

# SPECIFIC SKILLS ASSESSMENT LEARNED BY STUDENTS OF BUILDING ENGINEERING AND TECHNICAL ARCHITECTURE IN TOPICS RELATING TO DURABILITY AND CONTROL OF CONCRETE STRUCTURES

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## Abstract

In many university courses such as Building Engineering or Technical Architectural, the high density of the contents included in the curriculum, make the student, after graduation, unable to develop the skills already acquired and evaluated in the disciplines of the first courses.

From the Group of Educational Innovation at the Polytechnic University of Madrid (UPM) "Teaching of Structural Concrete" (GIEHE) we have conducted a study in which are valued specific skills acquired by students after the first courses of career. We have worked with students from UPM fourth-year career and with Technical Architecture students who have completed their studies and also have completed the Adaptation Course of Technical Architecture to the Building Engineer. The work is part of the Educational Innovation Project funded by the UPM "Integration of training and assessment of generic and specific skills in structural concrete" We have evaluated specific skills learned in the areas of durability and control of structural concrete structures.

The results show that overall, students are not able to fully develop the skills already acquired earlier, even being these essential to their professional development.

Possibly, the large amount of content taught in these degrees together with a teaching and assessment of "flat profile", ie, which are presented and evaluated with the same intensity as the fundamental and the accessory, are causes enough to cause these results.

Keywords: Building Engineering, Durability, Control, Concrete Structures.

## 1 INTRODUCTION

The incorporation of the Spanish University educational system to the European Space of Higher Education demands from the Universities the adaptation of the degrees according to common structures. Since we are in the early years of implementation of the new curriculum, distribution and extent of the content set out in the programs of the different subjects continues to evolve. These new university educational approaches involve the change of the existing degree of Technical Architecture by the Building Engineering and the adaptation process supposes to implement new teaching strategies to cope successfully with the training requirements of the Building Engineers[1], [2], [3].

The educational organization created by the EHEA, resulted in the implementation of the credit system and is based on the reduction of the number of hours of class in favor of number of working hour of the student. From the educational point of view, the result is the reduction of class hours on-site for practices supervised by the teaching staff. Higher education will be divided into two cycles, a generalist orientation degree and a postgraduate degree of specialist guidance.

We must emphasize that the principle that articulates this system is the acquisition of skills, opposite to the acquisition of knowledge, so these degrees and postgraduate courses will be strongly directed to give answer to the labor needs that exist in the society.

Therefore teachers before this change, we are changing and trying to adapt, both programmes and methodological learning strategies, in the most appropriate way to approaches that require the new plans of study projected in the University Education. All of this is aimed at solving problems of absenteeism, abandonment and improve academic results.

The Technical Architects and soon the Building Engineers are the persons responsible for the process of execution of architectural projects. It is a figure necessary for the management of the implementation process, which assumes the Organization of proceedings of the rest of professionals involved in the different phases of the same one [4].

In the process of execution of the architectural works, this multidisciplinary confluence integrates a plurality of complex activities of managing such as the Organization of personnel and companies involved in the work, economic management of the work, safety of workers, quality of the process, etc. These activities justify a solid training and coordinated the technical responsible for the building process.

This multiplicity of activities all them different but integrated in the challenge to construct quality buildings makes the process of execution of works managed by competent technicians perfectly trained and able to develop their skills with knowledge and professionalism [5].

To do so, there are formed the Programs of the subjects to respond to the needs and which are integrated into the disciplines that constitute the Plan of Studies of Engineering of Building of the Polytechnic University of Madrid are configured [6].

In the teaching guide there are specified the activities that are going to be realized, the content of the theoretical classes and their distribution, the practices, works in group. The Specific and general skills to be acquired. General and specific competences which should be able the student, the activities through which checks, and how these skills are evaluated.

The learning guide (tutorial) describes the activities of teaching, learning and assessment. Also the methodology in which they are based those activities, the schedule of work, the general system of evaluation and resources for teaching and learning.

