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COORDINATION AND COOPERATIVE LEARNING IN ENGINEERING STUDIES

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Abstract. This project describes the coordination undertaken in the Bachelor's degree in Geomatic and Surveying Engineering in the University of the Basque Country (UPV/EHU) after the integration in the European Higher Education Area, explaining how cooperative learning can positively contribute to the teaching-learning process.

Keywords: Competency based learning, cooperative project, active methodologies, coordination.

1 INTRODUCTION

In the 2010-2011 academic year, the transition began from the qualification of "Ingeniero Técnico en Topografía" (Technical Engineer in Topography – ITT for its Spanish acronym) to the "Grado en Ingeniería en Geomática y Topografía" – (Degree in Geomatic and Surveying Engineering - IGT for its Spanish acronym) in the Faculty of Engineering of Vitoria-Gasteiz (EUIVG). The new Degree certification allows for the regulated exercise of the profession of ITT (Orden CIN/353/2009).

The transition is regulated by the RD 1393/2007, the Orden CIN/353/2009 and the UPV/EHU Resolution of the 20th of December of 2010. The main characteristics of the new certification are as follows:

- The measure of the subjects is done in ECTS (European Credit Transfer System) credits.
- The duration is 4 years, one year longer than the old certification (ITT), with a total weight of 240 credits.
- The subjects are compulsory or optional (whereas in the old qualification they could be core subjects, university compulsory or optional). Compulsory subjects are grouped in three modules: Basic module (FB) (60 credits, 25%), a common

module of the topographic field (CRT) (60 credits, 34%), and the specific technologies module (TE) (48 credits, 20%). Besides, students must develop an end of degree project (EDP, 5%).

- Subjects are quarterly (whereas in the old plan they could also be annual subjects). Besides, it is specified that a student cannot take more than 30 credits per quarter. For this reason, most subjects must amount to 6 credits, even though some of them are actually 9 credit subjects. The EDP goes from having 4,5 in the old plan to 12 credits, and each optional subjects (16%) have a weight of 4,5 credits.
- The last two terms (4th year) have practically no compulsory teaching so that the students can: opt for foreign placements within the ERASMUS programme (hence facilitating the mobility compromise which the principle of Bolonia promotes), developing company placements or taking the necessary optional subjects (39 credits), therefore completing the required 240 credits.

The European Union project for the creation of the European Higher Education Area (EHEA) has meant the acceptance of a change within the internal management of all the processes which intervene in the development of the studies in the IGT degree, both at organizational (Section 2) and methodological level (Section 3), being both closely intertwined. The coordination of the degree studies allows for this interconnection, and establishes and guarantees the necessary quality parameters for continuous development in the delivery of the studies and the obtained results.

2 COORDINATION IN THE IGT DEGREE

The task of coordinating the IGT degree is organized in three levels. In the first level the vertical coordination of the degree is carried out, via a lecturing team (Degree Commission) comprised of the quality subdirector, the degree coordinator, the course coordinators, two lecturers who provide teaching in the degree and a student. In the second level a course or horizontal coordination is established, through four lecturing teams of the four courses of the degree, comprised of the course coordinator, the subject coordinators for each course and the course´s delegate student. In the third level the subject coordination is undertaken, in lecturing teams trained up by lecturers who provide training on that subject, and the lecturer responsible for the subject.

2.1 Degree coordination process

The IGT degree coordination is developed following different lines of action, defining for each of them the improvement actions in order to achieve its objectives. The lines of action can in turn be distributed in four groups: organization of studies, methodology, monitoring and promotion. Each of these is briefly explained below.

- ORGANISATION OF STUDIES. It is constituted by those lines of action related to the general organisational aspects of the qualification.

- TEACHING GUIDES: The objective is for all the teaching guides for all the subjects of the degree to have the optimum level of information for the student and for its publication, being at the same time homogeneous between the degree subjects.
- TIMELINES OR EVENT PROGRAMS: The drawing up of the event programs for each course of the qualification, agreed during the course commissions, intends to distribute in a homogeneous way the work of the students throughout the period of study.
- TEACHING VECTORS: The adequacy for each subject´s teaching vector is analysed, and, if necessary, the relevant modifications are requested.

