

Proposal of a competency-based curriculum matrix for the Civil Engineering in Computer Science degree at Universidad Austral de Chile

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Abstract

This article describes the development of a competency-based curriculum matrix for the Civil Engineering in Computer Science degree at the Universidad Austral de Chile. The starting point for the construction of the matrix is the graduate student profile that was obtained according to information provided by alumni, employers and teachers and the ACM curriculum guidelines. From Career Profile we selected the competence domain that allow the Civil Engineer in Computer Science "to develop software systems according to processes and products quality standards" and we built a competency based curriculum matrix for that domain. As an illustrative example, a module was developed for the subject Object Oriented Programming.

Keywords: Competence, Curriculum Matrix, Module, Software Engineering, Object Oriented

1.- Introduction

The Universidad Austral de Chile (UACH) is characterized as complex regional university in the sense that its mission is to carry out teaching, research, extension and technology transfer in a broad spectrum of subjects. Two of its campuses are located in the city of Valdivia, Chile, producing a major impact in its cultural and professional life. This impact can be seen in the various cultural activities organized or sponsored by the University such as The International Film Festival of Valdivia, and other cultural events involving Jazz, Theater, Olympic sports, music concerts, art exhibitions, literary presentations, etc.

It should be noted that college students are characterized as coming from families of different social origins, in particular, there is a significant proportion of them from small towns in the region.

Since 2004, the Academic Management Unit of the UACH, has been promoting new undergraduate policies with the aims of: a) improve the positioning of the Universidad Austral de Chile in the high education system, as well as levels the quality and equity of learning standars between the various degree offered. b) Establish a student-centered curriculum structure and a learning process as a prerequisite for the establishment of a culture of continuing education, open to new scenarios of performance in the national and international context. c) Certify the different levels of education and degree to recognize and ensure the achievement of the necessary skills and promote student mobility. d) Properly links the undergraduate and graduate programs, maintaining the consistency of the goals of the various curricula.

Aware of this initiative, the School of Engineering Sciences presented and awarded a project funded by the Ministry of Education of Chile (AUS MECESUP 0301). The project wanted to improve the quality of engineering education by implementing competence based curricula. This article shows the proposal for a competence-

based curriculum matrix and the specific curricula for one module on the subject of object oriented programming, both for Civil Engineering in Computer Science degree at the Universidad Austral de Chile.

2. Current scenario of higher education in the region

2.1.- Changes in the external environment and its impact on the institution (UACH)

In recent years, there has been an explosion in educational provision in higher education at regional level. Six years ago UACH was the only university in the city of Valdivia and only one other university was in the region. Currently there are four Universities in the city and four Technical Training Centers. The current supply in the area of Information Technology includes Civil Engineering in Computer Science at UACH and Civil Engineering in Computer Science, Software Programming and other related degrees in Technical Training Centres.

Also it is observed an increase in the number of companies and projects that require highly qualified personnel in the area of computing with leadership skills. Moreover, the nature of the current company, with a high degree of diversification in their products or services, requires flexible professionals with learning skills, the ability to work in multidisciplinary teams and with strong level of networking nationally and internationally.

In addition, the global society in which we live requires professionals able to communicate in more than one language, and whose formation is readily comparable.

2.2.- Need for reorientation of the educational activity UACH

External environmental changes described above raise the need of reorient the educational activity in the UACH. In particular:

- i) The development of more flexible curricula including various levels of degree, which increase the attractiveness of academic offerings and at the same time responds to the extremely heterogeneous of our students.
- ii) The inclusion of generic and long term skills, to develop future professionals with such capabilities as fluency in communication in more than one language, teamwork and leadership, adaptability to new situations, holistic thinking, interdisciplinary, learning to learn, among others.
- iii) To increase student mobility, inside and outside the university, nationally and internationally.

2.3.- Characteristics of the student entering the Civil Engineering in Computer Science degree in UACH

a. - Educational Level: Students entering the degree generally comes from both private and public high school They are characterized by very heterogeneous levels of education.

b. - Learning Styles: We have studied the learning styles of our students, using the questionnaire of Honey and Alonso on Learning Styles (CHAEA). Currently, 35 students have answered it in the second half of the first year of the degree. This

study reveals that students in this group have mostly a reflective learning style, second theoretical and in rare cases, can be characterized as active or pragmatic.

c. - Technology Use Skills: The level of technology knowledge and basics skills of the students is satisfactory due in part to the effort made by government to incorporate technology in schools. The good level is also explained considering that students are motivated by the computer area.

d.- Organizational Culture: As described, UACH is committed in changing the traditional approach with one based on competence, which is reflected in the academic guidelines raised by the administration and the development of various MECESUP (Ministry of Education de Chile) project which take over the quality of education issues. However, until now, the incentives for the participation of faculty are not fully understood and the academic (over)load that this change brings has not been appropriate estimated. With respect to students, we see a lack of information regarding educational changes and even, some bewilderment.

e.- Student-teacher interaction: interaction between students and teachers is in general perceived by teachers as largely passive on the part of students. Students are still looking for the teacher's authority. In a smaller percentage, students are participatory and show a good degree of autonomy in their learning process.

