

TUNING (CIVIL) ENGINEERING: THE 2013 EU-CHINA STUDY

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INTRODUCTION: WHAT IS “TUNING”?

“TUNING Educational Structures in Europe” started in year 2000, following the experiences of the ECTS pilot projects of the 90’s, as a project to link the political objectives of the Bologna Process (and at a later stage the Lisbon Strategy) to the higher educational sector. Over time, these activities evolved in some disciplines into an attempt to “redesigning, develop, implement, evaluate and enhance quality of the first, second and third cycle degree programmes in Europe” [1], while the “Tuning Academy” was founded. The “Tuning” procedures and processes have been tested by many Higher Education (HE) institutions around Europe and now the world.

The denomination “Tuning” was adopted to express the need to search for cooperation, for benchmarking and for transparency of the European HE course curricula and programmes, taking into account the diversity and the richness of the European HE. “Tuning” was not created to standardize or to format the curricula and programmes, and addresses the HE institutions and its academic staff at the subject areas and at the content of the programme courses. The opportunity and usefulness of the “Tuning” initiative are related with the transformations in education systems in Europe motivated and supported by the Bologna process.

“Tuning” distinguishes between Learning Outcomes (LO) and Competences. Learning Outcomes are defined as descriptions of what a learner, at the end of the learning process, is expected to know, to understand and be able to demonstrate. LOs can be related to a programme, a course or a module; they are defined by the academic providers in conjunction with the society representatives and stakeholders. Competences are the collection of knowledge, understanding, skills and abilities. Competences are relevant for stakeholders outside the academic arena like professional organizations and the society at large. These are generally considered

and evaluated at the end of the programme or a stage of it, like a first cycle or a training module. Competences are defined by accrediting professional bodies or by government agencies.

The main goal of Tuning is to promote, maintain and increase the quality of the programs in Higher Education using tools based on the project outputs. The adopted strategy was based on building mutual understanding of the programs across nations and institutions so trust can be nurtured among the stakeholders involved: students, academic staff, HE institutions, educational bodies, professional organizations and society as a whole. The typical Tuning approach consists a drafting sets of competences for each tackled subject areas, composed by two groups: Generic (or Transversal) Competences and Subject-specific competences, and then performing surveys and dialogue with the related stakeholders like employers, academics and professionals in each of the subject areas. This work has been carried on for several years and has allowed identifying Generic Competences, common to all subject areas, and Specific Competences for each subject area [2].

2. TUNING AND ENGINEERING

2.1 Initial subjects, synergies, and problems

The initial Tuning project was limited to five subject areas: Mathematics, Business Administration, Education Sciences, History and Geology (Earth Sciences), but several possible “synergies” were soon recognized in other subject areas, like European Studies, Nursing, Physics, Chemistry and Engineering.

The Socrates/Erasmus Thematic Network “Enhancing Engineering Education in Europe – E4” formed an *ad-hoc* “Synergy Group”, who prepared a 48-page Report that was included in the 2003 E4 final Proceedings [3]: this Report contained an analysis of the Tuning approach and achievements, and positive suggestions on how to develop them with particular regard to the engineering field. Unfortunately, these suggestions had no effect whatsoever, and the worlds of Tuning and of Engineering Education remained disconnected.

But reality is now prevailing, since most, if not all, new Tuning projects require some “engineering” among their subjects, and the Tuning leaders seek relevant experts from sister organizations (SEFI, EUCEET, ENAEE, ...), as in the following examples.

2.2 The Tuning-AHELO Framework (2009)

Within the first stages of the AHELO (Assessment of Higher Education Learning Outcomes) project, promoted by the OECD Directorate of Education, the Tuning Academy was asked to define conceptual frameworks of expected/desired Learning Outcomes in Engineering and Economics following the Tuning approach. Two groups of experts were formed, and met in Brussels on 4-5 May 2009.

The Engineering Framework [4] was the result of a comparative review of the EUR-ACE Framework Standards for the Accreditation of First-cycle Engineering Programmes and the ABET criteria for accrediting engineering programmes, consistent with other relevant sets of learning outcomes. The Learning Outcomes are grouped under five headings: Generic Skills, Basic and Engineering Sciences, Engineering Analysis, Engineering Design, Engineering Practice. Learning outcomes for three main engineering branches (mechanical engineering, electrical engineering and civil engineering) were also developed.