- METHODOLOGY. In this section the lines of action related to the teaching methodologies and evaluation systems are grouped.

- TEACHING / LEARNING METHODOLOGIES (T/L): Information is gathered annually about the teaching methodologies in the different subjects within the degree, driving the adoption of new teaching methodologies, active learning methodologies and specially the cooperative learning methodology.
- ASSESSMENT SYSTEMS: Data related to the assessment systems for all subjects is gathered, boosting the implementation of continuous evaluation methodologies.

- MONITORING. These lines of action have the objective of establishing monitoring or control of the development of the study plan, as well as the academic results obtained.

- OVERLAPS AND DEFICIENCIES OF SPECIFIC CONTENTS: The analysis of the specific competencies of the compulsory subjects of the IGT degree has the objective of detecting duplicities in content / specific competencies and possible deficiencies. It is carried out internally in the degree and course commissions, as well as externally, during the Director Conferences of those universities who offer the IGT degree at state level. This has the aim of tailoring the degree to the needs of today´s society.
- WORK AND EVALUATON OF THE TRANSVERSAL COMPETENCIES: In this line, a general analysis of the distribution of the transversal competencies (TC) is carried out, and the distribution between courses and subjects, promoting the creation of unified tools for the work on the transversal competencies (TC) and the rubrics for their evaluation.
- ACADEMIC RESULTS (AR) INDICATOR ANALYSIS: The analysis of each course´s academic results indicators and for the whole qualification falls within a process of evaluation of the quality of the teaching of the degree, which allows for the establishment of improvements related to the implementation of new teaching methodologies, timetable optimisation and evaluation systems. Ultimately, it constitutes the key process in the design of the lines of action in the degree coordination.

- PROMOTION.

– GEOMATICS: The actions of promotion of the Degree are developed both at local level, within the UPV/EHU, and specifically within the EUIVG, and at state level, together with all the universities which provide the IGT Degree.

2.2 Transversal competencies in the IGT Degree

The European Union Project for the creation of the EHEA has meant the acceptance of a change in the university teaching methodology, with the Competency Based Learning (CBL) system being adopted. This system is focused on the student, in his or her capacity and responsibility, as well as in the development of his or her autonomy. Until Bolonia, the university system was based fundamentally on the transmission of knowledge to the student. Now, as well as obtaining the specific competencies (SC) related to the university qualification chosen by the student, the system must guarantee the acquisition of dexterity and skills specific to the profession to which the studies are focused, and which allow the graduate to be efficient and effective in his or her professional and social environment. Through the application of the CBL, it is required to work not only the SC of the qualification, but also the TC, being the latest the ones which prepare people for their insertion in the complex educational, occupational and social systems, multidimensional and with knowledge which changes continuously [1].

In the case of the UPV/EHU IGT Degree, the adaptation to the EHEA has meant the creation of the need for coordinated work and evaluation of the TC, which in the previous qualification (ITT) was achieved in a non-global way and in the individual context of each subject. Being aware of the need of a coordinated environment for the work on the TC, in the case of the UPV/EHU IGT degree, the difficultly was that in the verification request statement of the official certificate [2], the qualification TCs are not specified. This is why a meticulous analysis of the qualification SCs has been necessary. From this, two of them, where transversality has been considered associated, have been selected:

C4. Ability for decision-making, leadership, human resources management and interdisciplinary team management, related to spatial information.
C7. Management and implementation of research projects, development and innovation in the engineering field.

Starting from these two competencies, which, although they are considered specific, could be related to the TC, and with the criterion of trying to clearly identify the most important TCs, the following have been defined for this qualification [3]: TC1: Teamwork; TC2: Written communication; TC3: Oral communication; TC4: Decision-making; TC5: Innovation; and, TC6: Quality. The analysis of each of these competencies has allowed for the identification of different levels of proficiency for each of them, establishing levels from one to three, according to the degree of depth con-

cerned. After the fact, it has been established in which course the different levels (table 1) would be worked on, and the corresponding indicators for each of them have been detailed, developing simple evaluation rubrics to measure the satisfaction level (bad – B, regular – R, and good – G), achieved in the levels of each of the TCs.

