document the programme against these standards. This documenting and evaluating systems consubstantiates the CDIO framework.

3. COOPERATING WITH THE INDUSTRY ON EDUCATION

Cooperation between industry and academia is an important support mechanism for the realisation of the knowledge-based economy. In Europe this cooperation in research has been growing over the last years with mutual benefits, such as allowing rapid conversion of scientific knowledge into commercial innovations, and facilitating the polytechnics/universities' access to new research opportunities and extra funding (Elliott, 2009). The European Commission has recognised the importance of this cooperation in research in such a way that, for the EU average, a university-industry cooperation contract involves a funding four times bigger than other forms of collaboration (Azagra-Caro, Carat & Pontikakis, 2009).

Regarding recruitment, in order to have qualified professionals aimed at positively responding to demanding projects, the companies follow basically two complimentary approaches: they hire experienced workers, or they hire recently graduates or students and go through a process of internal training. The first approach is expensive, as skilled professionals are difficult to attract, but provides results in a very short time. The second approach is not as expensive because it is easier to find recently graduated professionals, but has the drawback of being risky and has a long return of investment. Through cooperative projects, the industrial companies get access to students even before they graduate, which facilitate their recruitment process.

With the integration of industrial training into curriculum contents, polytechnics and universities are thus able to offer students direct access to current industry practices, facilitating real world learning and maximizing graduates potential for integrating roles in the industry (Herrington & Oliver, 2000). However, regarding education, student objectives and educational requirements often conflict with the interests of the industry (de Vere, 2008). It is sometimes impractical for academic programmes to accommodate many valuable subjects for the industry into an academic calendar. This is why most of the cooperation between academia and industry is limited to internships or small projects, often regarding research topics, and no direct involvement in industrial practices.

Engaging the industry with an academic programme, while promoting the benefits and interests for both parties, is fundamental for a

cooperation concerning the education of the students. In this sense, schools have an important role in attracting the industry into more than a superficial cooperation such as internships or common academic projects. By having the companies involved in the whole process of students' education, such as curriculum definition, students' recruitment, teaching and quality assurance, they become totally committed with the programme, controlling its outcomes, and thus being co-responsible for the qualification of their potential future employees. With such a strong partnership, companies benefit from a solid and useful education of the graduates they shall recruit, while the schools benefit from expertise and on-the-job experience from the companies' staff, assure the best possible industry-aware curriculum, though promote employability of the graduates, and gets financial support.

In the following section we describe such cooperation between ISEC and four local companies in the development of a Master's programme in Embedded Systems.

4. THE MASTER'S PROGRAMME IN EMBEDDED SYSTEMS

We have proposed to four of the most significant companies of Coimbra's region in the embedded systems' area, a close cooperation on the design, from scratch, of a specialized programme in embedded systems. This graduation programme should be able to fulfil the companies' needs by providing the students with the required skills. Since the companies actively participate in programme definition, quality assurance, students tutoring, and student placement within the companies, they will have, by the end of the programme, qualified graduates able to immediately respond to most of their projects in this area.

The so-designed Master in Embedded System was thus planned with the following main goal:

- » To educate students with specialized knowledge in the design, build, evaluation and operation of embedded systems, and with the necessary skills to perform an effective work in an industrial environment.

4.1. CONTEXT DEFINITION

Having in mind the goal of the programme, several decisions have been made defining its context:

- » this programme mixes knowledge from Electrical and Computer Engineering. Students that enrol into this programme will mainly originate from Bachelors from these areas. There should be homogenization courses so that the fundamental knowledge of both engineering areas is assured by all the students;
- » there should be one design-implement course to provide the necessary skills of design-implement experiences, in working groups, relating fundamental subjects in the associated engineering knowledge areas;
- » there should be one design-implement course, where students must apply their skills in real-world projects provided by the industrial partners;
- » there should be a learning workspace that mimics an industrial environment, where students may follow the classes and work on their projects;
- » the courses shall be organized in modules, such that each module may be conducted by a specialized instructor, which may originate from the academia or the industry. Each of these modules has 8 class-hours, which are scheduled for single-days, thus facilitating the participation of invited lecturers;
- » the modular organization of the courses shall also allow external students to attend single modules; the external students may be workers from partner companies or any other interested people;
- » the partner companies shall be part of a consulting group and shall be co-responsible for the programme coordination and quality assurance;
- » each student shall be tutored by one company during his entire academic path;
- » the students shall spend 3/8th of the programme working on an industrial placement (this fulfils a Portuguese legislation demand).