3.- Methodology for definition of the competency profile

To raise the competency profile for the Civil Engineer in Computer Science from the Universidad Austral de Chile, we use a lot of information originating from our graduate students and their employers. Through it, we could detect the professional skills required and we put them in the graduate profile. Also we made use of standards of international institutions such as the ACM and IEEE, and nationally, the recommendations that CNAP (National Professional Accreditation Commission) make for engineer degree.

The methodology chosen to raise the profile of skills, has been the constructivist analysis, characterized by being focused on work activity and its dynamics, ie a more complete analysis than other tests (DACUM, AMOD and Functional Analysis) and that incorporates the temporal dimension. It realizes in a better way the work of a Civil Engineer in Computer Science. Moreover, the principles of cognitivist and constructivist underlying learning methodology are consistent with the implementation of competency-based curriculum, whose main tool is the diversification of teaching-learning methods to the so-called active methods, whose main base is constructivism [1] [3].

We concluded that the professional profile of Civil Engineering in Computer Science from the Universidad Austral de Chile must describe professionals qualified in the following areas of competence:

- i) Manage the integration of technology solutions to organizational strategy and environmental variables.
- ii) Develop software systems according to quality standards in processes and products.
- iii) Planning and managing effective and efficient use of information and communications technologies, working in multidisciplinary and multicultural teams, as part of the formative plan of the Universidad Austral de Chile.

The educational route used to achieve the above corresponds to a modular organization, allowing greater flexibility and follow a logical sequence to the characterization of pedagogical skills. Also, some considerations involving institutional policies must be taken into account:

- i) The extent of each module can not exceed one-half.
- ii) The career structure has three cycles: bachelor's degree (2 years), BA (4 years) and professional (6 years).
- iii) The UACH has defined a set of skills as a part of its identity and they must be consider and conducted by each of its careers .

4. Building a curriculum matrix for the domain "Develop software systems following quality standards in processes and products"

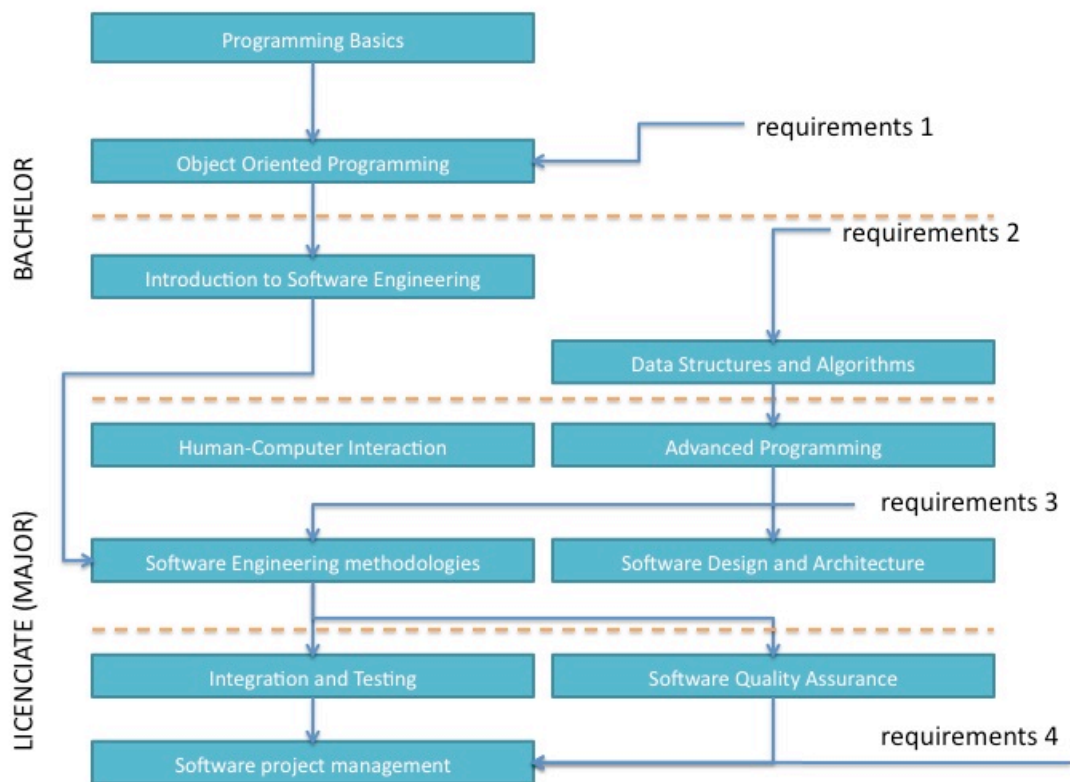
A Curriculum Matrix can be defined broadly as the set of content or materials grouped by subject areas in order to account the professional profile / occupational skills. They are distributed according to the time and credits of the curriculum[1]. In the competency-based approach, the content selection is made based on the profile of competency previously identified. Thus, once the domain expertise is identified, we have to look for the required different types of knowledge needed to develop them. For the selection of content we used two types of criteria. On the one hand the technical criteria of the teachers responsible for teach in the domain of Software Systems Development and on the other hand, the core contents of the Software Engineering established in the ACM.