Table 1. - TC Proficiency levels and distribution by course in the IGT Degree (UPV/EHU)

4-EDP	Level 2	Level 3	Level 2	Level 2	Level 1	Level 2
4th course	Level 2	Level 2	Level 1	Level 2		Level 2
3rd course	Level 1	Level 2	Level 1	Level 1		Level 2
2nd course	Level 1	Level 2	Level 1	Level 1		Level 2
1st course		Level 1				Level 1
	TC1	TC2	TC3	TC4	TC5	TC6

The transmission of the design of the work and evaluation of the TCs to the study plan of the IGT degree qualification requires the coordination of the lecturers who provide training of the different subjects in the qualification. This coordination is achieved through the qualification commission, which has been responsible for the proposals of the qualification´s TCs, the proficiency and distribution levels and the definition of the indicators for its evaluation. This is transferred to the course commissions, where it is established in which subjects and to what level the accorded TCs will be worked on, establishing in which of them it will be evaluated and obtaining consensus on the working tool.

2.3 Coordination of the 2nd course of the IGT Degree

In this section, the coordination undertaken on the 2nd course of the IGT Degree is explained, given that this is the course with the highest percentage of subjects related to the common module of the topography field (CRT), which in turn corresponds with the block of highest percentage of ECTS credits (T:theory; P:practice).

Table 2. Subject distribution per term in the 2nd course.

First term			Second term		
Subject	Credits		Subject	Credits	
	T	P		T	P
Geomorphology (G)	4,5	1,5	Economics and Business Management (EBM)	4,5	1,5
Digital image processing (DIP)	3,0	3,0	Photogrammetry (P)	6,0	3,0
Cartographic design and production (CDP)	3,0	3,0	Geographic Information Systems (GIS)	1,5	4,5
Geometric Geodesy (GG)	3,0	3,0	Spacial Geodesy & Mathematic Cartography (SGMC)	6,0	3,0
Topographic methods (TM)	3,0	3,0			

The IGT Degree studies in Vitoria-Gasteiz in the second course are organized in two terms of 30 credits each, through 7 subjects of 6 ECTS credits, and 2 subjects of 9 ECTS credits. These last ones are set out in the second term (table 2). In this course

most of the subjects belong to the CRT module, except Geomorphology and Economics and Business Management, which belong to the FB module, and Satellite Geodesy and Mathematic Cartography which belongs to the TE module.

Table 3. Transversal competencies for evaluation in the second course.

Subject	TC	Level
Economics and Business Management (EBM)	CT1	Level 1
Geomorphology (G)	CT2	Level 2
Photogrammetry (P)	CT3	Level 1
Geographic Information Systems (GIS)	CT4	Level 1
Satellite Geodesy and Mathematic Cartography (SGMC)	CT5	Level 2

Aside from the SC, the TC, already discussed in section 2.2 must be achieved in the Bolonia framework. Thus, in the 2011-12 course, the second course commission established the most appropriate subjects for its evaluation (table 3), creating a common rubric for the four courses of the qualification, thus allowing for the evaluation of the TC in a homogeneous way throughout the qualification.

In order for the student body to achieve the total of the SC and TC required in each course, during the exam period of the previous term, the timeframe of the following term´s subjects is agreed in the corresponding course commission. This way, the first term´s event calendar is agreed in June, and the second in the first few weeks in January. During its creation the tasks to be developed by the students was uniformly distributed throughout the fifteen weeks of the term, avoiding work overload for students in specific weeks.