The Master in Embedded Systems has thus been designed as a two-year programme, awarding 120 ECTS Credits (European Credit Transfer and Accumulation System, that correspond to a total student workload of 3120 hours, from which 1170 hours are spent in an industrial placement.

The structure of this programme is presented in Figure 1.

Year 1		Year 2	
Semester 1		Semester 3	
Fundam. Course 1 (5 EC)	Applied Lab 1 (15 EC)	Special. Course 1 (5 EC)	Industrial Placement (45 EC)
Fundam. Course 2 (5 EC)		Special. Course 2 (5 EC)	
Elective Course 1 (5 EC)		Elective Course 3 (5 EC)	
Semester 2		Semester 4	
Fundam. Course 3 (5 EC)	Applied Lab 2 (15 EC)		
Fundam. Course 4 (5 EC)			
Elective Course 2 (5 EC)			

Figure 1 – Organization of the Master's Programme in Embedded Systems
(EC – ECTS Credits; 1 semester = 30 ECs)

The first two semesters are organized around two courses based on conceive-implement strategy, named Applied Lab 1 and Applied Lab 2. Students, working in groups, have to design and implement one or more projects/products, based on specifications from academia and/or from industrial partners. The project or product to be designed and implemented in each semester should be closely related to the topics of the two Fundamental Courses of the same semester, aiming at applying and consolidating their topics and skills. In these two semesters the students also attend two Elective Courses, aimed at homogenizing their skills, due to their different backgrounds (mainly from the Electrical Engineering or Computer Engineering Bachelors).

In the third semester, two Specialized Courses provide topics closely related to the industrial partners' working areas, where the students shall complete their industrial placements. Another elective course allows the students to complement their education in areas where they lack the necessary knowledge or skills.

4.2. DEFINING SPECIFIC LEARNING OUTCOMES

In the early stages of the curriculum development, industrial partners were asked about the skills they classify as the most important for students to acquire throughout this programme. While asked for identification of both engineering knowledge and personal skills and attitudes, the industrial partners demonstrated to have strong opinions about the desired engineering skills and knowledge, but lacked the

same clarity as to the personal skills and attitudes.

We have thus built a table identifying the most desired engineering skills by the industrial partners (Table 1), which was used to design the curriculum.

Table 1 - Learning Outcomes obtained from partner's evaluation process

<i>Learning Outcomes</i>		<i>Importance</i>
<i>On completion of the programme, students shall be able to:</i>		<i>0 - null; 1 - relevant; 2 - fundamental</i>
1	Program systems at different levels, from object-oriented to assembly.	2.0
2	Analyse, design, program and evaluate real-time applications with timing and spatial constraints, using software engineering best practices.	1.8
3	Model, design, program, synthesize, simulate, assemble, test, and debug systems with programmable logic devices.	1.4
4	Know, evaluate, and adapt at functional and structural level operating system kernels, including real-time kernels.	1.4
5	Use techniques for the implementation, development, verification and validation of embedded systems, according to standards.	1.4
6	Know, evaluate and apply different types of sensors and actuators used in embedded systems.	1.2
7	Design, produce, assemble, test and debug digital circuit boards.	1.0
8	Know and evaluate architectural details of modern microprocessors and associated units, such as buses, memories, mass storage devices, and input/output devices.	1.0
9	Know, evaluate and apply different communication medias and standards, wired or wireless, internal or external to embedded systems.	1.0
10	Analyse, design, program and evaluate applications for mobile devices (PDA and cell phones).	1.0
11	Analyse, design, simulate and test digital control systems.	1.0
12	Understand the behaviour of digital and analogue electronic systems under faults, and apply test and verification techniques.	0.8
13	Use basic concepts of industrial vision.	0.8

4.3. DESIGNING THE CURRICULUM

The context and the learning outcomes were the basis for designing the curriculum of the Master's programme in Embedded Systems.

Each Course, or Curricular Unit, either Fundamental, Elective or Specialized, was designed having 5 ECs, divided into modules of 1 or 2 ECs. Each module of 1 EC corresponds to 9 lecturing hours plus 16 hours of self-study or work assignments, totalling 125 hours of student workload for each Course/ Curricular Unit. All these courses are scheduled to the first half of the corresponding semesters, reserving the second half of the first two semesters to the Applied Lab courses. The Industrial Placement starts at the second half of the third semester and continues until the end of the programme.

Table 2 presents the curriculum of the MES, with the corresponding Course Types, Student Workloads and weights in terms of European Credits.