4.2 Determination of main specific knowledge and skills to develop

In the curriculum matrix for the domain "Developing software systems following quality standards in processes and products", Annex 1 shows all the specific knowledge and skills to develop for each competence associated with the domain. The knowledge is characterize in declarative, procedural and attitudinal dimensions and ranked in essential, necessary and complementary. Also we have determined the module in which it is achieved the stated knowledge and skills.

4.3.- Module Sequence

Modules were organized sequentially from bachelor through the graduate and professional level (see Figure 1).



Requirements 1: algebra, basic abstraction

Requirements 2: linear algebra

Requirements 3: basic english, fluid communication, reading comprehension, ability to synthesize and contextualize, writing, respect

Requirements 4: self-confidence, elements of finance, basics of organizational theory, operations research and optimization of resources, methods of statistical inference.

Figure 1: Module sequence

5. Module details and description

Name: Object Oriented programming

Introduction

This module develops in the student the ability to build software systems using Object Oriented paradigm. To do this, the student should be able to identify and interpret UML artifacts provided for the analysis and design of a software application. Then, she must be capable of code the software in Java.

This module connects to the previous modules through partially developed skills related to algebra, algorithms, teamwork and oral and written communication skills. This

module is part of the formation of the domain of Software Engineering and is requisite for Introduction of Software Engineering module.

Competence

Building object-oriented computer programs that meet pre-defined UML designs, including user interfaces.

Competence breakdown

Unit of competence 1

Build basic programs in JAVA language from a UML class diagram and a description of functionality

Unit of competence 2

Building Java programs from a UML class diagram including composition and inheritance relationships.

Unit of competence 3

Build computer programs that include graphical user interfaces.

Scenary of competence

The Civil Engineer in Computer Science in her professional work will face participation in software development teams. In this area a recurrent problem is the interpretation of UML diagrams, possibly developed by other team members. From this interpretation she must code programs in a object oriented programming language.

Knowledge selection

Competence Unit 1

- Basic UML class diagrams.
- Coding software as a part of the software developing process.
- Introduction to Java programming language and building first programs.
- Manipulating Java arrays.

Competence Unit 2

- Composition and inheritance relations in a UML class diagram
- Composition and inheritance relations coding in Java.

Competence Unit 3

- Graphic user interfaces without interaction capabilities.
- Graphic user interfaces with interaction capabilities (events and listeners).

Methodological strategy

a) Activities (for all units)

- Developing a portfolio for each student that includes a tracking sheet for the exclusive use of the teacher.
- Attendance at lectures (Chair) including dynamic discussion and working in groups.
- Guided activities in computer lab.

b) Assessment and Grade

Will use the following assessment tools for the development of each of the competence units

- Diagnostic test (unit 1 only) testing the required previous skills for abstraction and basic elements of programming (data types, control structures, operations, logic)
- Individual Portfolio, which allows to determine the performance throughout the unit and to observe the behavior of students in classroom and laboratory as well as to review written assessments and group work informs.
- Partial test (written) to measure the level of acquired content and its application in specific cases.
- Reports (written) of guided laboratory activities in which students must put into practice the skills acquired on the basis of content . Also, they must show writing skills regarding analysis and synthesis of text.

c) Relation with the curriculum

Competence developed in this module is connected with skills developed in whole or in part in previous modules such as algorithmic, creativity, teamwork, oral and written communication. In this way the module has an integral role with the previously acquired skills.

The competence is developed at a medium level of complexity in this module. In subsequent modules it goes deeper by both increase of the problem's complexity and in the variety of paradigms applied (concurrent programming, component-based programming, etc.).

d) Resources

- Classroom with a capacity for all students of the subject, with multimedia projector and blackboard. Must have mobile desks for group activities.
- Access to LMS (Siveduc) for delivery of reports, publication of notices and unloading material.
- E-mail to send messages and announcements.
- Computer lab with J2SDK1.5.0 software or higher installed.

- Develop laboratory assistantships, peer support to students.

6. Hours

Total amount of hours needed: 99 (see detail in Table 2)
Lecture and laboratory hours: 45

Unit 1	Lecture: 9 Laboratory: 9 Homework: 15
Unit 2	Lecture: 7.5 Laboratory: 6 Homework: 16.5
Unit 3	Lecture: 3 Laboratory: 10,5 Homework: 22,5

Requirements

- Mathematical abstraction
- Basics of programming
- Basics group working
- Communication orally and written.

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6. Conclusions.

This article has described the development of a competency-based curriculum and one of its module for the Civil Engineering in Computer Science Degree at Universidad Austral de Chile. It underlines that in this process takes explicit considerations regarding skills than in a regular curriculum are hidden or undervalued, such as fluency in communication, teamwork and leadership, adapting to new situations, learning to learn, among others. The curriculum developed has the flexibility and potential to meet the competences required by the employers.

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