Table 4. Event calendar by subjects and terms

WEEK	First Term		Second Term	
	Task	Subject	Task	Subject
4	Report Submission	DIP	Control	SGMC
5	Control	G	Practical Exam	GIS
	Practical exam	CDP		
6			Field work submission	P
7	Report Submission	G		
8	Report Submission	TM	Practical submission	SGMC
	Report Submission	DIP	Practical exam	GIS
9	Control	G	Presentation	P
	Exam	CDP		
10	Report Submission	TM		
	Control	G		
11	Report Submission	TM	Presentation	P
12	Control	GG	Practical exam	GIS
13	Exam	DIP	Presentation	EBM
14	Report Submission	TM	Presentation	GIS
			Presentation	EBM
15	Practical Exam	GG	Presentation	EBM
	Exam	CDP	Practical exam and integration	GIS

In the second course, it can be said that the timeframes respond to the outline in table 4, where it can be appreciated that in the first three weeks they have no tasks to develop, being the last weeks (14 and 15) the ones with the biggest workload. In view of this situation, during the last two academic years we have tried to avoid these concentrations of workload and they have been lightened, reaching the conclusion that they can hardly be avoided, noting that the calendar helps to achieve the TC and SC more effectively. Besides, it has been necessary to analyze the overlaps and deficiencies between subjects, specially within the same course (horizontal coordination).

Finally, it must be indicated that the coordination for this course has managed to achieve that in a great part of the subjects, active methodologies are applied, leading to the development of a teaching method of learning based in a cooperative project with encompasses the subjects of TM, GG, SGMC, GIS, DIP and P, as explained in the following section.

3 COOPERATIVE LEARNING

Nowadays, one of the labor market´s biggest demands is that the graduates and future professionals possess communication and teamwork skills, as well as a wide understanding of social, environmental or economic issues. Achieving and dominating all of these competencies is a task which is acquired all throughout the learning itinerary of the student, as has been evidenced in section 2.2.

Between the lecturers, it is very frequent to carry out teamwork activities which can be developed both in a collaborative or cooperative manner. Even though according to the consulted bibliography both can be considered extremely similar, there are some differences depending on the desired objective, the structures and the lecturer´s role [6].

Thus, the students work in a collaborative manner when one of the members of the team is in charge of carrying out a specific task, unifying everybody´s individual tasks into a final project in a second phase. By contrast, in a cooperative project all the members of the team develop all of the assigned tasks together [4].

Not all the teamwork activities can be considered cooperative learning, given that for this to be true all of the following elements must be fulfilled [7]: positive interdependence, team and individual responsibility in the achievement of the objectives, personal interaction, attitude and interpersonal skills development, as well as teamwork, monitoring and periodical group reflection about the work performed. For this learning the lecturer´s role is essential, becoming a moderator, coordinator and mediator, rigorously planning in advance a series of well-defined and measurable activities which allow for the achievement of such learning.

3.1 The cooperative Project in the second course of the IGT degree

The EUIVG, with the appearance of the new degrees, promoted from the start a vertical coordination between the courses and a horizontal coordination between the subjects within the same course (section 2). As a result of this latest coordination, and prior to the start of the 2013-2014 course, the idea arose to set into motion a cooperative project (CP) which encompassed 6 out of the 9 subjects in the second course of the degree and which involved 5 lecturers.

Table 5. Task to be developed in each subject

Task	Subject	Weeks
1 – Analysis of support photography characteristics	DIP	6,7,8
2 – Projection, observation and XX of the topographic network	TM	6,7
3 – Topographic surveys	TM	8,9,10
4 – Analysis of photogrammetric flights	GG	16,17
5 – Planning for photogrammetric flights	P	17
6 – Planning for photogrammetric support	P	17
7 – UTM calculation of the topographic network	SGMC	18
8 – Ground point measuring with GPS-RTK	SGMC	19,20
9 – Re-observation of the topographic network by GPS-RTK	SGMC	21,22
10 – Projection, observation and calculation of the geodesic-topographic network using GNSS	SGMC	23-26
11 –GIS integration in the observed networks	GIS	27
12 – Photogrammetric support verification	P	28
13 – Photogrammetric restitution	P	29
14 – GIS integration in the restitution/topographic survey	GIS	30

The objective set to the students was that at the end of the course they had to be capable of incorporating their obtained cartography in a geographic information system, either via topographic methods or via photogrammetric techniques, in a determined and defined area of the university campus. This way, in order to achieve their objective, the students would acquire all the necessary skills of the different involved subjects over the two terms of the course. For this, it was necessary for the lecturing team to design and plan a series of closely linked activities to be developed (table 5), and defining an itinerary to guide the student in the achievement of the objective set. This meant a lot of meeting hours for the involved lecturers, a lot of coordination work, and an extensive knowledge, not only of each lecturer´s own subject, but also of the rest of the lecturers´, so that each of the practices in every subject could be adequately defined within the context of CP.