Poor academic results and abandonment of the studies are the result of many factors, but teachers need to establish methodological strategies to motivate students and allows them to overcome with solvency their curricular objectives [7]. The objective is to train competent professionals of construction, which combine the specific scientific knowledge of the subjects under study with the demands of the professional practice [8].

An important factor in raising the quality of education is the change in the pedagogic practice of educators. Teachers should act more as strategists, managers or learning mediators that as transmitters of information.

The new education model based his theory on the concepts of motivation, structure, sequence and reinforcement, which rigorously an educator must be take into account at the time of teaching or the planning of the class. The student must be willing to learn, knowledge from a subject should optimally

be organized so that it can be transmitted in a manner that is understandable. The content must be organized in a certain sequence and, finally, the learning must be reinforced.

To obtain an integral formation faced to the theoretical and practical knowledge, one chooses to integrate the acquisition of the objective knowledge and the putting in practice of the same ones in subjective situations, that is to say:

a) The skills that must be acquired for the correct planning and execution of the work, objective ambience that decides in the Memory of the Qualifications of Engineering of Building.

b) The skills that it must develop for its domain and putting in practice by means of learning of methods of work adapted to such an end(purpose) in a specific way, as it is the work of building –

This dual action theory-practice allows you to develop transverse skills inherent to an integral formation of the students, as well as specific powers of a personal nature and systemic [ 9].

With the new teaching and learning strategy is pursued a comprehensive training of the student to respond to the training needs of the Building Engineers responsible for the execution of projects, according to the legal requirements and social needs.

As a reference, some of the basic objectives that are to achieve with the new training strategy are [10]:

- Promote the personal development of the student, promoting a positive attitude towards the knowledge of cross-cutting skills of a specialist technician in construction.
- To promote the technical and professional development of students through the specific knowledge of the skills needed to organize a work of building.
- Direct the formation of the student towards autonomous learning and the use of the acquired knowledge, and thus discover its practical applicability.

Educational strategies should seek to training that combines the acquisition of scientific knowledge and practical skills of the Engineer [11], [12], [13].

As a result, must be formed professionals capable of managing the material execution of the construction building, carrying out qualitative and quantitative control of what has been built.

According to J. Biggs [14], it is possible to formulate the assumptions underlying three common theories of teaching:

1. Learning is primarily a direct result of individual differences between students.
2. Learning is primarily the result of appropriate teaching.
3. Learning is the results of students' learning-focused activities which are engaged by students as a result both of their own perceptions and inputs and of the total teaching context.

Education, therefore, should be directed to the student to learn how to manage the implementation of the construction works with Concrete Structures of their materials and elements. Ultimately, it must be able to perform exacting standards on Concrete Structures, Inspections, Analysis, Reports and Technical Documents.

With all these background arose, on the initiative of a group of teachers at the School of Building Engineering in Madrid, the creation of a research group to conduct a follow-up to the students on the skills acquired in a subject (so important to your training as Building Engineers), as is the structural concrete.

From the Group of Educational Innovation at the Polytechnic University of Madrid (UPM) "Teaching of Structural Concrete" (GIEHE) we have conducted a study in which are valued specific skills acquired by students after the first courses of career to develop the topics related to the Structural Concrete. In the research group there are participating teachers of 7 subjects of the degree.

The objectives of this study are on the one hand check whether students have acquired the skills necessary in specific field of structural concrete or if, on the contrary, have not yet been reached and then be able to detect which have been the reasons. Currently, the research is still in progress which is why, in this paper we present the approach and methodology of the project and partial results. .

## **2 METHODOLOGY**

First of all, there was proposed the achievement of a survey directed to the pupils who were studying the Project of End(Purpose) of Career of Technical Architecture: in the survey questions were formulated about the educations received in the different subjects on the Structural Concrete in all its aspects: Material, Construction, Calculation, Peritación, Repair, Measurement, Durability, etc.