2.3 Tuning in Latin America

As a consequence of the expansion of Tuning to other areas in the world, two projects were carried out in Latin America. The first one occurred between 2004 and 2007 in the context of programme Alfa of the European Commission. It was proposed after exploratory conversations between the Tuning coordinators and representatives from the HE in Latin America initiated in Cordoba, Spain in 2002 and with a proposal finalised in 2003. The objectives for Latin America HE of this Alfa Tuning project were to contribute to the development of comparable and comprehensible qualifications, to promote a significant level of convergence in HE in twelve subject areas, to develop professional profiles in terms of generic competences, to facilitate transparency of educational structures, to create networks for exchange of examples of good practices, to promote recognition of qualifications and to connect universities with qualified bodies. One of the subject areas studied was Civil Engineering. The Tuning approach was used with the participation of several European experts and involved 183 universities from eighteen countries of Latin America [5].

A second project started in 2011 and used the outputs of the previous one trying to make the educational structures converge using the Tuning framework [6]. The work intends to collect and exchange information and to improve the collaboration between Latin America HE institutions. There are about 230 academics involved from eighteen Latin American countries and from thirteen European countries. The project management created sixteen subject areas networks. The main tasks of these networks address the identification of the subject area learning outcomes at the course and program levels and to define the profiles in terms of competences for professional qualification. As examples of the implementation of the Tuning framework Generic Competences (Annex 1) and Specific Competences for Civil Engineering (Annex 2) were adopted.

2.4 Tuning in Canada

Another expansion of the Tuning framework and initiatives was the Canada – EU Tuning Feasibility Study financed by the European Commission and occurring between 2011 and 2012 [7]. It was coordinated by the Tuning Association having as counterpart in Canada the Canadian Bureau for International Education (CBIE). This study arises from the EU-Canada Policy Dialogue included in the third EU-Canada Agreement in Higher Education, Training and Youth, 2006-2013. The project had as objectives to investigate the alignment of academic standards and reference points in HE for Canada and the EU, to assess the opportunity of a Tuning approach in Canada and to propose a way to realize a Tuning pilot project.

The study consisted in having the results from study visits to Canada and from desk research performed by a group of Tuning experts. The visits were made to a group of selected HE Canadian representing the country structure and the three subject areas studied (Engineering, History and Nursing). The outcome of the project was a final report pointing out the possibilities of further dialogue between stakeholders in Canada and the EU. The items to be addressed are related with offering attractive education, student and graduate mobility and clear understanding in terms of learning based on compatible and comparable outcomes and recognition of prior learning. The academic structures of qualification of the engineers in Canada and in EU are identical. Concerning professional qualification of the engineering programs both parts have procedures based on learning outcomes and on competences. The differences of the accreditation programs are in the duration of the periods of accreditation, in the constitution of the accreditation teams, of the methods used to

evaluate the quality of the programs and of the number of learning outcomes.

2.5 The “TUNING Russia” project

“Tuning Russia” [8] was a TEMPUS project of a consortium of 16 universities, 12 from various regions of Russia and 4 from Europe, lead by Astrakhan State University. The goal of this project was to coordinate European and Russian models of education in 8 different subject areas, among which Environmental Engineering. The project developed generic and subject-specific competence lists; the Generic Competences Lists were also compared with the lists of generic skills competencies provided by CDIO Syllabus v2.0 [9], showing that, according to the Authors [8], the European, Russian, and American higher educational systems formulate their generic competencies in a very similar way, which suggests that there are good prospects for convergence and collaboration between Russian and EU universities.

3. TUNING IN CHINA

3.1 Motivation and objectives of the EU-China Tuning Study

This study, the latest endeavour of Tuning, supported by an EC grant (DG Education and Culture), intends to contribute to the current development and modernisations of Chinese Higher Education.

As stated in the *Chinese National Program for Medium/Long Term Education Reform and Development* adopted in 2010, education is seen as the cornerstone of national rejuvenation and social progress, and a fundamental way to improve citizen quality and promote their all-round development. The nation experiences developing education and raising its modernization level a condition for building a prosperous society in all respects and for making China a strong, democratic, culturally advanced and harmonious modern country.

Since the beginning of the 21st century, free compulsory education has become the norm in urban and rural areas, vocational education has made fast headway, higher education has reached a new stage of popularization, rural education has been growing in strength, and remarkable progress has been made in achieving education equity. Education development has vastly enhanced the quality of the entire nation, stimulated innovation in science, technology and cultural prosperity, thereby making irreplaceable and significant contributions to economic growth, social progress, and the enhancement of people’s lives. China has by now accomplished the transition from a populous nation to a nation with a larger scale of human resource. While the world is undergoing profound changes, in China science and technology are making rapid strides, and competition for talents or professionals is intensifying on a daily basis.