Table 2 – MES curriculum

Sem.	Course	Type	Student Workload	European Credits
1 st	Real-Time Systems	Fundamental	130	5
	Electronic Systems Design	Fundamental	130	5
	Computing Architectures and Platforms	Elective	130	5
	Instrumentation and Electronics	Elective	130	5
	Applied Lab I	Lab	390	15
2 nd	Embedded Systems Programming	Fundamental	130	5
	Digital Circuit Design	Fundamental	130	5
	Software Development Fundamentals	Elective	130	5
	Applied Control Systems	Elective	130	5
	Applied Lab II	Lab	390	15
3 rd	Communication Systems and Smart Buildings	Specialized	130	5
	Advanced Programming	Specialized	130	5
	Systems Dependability	Specialized	130	5
	Communication Systems and Wireless Networks	Specialized	130	5
	Elective	Elective	130	5
3 rd / 4 th	Industrial Placement	Placement	1170	45

The Bologna Process (The official Bologna Process website 2007-2010) within the European Higher Education Area defines generic

learning outcomes for students to be awarded with Bachelor's, Master's or Doctorate's degrees. These are based on the 'Dublin' Descriptors, which indicate shared expectations about student's achievements and abilities at the end of each of the cycles of the Bologna Process.

The MES curriculum was thus designed with mutually supporting disciplines integrating all skills defined by both the 'Dublin' Descriptors (Shared 'Dublin' descriptors for Short Cycle, First Cycle, Second Cycle and Third Cycle Awards, 2004) and the specific learning outcomes identified by the industrial partners. This demonstration is resumed in Table 3.

Table 3 – MES integrated curriculum demonstration

Matrix demonstrating the acquisition of generic and specific competences.	Year 1										Year 2			
	Real-Time Systems	Electronic Systems Design	Instrumentation and Electronics	Computing Architectures and Platforms	Applied Lab I	Embedded Systems Programming	Digital Circuit Design	Software Development Fundamentals	Applied Control Systems	Applied Lab II	Communication Systems and Smart Buildings	Advanced Programming	Systems Dependability	Communication Systems and Wireless Networks
Generic Competences (Dublin Descriptors)														
a) demonstrate knowledge and understanding	3	3	3	3	3	3	3	3	3	3	3	3	3	3
b) apply knowledge and understanding	3	3	3	3	3	3	3	3	3	3	3	3	3	3
c) integrate knowledge, handle complexity, formulate judgements	3	2	2	2	3	3	3	1	2	3	2	2	3	2
d) communicate conclusions, knowledge and rationale	1	1	1	1	3	1	1	2	2	3	1	2	1	1
e) continue to study in self-directed or autonomous way	1	1	1	1	3	1	1	1	1	3	1	1	1	1
Specific Competences (Identified by Industrial Partners)														
1. System programming	3	2	2	A	3	2	3	3	A		3	3	3	A
2. Real-time applications	3			A	2		2		A			2	2	A
3. Programmable logic devices.				2	A	2	3		A					A
4. Operating system kernels.	3		2	A	3	1			A					A
5. Embedded systems standards.		1	1		A		2		A				3	A
6. Sensors and actuators.		3	3		A				A		2		2	A
7. Digital circuit boards.		3	2		A				A		2		2	A
8. Microprocessors architecture.		1		3	A		2		A					A
9. Communication medias and standards.		2			A				A		3		3	A
10. Applications for mobile devices.					A				A			2		A
11. Digital control systems.					A			3	A			2		A
12. Faults, test and verification techniques.		2			A		2		A			3		A
13. Industrial vision.					A				2	A				A

1 – Introduced in the Course, but is not part of the students' assessment.

2 – Addressed in the Course, and may be part of students' assessment.

3 – Covered by the Course, included in course learning outcomes, and is part of the students' assessment.

A – May be covered by the Course, depending on the projects.

4.4. ADHERING TO CDIO STANDARDS

The Master's programme in Embedded Systems was designed from scratch having in mind the CDIO principles for teaching engineering. The programme structure is thought to favour long project implementation periods allowing students to go through all the conceive-design-implement-operate steps. Also team work is favoured by the Applied Lab and Industrial Placement structure. The teams should include instructors, industrial partner's advisers as well as first and second year students. Students should develop technical, personal and interpersonal skills to implement a system or product taking into account client characteristics but also system's implementations and operational environmental consequences. All these are fundamental principles of CDIO, which reflect the will to join this initiative with this programme. In Cunha, Amaro and Marques (2010) we have analysed the adoption status of the CDIO, and the plans for future approaches.

5. CONCLUSION

Building an engineering programme at master's level, aimed at preparing graduates for the labour market, require a close cooperation with the industry for the elaboration of a syllabus. Furthermore, if the industry itself participates actively in the whole process of setting-up the programme, such as in the preparation of the lab spaces, in the lecturing of some subjects, in the enrolment of the students, and in the quality control, the probability of the students being integrated in compatible roles in the industry is largely enhanced.