The raised questions contemplate aspects like(as): evaluation of the contents of every subject regarding the structural concrete and its adequacy to the professional training, to judge if the content is insufficient or on the contrary excessively, to think if solapan in excess the educations on the structural concrete between subjects and, finally that should realize a general evaluation of the knowledge acquired in the matter in the set of the experienced subjects.

To achieve the objectives set, the project has split into different phases defining the results for that we wait in each of them.

### **2.1 First phase**

The first stage of project development has been the assessment of skills acquired by students of the EUATM on matters related to the Structural Concrete.

This work has been carried out to assess pupils of End of Career Project (PFC) of the curriculum of Technical Architecture (AT). The evaluation has been carried out through the design of two integrators work of the field of structural concrete. It is delivered to two groups of students from PFC (each group is composed of 5 students) a basic project of a concrete structure.

One of the projects has delivered an innovative character, while the other is conventional. Each group develops the project with all its documentation in response to all matters related to structural concrete: materials, construction, design, calculation, measurement, prevention, security, organization and maintenance. The proposed works are the following:

#### *2.1.1 Work with innovative Concrete Structure:*

Robotic parking Concrete Structure.

#### *2.1.2 Work with traditional Concrete Structure:*

Residential Building Concrete Structure project.

Once delivered the basic project to the two groups, the students have to carry out the proposed work. The permanent mentoring during the realization of these jobs will allow you to detect the level of skills acquired throughout the academic courses. Therefore, this monitoring will allow the evaluation of cross-curricular skills and specific acquired by the pupils and the detection of the competencies not reached.

## 2.2 Second phase

In this second stage, the seeks to implement the integration of the training and assessment in transversal competencies with the preparation in specific competences in Structural Concrete

From the Ministerial Order ECI/3855/2007 and the teaching guide of the EUATM, obtain the transversal competencies and specific that should be achieved in the subject Structural Concrete.

1. Definition of a "minimum program" for the Structural Concrete.
2. Identify the subjects of the degree program that contribute to the development of specific competencies in Structural Concrete.
3. Identify the specific contents of each subject that contribute to the development of specific competencies in Structural Concrete.
4. Identify the transferable skills of each subject matter related to the Structural Concrete.
5. *Design of two cases to integrate the training and assessment in transferable skills with training in specific competences in all parts of all the subjects related to the Structural Concrete.*

**Case 1.** Expertise of a reinforced concrete structure. To achieve the specific competence 'fitness for the testing of concrete structures' can be followed the methodology of teaching cases 'development', in this case development of a case as a team. In this way, the transferable skills of organizational capacity, knowledge of a foreign language and team work are put into play from the activities and exhibition of work and employment of terminology in english, for the preparation of a specific competence. Will be delivered the documentation of a structure that has already been carried out so that the students carry out their check, based on different rules. The documentation will be delivered in English and in Spanish. The work will be carried out in teams of 5 students of degree.

**Case 2.** Implementation of a concrete structure unique. From the documentation of a non-conventional structure, a group of 5 students will carry out the plan of implementation of the same, integrating materials, construction, prevention, safety, organization, measurement and maintenance.

During the development of the second phase will be followed by a mentoring and evaluation of the activity of the students.

## 3 RESULTS

As the project is still in progress, we have only partial results. To assess the results we are preparing different documents:

- Working Proposals for PFC
- The result of the tutoring to students during the development of the work. They are also doing reports on general and specific skills that should reach the students and the really reached. These documents will serve as indicators for assessing the results.
- Specific and transferable skills that must be reached in Structural Concrete.
- Specific and transferable skills attained by the students in the field Structural Concrete.
- Program for the minimum of the Structural Concrete.
- Specific competencies achieved in Structural Concrete.
- Generic Skills of each subject related to the Reinforced Concrete.
- Results of the guardianship made on students who have worked on the Case Study: expertise of a reinforced concrete structure.
- Results of the mentoring made on students who have worked on the Case Study: Implementation of a concrete structure unique

In these documents will be reflected all the obstacles that will face the students at the time of solving real-world cases and address issues relating to the building with structural concrete.

