

A PORTFOLIO APPROACH TO A M.SC. DEGREE IN CONSTRUCTION MANAGEMENT USING A COMMON PROJECT

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Abstract

The M.Sc. in Planning and Management in Civil Engineering, sponsored by the Universitat Politècnica de València, has been implementing innovations since its inception in 2008. During the last three academic years a single civil engineering project has been used as a common reference for the mandatory courses taught during the first semester. This implementation intended that the students were able to generate a portfolio. In the context of this paper, a portfolio is a collection of documents generated by coursework linked to each of the subjects, which are related to the management of the infrastructure throughout its chronological life-cycle: feasibility, design, construction, and operation. The goal of the implementation of the portfolio using a common project in the program is to generate a holistic vision of the students in the construction management field, as well as to guide students in the process of building their own knowledge, to facilitate their understanding of the construction management field as a system, and to acquire meaningful learning and horizontal competencies. The portfolio allows instructors to provide the necessary evidence for a more realistic and accurate assessment. This paper presents a specific application of the portfolio as a teaching and learning strategy that develops better coordination between subjects.

Keywords: construction management, learning, M.Sc., portfolio, project.

1 INTRODUCTION

The Master of Planning and Management in Civil Engineering (MAPGIC henceforth) sponsored by the Universitat Politècnica de València is developing a project on innovation and education improvement during this academic year 2013-2014 [10,22,23]. The main goal of the project is to improve the implementation of the case study method, which was firstly introduced during the academic year 2010-2011; this common project was used as a reference for the homework demanded by the teachers during the first quarter of the academic year [10,22,23].

MAPGIC applies a holistic management approach to construction from a business point of view [10,22,23]. Ever since then, the majority of the faculty has been deeply involved in a continuous improvement philosophy, implementing several initiatives to innovate the program and control its evolution and success [10,20,21,22,23]. The program is structured in one year of tuition divided into two semesters, plus an additional semester to develop a Master Thesis. There are 48 ECTS of mandatory course, 12 ECTS of elective courses, and a Final Master Thesis of 15 ECTS [10,22]. The courses are grouped by subjects, which are the ones that have to comply with the competencies established for the degree. Furthermore, in order to get accreditation the program has to comply with regulations from an external and recognized institution, in this case ANECA [1,2] in order to get the accreditation ACREDITA PLUS [3].

Due to the high current professional and academic mobility is necessary that national accreditations be recognized outside the countries where they are achieved. That is the reason for the establishment of the European Association for Quality Assurance in Higher Education (ENQA) as well as a European register of agencies (the European Quality Assurance Register for Higher Education, EQAR). In this context the creation of quality labels for certain areas and scientific, technical and professional sectors arises. The EUR-ACE® label, managed by the European Network for the Accreditation of Engineering Education (ENAE) ensures the quality of engineering programs in accordance with European criteria.

Taking advantage of the renewal of accreditation, ANECA offers the possibility of obtaining an additional international accreditation, ACREDITA PLUS [3]. The MAPGIC is included within the process that will be used to obtain the EUR-ACE ® label following the process of renewal of the accreditation. Therefore, it is an opportunity to increase the international visibility of MAPGIC producing more and better projection of the graduates of the MAPGIC.

The evaluation model for obtaining the EUR-ACE ® label sets rules and evaluation criteria affecting needs, objectives, outcomes, educational process, resources, evaluation of the educational process and the management system itself. Therefore helps MAPGIC to fulfill the criteria through actions based on strategic analysis and teaching competences.

2 PORTFOLIO AS A TEACHING AND LEARNING TOOL

Portfolios are the most appropriate tool for the development of students' skills through meaningful learning and also allow the use of different teaching methods for the development of content in the classroom. Forster and Masters [4] defined portfolios as sources of achievement evidence that can be applied to a variety of contexts, from the monitoring of student performance in the classroom to the continuous assessment. Many authors also define portfolio as a useful tool for evaluation because it can demonstrate the skills acquired by a person in their own learning process [5,6,7], thus becoming an evaluation tool not only for what was learned but also for the learning capacity of students and skills acquired. In short, the portfolio produces an accurate and comprehensive picture of the student's work, and it gets the student involved in decisions relating to the quality of their work [8].