The Master in Embedded Systems is a unique programme in the Portuguese context, aiming at a close relation between Academia and the Industry regarding the education of future graduates that shall become highly required not only by the companies that support them, but from the labour market in this promising area.

The first step was successfully implemented, by having the programme formalized and accepted by the Portuguese Ministry and the scientific council of ISEC. The start of the programme is dependent on the decision from the school administration.

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PREPARING TEACHERS FOR MULTICULTURALISM: ARE WE GOING BEYOND THE SURFACE?

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ABSTRACT

The demographic composition of public school education in many European countries is increasingly culturally and linguistically diverse. However, while students as well as the general population are becoming increasingly diverse, public school teachers are generally not; they tend to remain, white, female and with little cultural diversity experience, expertise and knowledge; representing the dominant culture of their respective countries. These changes in conjunction to the continuing lack of diversity in the teacher population has led to growing concern about how to meet the educational challenge of learner diversity. Teachers face the challenge of finding the means of effectively working with students that are increasingly multicultural and multilingual and yet many have limited and cursory orientations to cultural diversity issues. In this article we will attempt to highlight the relevance of cultural competence, how teacher education programs have to date dealt with the issue and the need for teacher education programs to include a focused cultural sensitivity and awareness element in their program of studies for pre-service teachers. We conclude with a brief description of potential approaches to studying the question of teacher education on the issues of culture, cultural sensitivity and their place in teaching.

INTRODUCTION

A basic objective of educational systems' curricula has been the reproduction of the dominant culture's values and beliefs as the basis for the educational strategies practiced in schools (Darder, 1991; Nieto, 2000). Tertiary educational systems (Stephenson, 2000; Buchberger, 1997) also tend to employ this model in the preparation of pre-service teachers. And yet, a basic characteristic of the changes in many Western societies is the rapid cultural and linguistic diversification of its population (Spinthourakis, 2007).

The demographic composition of public school education in many European countries has undergone changes in part because children from culturally and linguistically diverse backgrounds now constitute a growing percentage of the school-age population (Eurydice, 2004). However, while students as well as the general population are becoming increasingly diverse, public school teachers are generally not; they tend to remain mainly white, female and with little cultural diversity

experience, expertise and knowledge. They represent the dominant culture of their respective countries. The changing student demographics in conjunction with the lack of diversity in the teacher population has led to growing concern about how to meet the educational challenge of learner diversity. Teachers face the challenge of finding the means of effectively working with students that are increasingly multicultural and multilingual (Seelye & Howell Wasilewski, 1996).

Does the reproduction though of the dominant culture's values and beliefs in schools realistically serve the needs of the increasingly multicultural populations that comprise many societies today? There are those who argue that it does. The arguments are usually of the type "We're different; historically and culturally we're unique; we aren't a pluralistic society and therefore have to make them [the others] more like us as to maintain our ethnic identity". A form of this argument has been used by others to support their incomparability in relation to teacher education program issues (Buchberger et al, 2000). However, arguments such as these seem to be out of sync with what's going on around us and appear to ignore the fact that we live in an increasingly multicultural world. We no longer live isolated from the other and therefore higher education needs to find ways to effectively maximize the potential of all (Gifford et al, 2008). Thus, teacher education needs to rise to the challenge of rapidly changing contexts and confront and continue to confront societies and education (Buchberger et al, 2000: 29-30). For teacher educators this suggests helping our pre-service teachers become conscious and capable of effectively dealing with diversity in the classroom as a means of meeting the needs of all students.

If one accepts that changes in the makeup of society correspond with the need to revisit the curriculum (Alachiotis & Karatzia-Stavlioti, 2006), then support for the idea of addressing the issue by changing the curriculum, perhaps simply by adding new and diverse materials and perspectives to be more inclusive, is on one level viable. However, this can be a somewhat simplistic approach to the issue, given that simply adding something, in and of itself, is no guarantee that it will be successful; those charged with implementing the change have to be adequately prepared to affect the new paradigm. Consequently it becomes very important that, in preparing pre-service teachers, teacher educators work to help them understand that employing

teaching strategies that are based on the culture and learning styles of the dominant group effectively marginalizes less dominant groups (Sleeter & Grant, 2002).

Teachers who receive limited and cursory orientations to cultural diversity issues tend to treat these issues in the same way; without depth and without specificity, often even going so far as to ignore them. In this article we will attempt to highlight the relevance of cultural competence and the need for teacher education programs to include a focused cultural sensitivity and awareness element in their program of studies for pre-service teachers.