The project is proving very interesting from the point of view that encourages creativity and encourages the student to put into practice everything you learned and well, learn from another way.

The students have responded very positively to the activities proposed and have been at the same time, to express the difficulties and obstacles that have been found.

Therefore, the project is serving to bring the teachers we realize the faults of approach and development in the teaching of matters pertaining to the reinforced concrete.

As less positive part of the study is becoming apparent that the students are not able to develop optimally all skills they have acquired throughout his career.

## 4 CONCLUSIONS

The results show that overall, students are not able to fully develop the skills already acquired earlier, even being these essential to their professional development.

Possibly, the large amount of content taught in these degrees together with a teaching and assessment of "flat profile", ie, which are presented and evaluated with the same intensity as the fundamental and the accessory, are causes enough to cause these results.

The teachers we have to coordinate the different subjects and clearly establish the competences we want to reach by the students and how to acquire them on such an important matter for an Engineer of Building as it is the Structural Concrete

## REFERENCES

- [1] Ley 39/1999 de 5 de Noviembre de Ordenación de la Edificación. Boletín Oficial del Estado nº266 de 11 de noviembre de 1999.
- [2] Ministerio de Educación, Cultura y Deporte. "La integración del Sistema Universitario Español en el Espacio Europeo de Enseñanza Superior. Documento Marco. Madrid, 2003.
- [3] Real Decreto 314/2006 de 17 de marzo por el que se aprueba el Código Técnico de la Edificación. Boletín Oficial del Estado nº 74 de 28 de noviembre de 2006.
- [4] Marcos Alonso, J.A. (1974) "La estructura productiva del sector de la construcción y la profesión de Aparejador y Arquitecto Técnico. Evolución Histórica". 1ª Parte. Vol. IV. Consejo General de Aparejadores y Arquitectos Técnicos de España. Madrid.
- [5] Gil Ibáñez, J.L. (1993) "Las competencias profesionales de los Arquitectos Técnicos y Aparejadores". Editorial Edelvives. Zaragoza.
- [6] Izquierdo García, P.(1998) "Evolución histórica de los estudios, competencias y atribuciones de los Aparejadores y Arquitectos Técnicos". Editorial Dykinson. Madrid.
- [7] González Soto, A.P. (2002) "Enseñanza, profesores y Universidad". Instituto de Ciencias de la Educación, Universidad Rovira Virgili, Tarragona.
- [8] López, Garrido, D. (1990) "La Ingeniería Técnica y la Arquitectura Técnica. La profesión y el reto de Europa". Editorial Aranzadi. Madrid.
- [9] Corominas, E. (2009) "Competencias genéricas en la formación universitaria". Revista de Educación nº 235. Madrid.
- [10] Libro Blanco del Título de Grado de Ingeniería de Edificación. Agencia Nacional de Evaluación de la Calidad y la Acreditación. ANECA. Madrid.
- [11] Monedero, C., Castelló, M (1997) "Las estrategias de aprendizaje. Cómo incorporarlas a la práctica educativa". Edebé. Barcelona.
- [12] Pescador, J. E. (2006) "Metodologías de enseñanza y aprendizaje para el desarrollo de competencias. Orientaciones para el profesorado universitario ante el EEES". Revista interuniversitaria de Formación del Profesorado. Vol, 20. Nº3. Zaragoza.

- [13] Benito, A.; Cruz, A. (2007). "Nuevas claves para la docencia universitaria en el Espacio Europeo de Educación Superior". Narcea. Madrid.
- [14] Biggs, J. (1999). What the student does: teaching for enhanced learning. Higher Education Research and Development, 18 (1), p.p. 57-75.