The evaluation of the acquired knowledge by the students during the CP was carried out independently for each subject, using the rubrics established by the degree qualification commission for the evaluation of the TC, and the rubrics designed by each lecturer for the evaluation of the SC.

4 CONCLUSIONS

The adaptation of the university qualifications to the requirements of the EHEA means substantial changes to the organization and development of the study plan of the Degree, as well as the T/L methodologies. The coordinated work of lecturers and the management team is the key aspect which allows for the continuous improvement of the degree. The work carried out by the course and qualification coordinators in the different lines of action make it possible to design the improvement actions which will be undertaken in the different lecturer teams.

The Degree Commission works on those aspects related to the organization of the studies and does the monitoring so as to obtain an "alive" degree, adapted to today´s society needs. Also, the abilities and skills that the student will attain, specially through the TC, is a quality that companies require in their future engineers. That´s why the lecturer has to adapt to the methodologic changes necessary for that aim; the role of the lecturer changes for the students and also in relation to the other lecturers of the qualification, their active participation in the lecturing teams being necessary.

The University of the Basque Country UPV/EHU, specifically the vice rectorate of innovation and degree studies, issues a questionnaire to the students at the end of every term, in order to know their opinion regarding the quality teaching of the lecturers. In these questionnaires they answer 40 questions of a different nature, and from the results very interesting conclusions can be drawn. Thus, one of the aspects which is covered is the perception of the student about the difficulty of the subject and their degree of interest before and after taking that subject.

The results for the 2013-2014 academic years have been gathered for the 6 subjects which conform the Cooperative Project (table 6), and in all of them it can be appreciated that the interest that the students show once the subject is finished is always higher than the interest shown at the beginning. So their expectations are always enhanced, even for those subjects they have classed as difficult or very difficult.

Table 6. Porcent of student rating regarding difficulty and interest

Subject	Difficulty level					Initial interest					Final interest				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
P	0	0	83	17	0	0	0	67	33	0	0	0	33	67	0
SGMC	0	0	0	43	57	0	43	36	21	0	0	29	57	14	0
GG	0	0	0	43	57	3	22	41	28	0	3	16	51	22	0
TM	1	1	34	46	17	0	6	60	30	4	0	4	60	31	5
GIS	0	0	80	20	0	0	10	40	50	0	0	10	20	50	20
DIP	0	0	88	12	0	0	0	88	12	0	0	0	56	44	0

Other aspects which are covered relate to the planning of the teaching. In other words, ensuring this teaching is focused on the development of the competencies; the teaching methodology to comment on the modalities of the teaching-learning process, the resources and the proposed activities. Also, the teaching development on the lecturer-

student relationship in any of its different facets. These results are shown in table 7, where it can be appreciated that the general rating from the students is quite positive, achieving an average on these three items of 3,9 out of 5,0. The lowest ratings are always related to those subjects which the student perceives as most difficult, although they always surpass the 3,5points on average anyway.

Besides, we must point out that both the active methodologies and the collaborative learning in this new design from the EHEA mean a challenge for university education, given that they intend for the student to achieve a higher success at the time of understanding and internalising the knowledge, especially the specific skills.

Table 7. Student rating related to lecturing planning

Subject	Planning	Methodology	Development
P	4,0	4,1	4,2
SGMC	3,5	3,3	3,4
GG	3,5	3,4	3,6
TM	4,2	3,9	3,9
GIS	4,0	3,8	3,7
DIP	3,9	4,1	4,3
Average	**3,9**	**3,8**	**3,9**

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