CULTURE, MULTICULTURALISM AND TEACHERS

Teachers are at the heart of the process of socialization, cultural transmission, and identity formation in that 'Culture is the product of choice, individual human choice, about what to sustain, what to transmit, how to train-how to educate. We do not have to choose one culture over the other'. (Ross, 2003: 5). A long standing argument supports the view that there is a new type of person developing, one whose orientation and view of the world can and actually goes well beyond his or her culture and that this development comes from the complex of social, political, economic, and educational interactions of our time (Adler, 1967, 2002).

Multiculturalism and cultural diversity in relation to teacher education tend to be associated mainly with countries outside Europe (Banks, 1996; Cochran-Smith et al, 2004) but they are also part of the European educational discourse (Debeauvais, 1992; Hillman, 1996; Mavrikos-Adamou, 2003; Mitter, 2007). The need for qualified teachers in an increasingly multicultural world has led many to examine the degree to which issues related to diversity make up part of the curriculum of higher education programs (Cochran-Smith et al, 2004; Darling-Hammond, 1999, 2000). Consequently, including multiculturalism as a fundamental component of teacher education programs is important as teachers need to work successfully with diverse learners at various levels including the methodological and practical among others (Fox & Gay, 1995). Teachers need specific knowledge, skills and attitudes with respect to cultural diversity, if they are to serve as positive catalysts of change (Banks, 2001; Garmon, 2004; Gay & Kirkland, 2003). Studies have shown that teachers who have not had the opportunity to

develop their awareness, knowledge and skills at working with diverse populations will be inadequately prepared to meet the challenges represented in the classrooms of a diverse society (Hollis & Guzman, 2005; Avery & Walker, 1993)

One of the things that appear to influence how well a teacher is able to positively interact with his or her students is their level of cultural competency. Teachers who understand, in interaction with people different from themselves, their specific concepts in perception, thinking, feeling and acting are considered to be culturally competent. Cultural competence directly deals with intercultural communication, an umbrella concept comprised of cognitive, affective and behavioural ability (Chen & Starosta, 2000; Fantini, 2005). "Culture" in terms of cultural competence, implies the integrated patterns of human behaviour that includes thoughts, communications, actions, customs, beliefs, values and institutions of racial, ethnic, religious or social groups. "Competence" deals with the capacity to function in a particular way within the context of human behaviour. "Cultural" competence refers to the ability to relate and communicate effectively when the individuals involved in the interaction do not share the same culture, ethnicity, language, or other relevant variables (for more information on the topic, see Spithourakis, 2006, and Hains, Lynch and Winton, 2000). Barrera and Kramer (1997: 217) define cultural competence as *"the ability of service providers to respond optimally to all children, understanding both the richness and the limitations of the socio-cultural contexts in which children and families, as well as the service providers themselves may be operating"*. Similarly, Lynch and Hanson describe cross-cultural competence as *"the ability to think, feel, and act in ways that acknowledge, respect, and build upon ethnic, [socio] cultural and linguistic diversity"* (Lynch & Hanson, 1993: 50). The common characteristic between the two definitions is that cross-cultural competence has multiple components that address attitudes, knowledge, skills, and actions; something that we believe teacher education programs must stress. Developing intercultural competence is a slow, gradual transformative learning process (Taylor, 1994: 22).

The majority of teachers represent the dominant culture with little if any direct training or contact with cross-cultural knowledge and experience (Barry & Lechner, 1995; Larke, 1990; Law & Lane, 1987; Milner et al, 2003) which may lead to signs of apprehension, uncertainty and a

semblance of intolerance to diversity in the classroom (Rowland, Harlan & Arnot, 1999). Thus, we often see that pre-service student teachers' stereotypical beliefs about culturally diverse children may interfere with their future teaching. Most dominant culture pre-service students bring little awareness or understanding of discrimination (Avery & Walker, 1993; Sleeter, 2001).

Teacher educators play a critical role in setting both an empathetic and experiential course by which pre-service teacher education students will encounter, understand and internalize issues related to diversity (Athanases, Christiano & Lay, 1995; Spithourakis, 2007). For students to advance from the knowledge level toward the action level which is a gradual progression (Banks & Banks, 2004) critical pedagogy needs to be engaged; one that activates affective and psychomotor capabilities, motivating them to be more actively involved.