The evaluation occurs in two parts: through the content that develops each student or group of students, and also based on the student's own self-assessment as a result of their individual and collective work. The latter promotes student self-reflection [9] contributing to the development of generic skills and developing critical thinking, thus making the students reflective and critical.

The origin of the portfolio is the need to express a person's capabilities and features that are useful for their professional and personal development. Thus, its use has been widespread in areas related to art and design, being traditionally used by writers, photographers, publicists, artists or architects. However, it has been increasingly introduced in other areas, especially in education.

There are numerous definitions of portfolio, however, all agree to define a wide collection of student work that shows their efforts, progress and achievements [11], and it is flexible enough to provide alternative mechanisms for teaching tools and evaluation in line with the competency model. Currently the portfolio is used as an evaluative instrument mostly at university level.

In the English-speaking world two types of portfolio are considered: portfolio assessment and portfolio process. Usually both terms are linked, since the portfolio is a collection of works that includes individual achievements, such as the results of genuine tasks, but also it is a documentary evaluable sample. Moreover, the portfolio contains the very self of its creator and it is this fact that also helps make it unique, genuine and fit for use in education. Self-assessment is a comprehensive process that involves having capacity of judgment to assess the quality of own performance and learning strategies, therefore, allows the development of student critical thinking. Its use in education has a number of advantages, but also some difficulties to be taken into account in the design itself to try to minimize them if they are to be effective portfolio (see Fig. 1).

Advantages	Difficulties
<ul style="list-style-type: none"> - Involve the students in the learning process. - Promote reflection and self-assessment skills from autonomy and motivation. - Develop critical and reflective thinking. - Promote the acquisition of cognitive and social skills by students. 	<ul style="list-style-type: none"> - Imply a lack of security in students not knowing if they are doing correctly. - Lead to excessive expenditure of time. - Require a high level of self-discipline and responsibility. - Do not eliminate other types of evaluation. - The assessment must be very systematic.

Fig.1. Advantages and difficulties of using the portfolio as an educational method [12]

The process of acquisition of skills by students is a slow mid-long term process. Teachers should focus on the students so they acquire these skills; in order to prove it, they need evidence.

The MAPGIC program uses three types of skills: basic, specific and general. The traditional educational system is used to evaluate the skills of a specific type that may be associated with assessment of knowledge acquisition. Several studies have shown the usefulness of the portfolio to assess conceptual and procedural skills curricula of graduate students [14].

By contrast, general skills and basic type are more complex to evaluate when abstract nature and directly related to the cognitive development of students. These competencies should be assessed through the use of teaching-learning methods in which the role of the teacher loses prominence, whereas students gain it, the latter being responsible for the development of their own knowledge [15].

The nature of the portfolio can address each of the documents composing it differently, responding both to the acquisition of specific, basic and general skills. This provides evidence of learning, necessary for quality assurance.

However, the portfolio cannot contain a set of activities or work offline; in order to work properly, the portfolio must be linked by a common thread. In the MAPGIC, the application of a single case study [10] is the most appropriate driver, considering the infrastructure life-cycle and its typical phases [16]: feasibility, design, construction and operation. The application of the teaching-learning portfolio is set as a strategy for the coordination of faculty, subjects, courses, syllabi and activities.

Previously, it was indicated the need for a thread of the contents of the portfolio. In the field of civil engineering, professional work is contextualized in the infrastructure life-cycle that reflects the passes of an infrastructure since the detection of a need or problem to its end use [16]: these phases are: feasibility, design, construction and operation.

It seems appropriate that this process, which encompasses all areas of work of the students at MAPGIC, leads the implementation of the portfolio; this way, the set of documents containing work, individually or collectively, is arranged chronologically and neatly reinforced by the fact that two of the subjects of the degree already work on the same project throughout the first quarter [10,22]; these two subjects are Project Assessment and Management and Construction Site Management.

3 PORTFOLIO ORGANIZATION

The organization of the portfolio, whether in print or digital (e-portfolios), can be varied because of its flexibility. It can be adapted depending on the objectives (learning, teaching or professional), the period of time, the nature of the evidence to be collected, and the valuation methods [8,17]. Whatever its organization, the documents it contains should be linked to each other.

The portfolio should allow better understanding of the individual characteristics of each student and how they have reached the competencies. Because it allows the modification of traditional formative and evaluative guidelines, it will be necessary to establish evaluation criteria and joint scheduling of all homework, so that their development is allowed minimizing interference. The establishment of the rubrics, despite being a complex task, ensures the orientation of students and the feedback [18].