In China all-round progress is being made in economic, political, cultural and social development as well as in promoting eco-environmental ethics. As industrialisation, informatisation, urbanisation, marketisation, and internationalisation develop in depth, pressures from the population, resources and the environment are mounting, the call for restructuring the economy and shifting the mode of development has taken on a more urgent tone. The world economic crisis has brought into bold relief the pressing need to enhance citizen character and cultivate innovative personnel.

The Chinese concept of education and teaching contents and methodology is, according to the Chinese authorities, relatively out-dated; schoolwork burdens on primary and middle school students are experienced as being too heavy, students are weak in their adaptability to society, and innovative, practical and versatile

professionals are in acute shortage. The Chinese educational system and mechanisms are seen as being not flexible enough, schools lack autonomy, and the structure and geographical distribution of education are yet uneven. It is therefore seen as imperative to persist in the cultivation of people as a fundamental mission, drawing strength from reform and innovation, emphasizing equity, carrying out quality oriented education in an all-round way, and pushing scientific education development.

For the EU-China Tuning Study three subject areas have been chosen, in consultations with the Chinese authorities, namely Education Sciences, Business, and Engineering (with special emphasis on Civil Engineering).

The authors of this paper are the European experts in the engineering area. They will assist the involved Chinese academics in pursuing the project objectives, which are:

- a) Development of conceptual frameworks tailored to the Chinese situation.
- b) Organisation of the consultation surveys in close cooperation with the different sectoral / subject area groups. Analysing of data which result from the consultation and comparison of those data with the outcomes of consultations executed in other regions of the world.
- c) Preparation of a report which identifies communalities and differences between the European and the Chinese higher education systems, offers mutually acknowledged criteria for quality enhancement and assurance and practical tools and mechanisms for mutual recognition of (parts of) academic studies.
- d) Preparation of intermediate reports regarding the progress of the study and a final report with respect to its outcomes. Further explanation of progress and outcomes will be done at face-to-face meetings in Brussels.

3.2 Work programme

The EU-China Tuning Study was formally opened by a Preparatory Meeting held in Xi'An on 23-24 March 2013. Each of the three Subject Areas (Civil Engineering, Business Administration, Education Sciences) is coordinated by a Chinese University leading in the field: Tong Ji University, Shanghai for Civil Engineering; Xi'an Jiao Tong University, Xi'an for Business Administration; Beijing Normal University for Education Sciences.

The Civil Engineering Working Party is lead by Professor Huang Hongwei of Tongji University and includes as experts Prof. Lv Dagang, Harbin Institute of Technology; Prof. Li Zhengliang, Chongqing University; Prof. Ma Zhiliang, Tsinghua University; Prof. Shi Qingxuan, Xi'an University of Architecture and Technology; Prof. Ye Weimin, Tongji University; plus the authors of this paper, G. Augusti and A. Soeiro, as European experts.

In accordance with the Tuning approach, a list of "Generic Competences" and three lists of "Subject Specific Competences" are being prepared and will be submitted to project participants and relevant stakeholders to assess

- (i) the importance of the skill or competence for professions related to the each subject area, and
- (ii) to which level each skill or competence is developed by degree programs in the respondents' university. It will be also possible to suggest important skills and/or competences missing from the lists.

In particular for Civil Engineering, it is planned to seek responses from 30 Graduates (7 years after graduation), 30 Academics (Professors and Lecturers), 30 Employers (government officials, owners of design offices, construction companies, etc.), 30 Students (4th year, Master and Doctoral students). The proposed draft lists should be distributed within May and the answers collected in June. The elaborated lists, a report of the first results and an updated work programme will be presented at the SEFI Conference in September 2013.

CONCLUSIONS: some proposals

In the last few years, the Tuning approach has been already applied several times to the subject area of Engineering and, in particular, to Civil Engineering. Most of these experiences, past and current, have occurred outside the European context. These cases, as illustrated in this paper, have been useful and effective. "Tuning in Latin America" succeeded in defining consensus for generic competences and specific competences in Civil Engineering. The feasibility study for Tuning in Canada addressed Engineering as a whole and managed to identify common features and differences in the educational structures, and showed it may be possible to obtain agreement on Tuning tools useful for EU and for Canada. The current "EU-China Tuning Study" is another example of the interest in applying the Tuning framework for Civil Engineering to improve quality of the educational structures.

It should also be noted that, notwithstanding the different approaches, all competences lists elaborated in these projects overlap in great measure the Engineering "Tuning-AHELO Conceptual Framework" [4].