WHAT WE DO VERSUS WHAT WE CAN DO TO DEVELOP CULTURAL COMPETENCY/AWARENESS

Culture can both create and solve problems. A lack of knowledge of it can lead to misunderstandings and conflict (Seelye & Howell Wasilewski, 1996). Interestingly, it's been argued that 'culture defines not only what its members should think or learn but also what they should ignore or treat as irrelevant' (Amour-Thomas & Gopaul-Nicol, 1998). Pedagogy utilizes several approaches for the development of an understanding of culture. One such approach has to do with building a learning environment that enables them to be involved in cross-cultural dialogues and recognizes the importance of intercultural communication and sensitivity. According to Milton Bennett, cultural sensitivity and, more specifically, intercultural sensitivity can be understood as a continuum ranging from an ethnocentric perspective to a more ethno-relative world view (Bennett, 1986). His continuum describes the development of a person's attitude towards other cultures through six stages (Bennett, 1993). Three ethnocentric stages in which a person's own culture is the measure of all things: *Denial* (does not recognize cultural differences), the pure ethnocentric believes that the whole world is like him or her; *Defense* (recognizes some differences, but sees them as negative), barriers are raised and negative judgements are made against those who are different; and *Minimization* (unaware of projection of one's own cultural values; sees own values as superior),

the logic of we're all essentially alike. And three ethno-relative stages in which a person understands and values other cultural points of view as equal to his or her own: *Acceptance*, (shifts perspectives to understand that the same "ordinary" behaviour can have different meanings in different cultures); *Adaptation* (can evaluate other's behaviour from their frame of reference and can adapt behaviour to fit the norms of a different culture); and *Integration* (can shift frame of reference and also deal with resulting identity issues). Although Bennett's model implies a developmental progression in individual awareness and understanding of cultural difference, it does not assume that progression through the stages is one-way, linear or permanent. However, each stage is meant to characterize a treatment of cultural difference that is relatively consistent for a particular individual at a particular point of development. Intercultural awareness therefore develops through a dynamic process where changes must occur in an individual's knowledge, feelings, attitudes and behaviours relative to both cultures for the process to progress.

While historically anchored in the teaching of languages (Brooks, 1968; Nostrand, 1974; Byram, 1989; Seelye, 1993), culture teaching may have an equally central role in the education of all teachers. In the history of culture teaching and specifically in the area of foreign language education we see examples of what can go wrong when there's a lack of substantive knowledge about teaching culture (Galloway et al, 1998; Chastain, 1988; Kramsch, 1991). According to Galloway et al (1998), the teaching of culture is often reduced to one or more of the four classic surface or monocultural approaches to culture: a) the *Frankenstein approach* which is a piecemeal cutting and pasting of different types of information to supposedly form a uniform presentation (taco, flamenco, gaucho, bullfight = the Spanish); b) the *4-F approach* which subsumes under the rubric, folk dance, festivals, fairs and food (Kramsch (1991) refers to this as foods, fairs, folklore and statistical facts; c) the *Tour Guide approach* wherein topics such as monuments, rivers, and cities are covered with a little history thrown in; and finally d) the *By-the-way approach* which is essentially random and often incomplete lectures or bits of behaviors that are usually chosen to highlight differences. On the other hand, Risager (1998) describes four approaches to teaching culture in relationship to the process of European integration. These include: a) the *intercultural approach* (based on the idea that it is best learned in comparison, their

own culture and the one being learned); b) the *multicultural approach* (which also uses comparisons but is formulated on the proposal that several cultures exist within one culture and that this needs to be taken into consideration when studying and comparing cultures); c) the *transnational approach* (whose basic idea is that in the modern world cultures are interwoven due to technology, tourism, etc and that we are really talking about looking for a lingua franca); and finally d) the *foreign cultural approach* (which is essentially synonymous with a monocultural approach and focuses exclusively on the culture/language being studied). Kramsch (1991, 1993) cautions against the mere transmission of information about a foreign culture and suggests ways to avoid it such as: establishing a sphere of interculturality, teaching culture as an interpersonal process, teaching culture as difference and finally crossing disciplinary boundaries. In this way, culture teaching should allow learners to increase their knowledge of the target culture in terms of peoples' way of life, values, attitudes, and beliefs, and how these are expressed literally and metaphorically.