The content of the portfolio is as follows:

- a) Index
- b) Introduction.
- c) General description of the methodology used and what is expected of it.
- d) A set of mandatory work conveniently cohesive..
- e) Evidence that students wish to bring added value to their professional profile.
- f) Conclusion.
- g) Critical reflection on the experience.

The evaluation criteria are merely indications to be valued in the work of each student. Each criterion should be assessed and weighed; descriptors should be set indicating achievement levels attained by students. Broadly speaking the following can be distinguished:

- 1) Presentation of the document.
 - a) ID, format, cleanup and disposal.
 - b) Linguistic expression.

- c) Organization.
- 2) Self-regulated learning.
 - a) Use of technology resources.
 - b) Development of reflective and critical thinking.
 - c) Originality.
 - d) Planning and management time spent on processing.
 - e) Attitude of participation or involvement of students.

4 IMPLEMENTING THE PORTFOLIO

The implementation of the portfolio method, based on the common project used in MAPGIC, involves the implementation of a strategy for teaching coordination since it requires a redefinition of both the teaching and the way to assess the students. The implementation proposes to carry out the portfolio in six compulsory courses pertaining to two subjects, incorporating the remaining three subjects in the near future if possible. The subjects are: Project Assessment and Management and Construction Site Management. These subjects are responsible for meeting a set of established competencies.

The courses that correspond to the field of Project Assessment and Management: Project Assessment, Project Management, and Project Scheduling Techniques. The courses pertaining to Construction Site Management are: Administration and Management of Construction Sites, Supervision and Inspection of Construction Sites, and Health and Safety Management in Construction.

The current problem is that the subjects evaluated all the competencies, being evaluated simultaneously on different courses. This creates a lack of time and anxiety in students and a lack of clear evidence of compliance for the competencies.

Following the implementation of a common case study, a qualitative research has been carried out from 2011-2012 to the current year. Using a Plus-Delta questionnaire, the strengths and weaknesses of each of the involved subjects are identified by alumni in order to improve teaching practice.

3.1. M-CoDef matrix

The M-CoDef matrix reflects in its columns, the courses grouped by subject, and in its rows, skills and deficiencies found applying a Delta-Plus questionnaire. The making of this matrix allows identifying the distribution of competencies throughout the subjects, combining them with the deficiencies in each of the courses. As a summation of columns actions are proposed. These proposed measures take into account the compliance of the competencies as well as the correction of the deficiencies.

3.1.1. Actions

After analyzing the collected data, actions are chosen among the different active-teaching methodologies. As noted above, the active methods are well suited for skills training, especially for those skills that are difficult to evaluate at a glance. Fernández [15] shows what method is best suited in terms of competencies.

Each subject works certain competencies; in turn, each subject works at different levels from 1 (recommended) to 4 (indispensable). For each of the subjects competencies are chosen considering the specific skills that each of them works. Core competencies established for MAPGIC are positively correlated with the extent of Bloom levels; due to this fact it is possible to establish a connection between them and the active methods, depending on the area of the pyramid (see Fig. 2).

The upper level of the pyramid involves having reached the lower levels. The top level represents the ability to make critical judgments. The top three levels are worked through team-work, whereas the bottom three ones are worked through the lecture. The lowest level represents the ability to recall information previously taken. The lecture can be formal or informal and it works the lower levels only; with the lecture a larger number of students can be attended. Teamwork covers a broad spectrum using case studies, problem-based learning, and project-oriented learning. If the student reaches the top levels, it also ensures the acquisition of the ones below.