It seems appropriate to reason that a possible next step for Tuning may be to consider Engineering as a "Tuning" subject area, and define lists, not related to particular projects, of generic and specific competences for engineering as a whole and/or some of its specializations (branches). These lists could be elaborated in cooperation with the European Network for Accreditation of Engineering Education (ENAAE), which has accumulated experience of dealing with the requirements of Engineering professional organizations and HE institutions. Such a project could benefit from the Tuning methodology and from the suggestions of the stakeholders of ENAAE, and foster an improvement of European Engineering Education.

With specific regard to the EU-China Tuning study, the proposed methods and working plans may bring a closer cooperation of Engineering in Europe and in China towards understanding and trust. This project can provide mutual knowledge and recognition of the level of quality of the educational structures. The study can also be expanded in the near future to other Engineering branches besides Civil Engineering, allowing the education of graduates with a recognized level of quality. It is known that Engineering professionals are an important economic asset that is required in all parts of the world. If two important regions, like China and EU, can establish a similar framework for assurance of the quality of the graduates that may foster joint development with checks and balances for both sides.

SUMMARY

"Tuning Educational Structures" is a university-driven process, developed in Europe to implement the Bologna Reforms, which offers a universal approach to higher educational reforms both at the macro-level of entire higher educational institutions and at the micro-level of individual disciplines or subject areas. The initial (and still basic) subjects of "Tuning" did not include engineering, contrary to what happens in all most recent and current initiatives, like the "EU-China Tuning Study", that will

tackle three subject areas, namely Education Sciences, Business, and Engineering (with special emphasis on Civil Engineering).

The Authors of this paper are the European experts in the engineering area and will assist the involved Chinese academics and the Tuning leaders.

DEDICATION

This paper is dedicated to the memory of Francesco Maffioli, who – among his many and manifold activities for the development of Engineering Education – promoted and chaired the “Tuning - Engineering Synergy Group” of the E4 Thematic Network [3].

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Annex 1: Tuning Latin America: Generic Competences (Civil Engineering)

- 1) Capacity for abstraction, analysis, and synthesis.
- 2) Ability to apply knowledge in practice.
- 3) Ability to organise and plan time.
- 4) Knowledge regarding the area of study and related professions.
- 5) Social responsibility and commitment to citizenship.
- 6) Capacity for oral and written communication.
- 7) Ability to communicate in a second language.
- 8) Ability to use information and communication technology.
- 9) Capacity for investigation.
- 10) Ability to learn and update learning.
- 11) Ability to search for, process, and analyse information from a variety of sources.
- 12) Critical and self-critical abilities.
- 13) Ability to react to new situations.
- 14) Creative skills.
- 15) Ability to identify, present and solve problems.
- 16) Ability to make decisions.
- 17) Ability to work as part of a team.
- 18) Interpersonal skills.
- 19) Ability to motivate and work towards common goals.
- 20) Commitment to look after the environment.
- 21) Commitment to socio-cultural environment.
- 22) Value and respect for diversity and multiculturalism.
- 23) Ability to work in international contexts.
- 24) Ability to work autonomously.
- 25) Ability to formulate and manage projects.
- 26) Ethical commitment.
- 27) Commitment to quality.

Annex 2: Tuning Latin America: Specific Competences in Civil Engineering

1. Ability to apply knowledge of the basic sciences and sciences of civil engineering
2. Ability to identify, evaluate and implement the most appropriate technologies for the context in hand
3. Capacity to create, innovate and undertake to contribute to technological development
4. Capacity to conceive, analyse, calculate and design civil engineering works
5. Skill in planning and programming civil engineering works and services
6. Capacity to build, supervise, inspect and evaluate civil engineering works
7. Capacity to operate, maintain and rehabilitate civil engineering works
8. Skill in evaluating the environmental and social impact of civil works
9. Capacity to model and simulate civil engineering systems and processes
10. Capacity to direct and lead human resources
11. Skill in administering material resources, teams and equipment
12. Capacity to understand and associate legal, economic and financial concepts in decision-making , project management and civil engineering works
13. Capacity for spatial abstraction and graphic representation
14. Capacity to propose solutions that will contribute to sustainable development
15. Skill in preventing and evaluating accidents and risks in civil engineering works
16. Skill in handling and interpreting field information
17. Skill in using information technologies, software and tools for civil engineering
18. Capacity to interact with multidisciplinary groups and come up with integral civil engineering solutions
19. Skill in employing quality control techniques in managing civil engineering materials and services