From this very brief review we see that foreign language teaching and teacher training literature can be a useful source of research and teaching methodology on the subject. It also has the added benefit of dealing with a number of the languages and cultures represented by the culturally and linguistically diverse students in many of our schools. This does not mean that we can simply go find something about these cultures and cut and paste it into our teaching strategies. We need to be reflective and critical and to adapt rather than adopt approaches or random elements of the aforementioned. As teacher educators, we need to enrich and seek alternative approaches and strategies to achieve our desired goals. With training grounded in theory, research, experience and critical reflection, university courses can enable pre-service teachers to become knowledgeably proactive, effective and not be prone to making sweeping oversimplifications about students with different worldviews (Spinthourakis, 2007a, b; Lestinen, Petrucijová & Spinthourakis, 2004). Research evidence suggests that teachers who have not been adequately trained to work with diversity have feelings that range from sensing that they are ill-prepared and thus have lower efficacy in terms of working with children different from themselves (Spinthourakis & Katsillis, 2003; le Roux & Möller, 2002) or go so far as to have a peripheral awareness of the issues arguing that their students are doing just fine with the traditional teaching methods currently

employed (Spinthourakis, 2007b, 2009). Teachers cannot be expected to teach multicultural content successfully and work effectively with ethnically diverse students without being professionally prepared for this task. As le Roux and Möller (2002:185) point out, “Knowledgeableness is the first and utmost minimum condition for effective teaching. How can inexperienced newcomers to the teaching profession be expected to teach what they do not know?”

However, traditionally organized pre-service teacher education programs that teach diversity issues appear to not have a significant impact on attitudes and beliefs (Spinthourakis, 2007b: 68). For the most part, most pre-service programs essentially attempt to address the cultural gap between teachers and children in the school through one or more approaches. In societies where there are members of minority cultures entering tertiary education there are often recruitment efforts to bring into the teaching profession more teachers who are from culturally diverse communities. Generally though, most university pre-service teacher education programs try to develop the attitudes and multicultural knowledge base of predominantly dominant culture pre-service students through various programmatic approaches. These include but are not limited to: a) no modifications to the undergraduate program of studies (something increasingly less visible but not totally eclipsed as yet); b) liberal arts program of studies which may include academic discipline courses such as sociology, psychology, philosophy and/or anthropology where references to different cultures and diversity may be made; b) education courses such as history of and/or comparative education, philosophy of education, educational psychology and sociology of education which presumably will have elements of their syllabi that deal with culturally diversity in education; and, c) education courses specifically entitled, for example, intercultural education, multicultural education, and/or intercultural pedagogy (for example see Karatzia-Stavlioti, Spinthourakis & Zografos, 2006 and Spinthourakis, Aktan & Korhonen, 2010). These courses are however, not always required courses as many are offered only on an elective basis. They may also have a supervised teaching element and/or a targeted immersion experience included but then again this is not uniform and the same is true of the curriculum to be followed. While it makes sense to assume that pre-service students who are taught something about culture and race will become better teachers in multicultural contexts than those who are not, it is usually something

that is decided by the individual faculty member teaching the course. Community-based immersion experiences require a good deal of work to organize and operate and are dependent on such a community being available and willing to become part of the university teacher education program.

On the other hand, when teacher education courses do not take into consideration the need for pre-service teachers to go beyond learning about what is meant by multiculturalism and interculturalism, there is the real danger in terms of the effectiveness of future teachers (Branch, Goodwin & Gualtieri, 1993). They may very well fail to acquire the knowledge, attitudes and skills needed to develop an empathy and understanding of the culturally different students. These students bring into the classroom differences which may manifest themselves through among other things different learning styles, behaviors and orientations which are a result of their cultural socialization. And when pre-service teachers enter the teaching profession without the necessary skills, the way they handle the diverse classroom may range from apathy to acrimony and blame (Spinthourakis, 2007a).

RESEARCH PROPOSAL

To this point we have tried to put into perspective some of the literature that abounds on the subject of multiculturalism, cultural competence and teacher education. What we have surmised is that there are no easy answers or magic solutions that can be implemented to improve the chances of both the teacher education graduates and the students they will encounter to succeed. We believe that, while there has been progress in terms of the kinds of approaches university teacher education programs have introduced in preparing pre-service teachers for cultural diversity, a different approach is needed; one that would incorporate intercultural competence, intercultural sensitivity and the teaching of culture for all teachers and not merely the foreign language teacher. This approach ideally would blend theory, experience and critical reflection in relation to culture and diversity and that would include teaching culture as a means of acquiring cultural sensitivity and awareness.

In the past we have researched the subject of pre-service teachers' intercultural sensitivity (Spinthourakis, Karatzia-Stavlioti & Roussakis, 2009; Spinthourakis, Aktan & Korhonen, 2010) as well as attempted to address the issue of multicultural awareness building in a university

teacher education course (Spinthourakis, 2007). Building on this research some of the questions that could be broached include: a) Does one's conceptualization of culture influence their incorporation of culture either directly or indirectly in the teaching?; b) Which factors or parameters at the individual as well as social, economic and political level influence one's knowledge of and on teaching culture?; c) Is teaching culture incorporated in regular teaching?; d) Is one's conception of the significance of multiculturalism in conjunction with cross-cultural sensitivity related to the strategies and techniques of teaching adopted in order to incorporate these in their teaching?; and looking outside one's national borders, e) What are the differences as well as similarities between different countries higher education teacher education faculties with respect to their approaches to teacher training with regard to issues of multiculturalism and more generically cultural diversity in terms of both the discourse and praxis sphere?