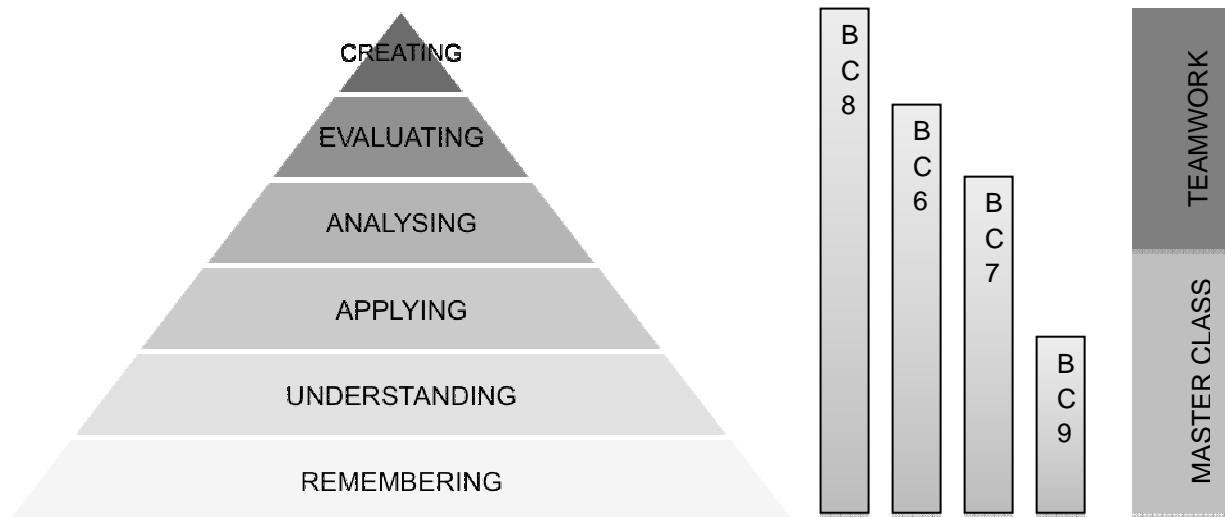


Fig. 2. Bloom's levels vs. basic competencies at MAPGIC

Thus, in the case of the subject of Project Assessment course, students have to learn the methodologies of multi-criteria and cost-benefit analysis in-depth; they also have to learn the basics of evaluation and selection of investments. The case study method is proposed since it works basic skills at higher levels and further resolves the deficiencies, such as a term paper inconsistent with the content developed as well as the need to improve teaching methodology. The proposal for a case study, project-based course, means that teachers work previously the content to impart through the case. The difficulty here is that the teacher becomes a guide for the student learning process.

3.1.2. Definition of the M-CoDef matrix

The complete definition of the matrix, with actions aimed at improving teaching, allows the competencies to be able to assess each course by subject in order to clarify the evidence of acquisition thereof. The documents that are generated, resulting from the application of the proposed methodologies in action, are to make up the portfolio of Civil Engineer. The resulting matrix can be seen in Fig. 3. This process favors:

- The assessment of competence.
- Coordination in the evaluation.
- The improvement of teaching practice.
- The quality of teaching.
- Adaptation to new knowledge society, evolving in line with it.
- Professional competitiveness of students.

However, it should be noted that the effectiveness of learning depends less on the teaching method itself than the quality and quantity of individual intellectual work generated by the students [19].

3.2. The portfolio of the MAPGIC

3.2.1. Relationships between courses, phases and methods

The portfolio of the MAPGIC is intended to be a portfolio built throughout the infrastructure life-cycle. The Gantt chart, shown in Fig. 4, depicts each of the phases (columns) and the courses (rows). The bars extend the phases occupying each of the subjects covered. Some are subjects that provide tools that can not only be used in a phase, but in several, highlighting the stage in which further develops its contents. The results of the M-CoDef matrix are also displayed.