In line with this research orientation and as the basis of a four country cross-national study, we are in the process of conducting both ad hoc informal interviews and a questionnaire survey with pre-service teacher education students and teachers in the field, attempting to identify to what degree their understanding of culture plays a role on if and how they incorporate it in their teaching. The aim of the research is to examine how both pre-service teacher education students and recent graduates respond to the research questions: a) how do teachers define culture, b) what are the factors that contribute to the teacher's knowledge of culture, and c) how do they incorporate culture in their teaching. We also examine their levels of intercultural sensitivity as well as multicultural efficacy. The research is being conducted in Greece, Slovenia, Finland and Turkey; each different from the other but each also facing the challenges that multiculturalism brings to their respective societies and educational systems.

The findings of this study may provide us with information that will allow us to better prepare both pre-service and in-service teacher education programs with respect to how issues of culture, cultural diversity and teaching interact. This is especially relevant in relation to situations where new curriculums that have a reference to multiculturalism have been or are to be introduced. Additionally, the preparation of teachers to meet the challenge the multiculturalism and multilingualism of societies warrants examination given the demographic changes many

societies have undergone over the last 20 years, as more and more children come to school with a home language and culture different from that of the nation in which they reside. Questions related to how teacher training addresses these new paradigms are relevant to the cultural diversity and higher education pedagogy discourse.

CONCLUDING COMMENTS

Many institutions of higher education have implemented a variety of programs to help increase student awareness of, and sensitivity to, cultural differences. This has led to an infusion of courses, programs and curricula related to multicultural and intercultural education and issues of diversity but few have focused on teaching culture as a venue for developing cultural competence. While teaching culture may not be new to foreign and second language teachers, it is however new to non language specialist pre-service teachers charged with dealing with culturally diverse students in the classroom. In many cases, teaching culture has been effectively reduced to a few lessons on holidays, customary clothing, folk songs, and food. While these topics may be interesting, without a broader context or frame they offer little in the way of enriching social insight and making their teaching more relevant in our multicultural societies. Understanding the cultural context that students bring with them into the classroom means more than just being able to superficially deal with the issues of diversity and clearly does not come up to the standards of the cultural competence construct.

The work of preparing teachers is fundamental to the development of a productive and pluralistic democracy. Programmes have too often perpetuated teaching practices that have historically benefited mainstream middle-class students. In this way they fall short, thus failing to deal with the learning needs of the culturally and ethnically different (Spinthourakis, Aktan & Korhonen, 2010). The literature about the direction of multicultural pre-service training indicates that the focus essentially takes three paths: 1) ensuring cultural knowledge of different groups; 2) addressing the beliefs and attitudes of pre-service teachers and, 3) training in cultural relevant pedagogical skills (Gibson, 2004). Lack of knowledge and understanding can lead to developing stereotypes. In many pre-service education programs, there is still minimal understanding of multiculturalism and what it encompasses. Pre-service teachers need to be given the opportunity to

learn how to critically reflect on and analyze their beliefs and attitudes on cultural issues and to be taught to become change agents with skills that include critical self-analysis, self-reflection, and understanding culture (Gay & Kirkland, 2003).

Taking into account the need for more effective teacher education, what can we do as teacher educators to help teachers meet the challenges of teaching in a multicultural and multilingual Europe? To begin to provide answers to this question requires looking at what we are doing in terms of our own teaching but it also necessitates looking within ourselves, at our own sensitivities but also at our own stereotypes and biases. This includes looking at facets of ourselves and our own training and preparation, issues that we have not broached in this article, but which clearly warrant closer consideration. These include the degree to which we as higher education educators have developed our own levels of intercultural sensitivity as well as how we are trained to approach in our courses the question of multiculturalism and cultural diversity (Gifford et al, 2008). These questions when linked to how, higher education educators construct the experiences future teachers experience to become acclimated to their future professional practices, are parts of the puzzle that higher education pedagogy is called upon to address. The need for more research and understanding of both the praxis and discourse surrounding the issue of multiculturalism and cultural diversity in relation to teacher education is a long way from being completed and will continue to hold a prominent place in higher education pedagogy for the foreseeable future.

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