		MATTERS												
Matter	Subject	PROJECT ASSESMENT & MANAGEMENT						MANAGEMENT OF CONSTRUCTION SITES						
		PROJECT ASSESMENT		PROJECT MANAGEMENT		PROJECT SCHEDULING TECHNIQUES		ADMINISTRATION & MANAGEMENT OF CONSTRUCTION		SUPERVISION & INSPECTION OF CONSTRUCTION		HEALTH AND SAFETY MANAGEMENT IN CONSTRUCTION		
		ACHIEVE	LEVEL(*)	ACHIEVE	LEVEL(*)	ACHIEVE	LEVEL(*)	ACHIEVE	LEVEL(*)	ACHIEVE	LEVEL(*)	ACHIEVE	LEVEL(*)	
COMPE TENC IES	BAS IC	BC006												
		BC007	x	3	x	3	x	3	x	2	x	3	x	3
		BC008	x	2	x	2	x	2	x	3	x	4	x	3
		BC009	x	3	x	2	x	3	x	2	x	3	x	3
		BC010	x	3	x	3	x	2	x	3	x	3	x	3
	SPEC IFIC	SC105												
		SC112	x	2	x	4	x	3						
		SC114	x	1	x	3	x	2						
		SC115												
		SC118							x	2	x	1	x	3
		SC119							x	4	x	4	x	4
		SC123							x	2	x	2	x	3
		SC124							x	2	x	2	x	4
		SC126							x	4	x	4	x	4
		SC128							x	3	x	4	x	3
		SC131	x	1	x	2	x	3						
		SC141	x	4	x	1	x	1						
		SC143	x	4	x	1	x	1						
		SC148												
		SC149												
SC172														
GEN ERAL	GC05	x	4	x	4	x	4	x	4	x	3	x	4	
	GC06	x	3	x	3	x	4	x	3	x	4	x	4	
	GC07	x	2	x	4	x	3	x	3	x	4	x	4	
	GC08	x	2	x	3	x	2	x	2	x	4	x	3	
	GC09	x	3	x	2	x	2	x	3	x	3	x	3	
DEF IC IEN C IES	DF01		x		x									
	DF02				x		x						x	
	DF03		x		x				x		x			
	DF04						x							
	DF05								x					
	DF06												x	
	DF07		x											
	DF08		x											
ACCIÓN PROPUESTA		Case Study	Simulation/Role Play	Problem-based learning	Project-based learning	Problem-based learning	Master class							

(*) Working level of competencies

- 1 Advisable
- 2 Convenient
- 3 Necessary
- 4 Indispensable

Fig.3. M-CoDef matrix

3.2.2. Organization and contents of the portfolio

Shulman [13] defines the organization of the portfolio as the development of the objectives of the curriculum and their translation skills for later achievement through training activities designed specifically for each of the purposes. The methodology described for the M-Codef matrix and the proposed active methodologies in teaching to achieve solving skills deficiencies, respond to the model

established by Shulman [13] to structure portfolios. Therefore, the portfolio includes MAPGIC genuine work generated by students through the implementation of active methodologies described for each of the subjects.

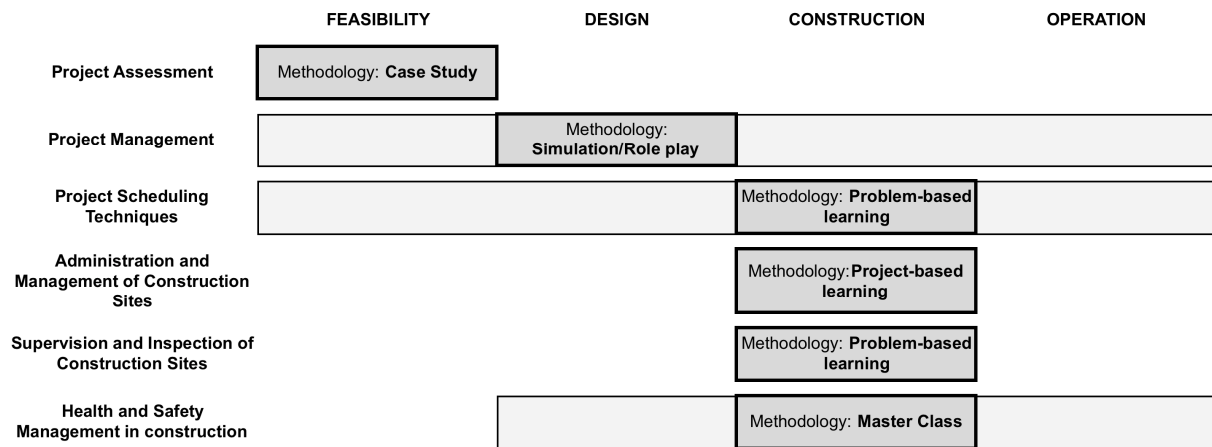


Fig.4. Gantt chart showing the relationship between courses, phases and methods

The organization of the portfolio is as follows:

- 1) Index
- 2) Introduction: It is the most important part and it shall contain: curriculum vitae of the student according to the European model, along with a cover letter reflecting on what their expectations are and how he/she feels about the use of this methodology.
- 3) Set the required work conveniently interrelated and whose closure will be in the student 's own behalf. Homework to make will be based on the unique coursework that will be addressed by each of the subjects from their own perspective. Each work must include a self-assessment at the end of it to report on: difficulties encountered, time allocated for their implementation, and critical assessment of its usefulness. These assignments are:
 - a) Economic feasibility study (Project Assessment). It will rely on the common case study. Data are taken from the common project for the course. For this, the economic feasibility of a construction project will be discussed and drafted. Teachers will not issue any information contained in the project, but they will facilitate the students the data necessary for their work.
 - b) Project management plan (Project Management). It describes how the administration and management of the project will be carried out, considering the resources and performance. According to the matrix, the appropriate method is the simulation or role play. In this case the project management plan will be discussed by students arranged in groups, each one of them acquiring a role. This is, if possible, to simulate a real consulting firm in the classroom.
 - c) Economic analysis of the construction project (Administration and Management of Construction Sites). It will be held from learning oriented to projects: the analysis to be carried out by every construction site manager previously to the procurement or to the beginning of the project; in the first case the objective is to get the tender awarded, and the second is to maximize profit.
 - d) Complementary activities for the scheduling of the project (Project Scheduling Techniques). These activities will be conducted through the methodology of problem-based learning. Teachers pose problems regarding the scheduling of work to which students must cope using the tools described in class (PDM, CPM, PERT,...). Software will be used to implement the exercises.

- e) Report on the construction works (Supervision and Inspection of Construction Sites). The volume of documents generated in a construction project is very high. The project manager is responsible for overseeing the construction project, as well as being the representative of the owner. The report will be developed using a methodology of problem-based learning. Students must provide a proper and genuine solution, organizing the documents in order to carry out the supervision and inspection of the site in a proper way.
- f) Identification, analysis, evaluation and prevention of construction risks (Health and Safety Management in Construction). The assignment has to identify, analyze, evaluate and provide preventive measures necessary to perform the construction works. The entire student body together has to identify activities that would lead to the implementation of the course project, after making a deal for this analysis. In this case the methodology to be used is the lecture, not only by the professor but also industry professionals.
- g) Complementary activities. These are those performed through the optional module and serve to fully define the professional profile.
- h) Conclusion. It should be a link to the Final Master Thesis, explaining what the content will be, as well as making a final critical appraisal of the degree, updating the curriculum and including skills achieved.

3.2.3. *Evaluation of the portfolio*

The evaluation is one of the most important factors in the portfolio. Through the defined structure, work evaluation assesses competencies. For this process to be as objective as possible, teachers will score according to previously established rubrics.

However, two types of evaluation are distinguished. The portfolio assessment takes into account the learning process carried out by the student, which means that it takes into account its evolution throughout the academic year. The skills assessment will be made through the score of the proposed work in each subject, using the methodology described. Finally, the portfolio will serve to prove that the student has acquired the skills established by the curriculum as well be a result of learning.

The portfolio will be a requirement to complete the MAPGIC. Each student on the day of the viva must show up and defend his/her portfolio as well as his/her Final Master Thesis. This will lead to the final grade attributed to the student. The portfolio will be a source of great value for their professional performance as it is a report showing the professional performance of a professional engineer.

4 CONCLUSIONS

The portfolio is intended as a coordination strategy between subjects working together in a single case study or common project. The set of documents generated by each course will respond to the development of the competencies established from their own perspective based on the common project. Thus each course will form part of a whole; this gives evidence of the learning process of students; it also serves in the future to improve teaching and learning at the MAPGIC.

The analysis to define its implementation also allows obtaining results of high value for the teaching task:

- A new methodology for analyzing quality through the M-CoDef matrix. The identification of this matrix involves significant work as well as being involved in a process of continuous improvement since the identified deficiencies can vary. Moreover, the analysis shows linkages between skills and deficiencies. This link leads to an appropriate response which encourages the development of gender mainstreaming through the application of appropriate methodology.
- Evaluation of the learning process and not just the results. Requiring the submission of the portfolio, together with the Final Master Thesis the evolution of the individual student can be assessed. Students clearly appreciate its evolution from the beginning to the end of the degree. This will lead to increase student satisfaction.
- Method of assessing competence. Skills assessment results in the evaluation of the work required

from the use of active teaching and learning methodologies. The general and basic skills are the most difficult to assess because they are more intangible. This method facilitates the stimulation of students as to the variability of methodologies to work on a single common project.

- The competency evaluation method facilitates the work of teachers facing the renewal of accreditation of the title in order to obtain the stamp EUR-ACE ®. Their acquisition would result in a greater degree of internationalization.

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