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IMPLEMENTATION OF PROJECT-BASED LEARNING IN BUILDING ENGINEERING IN SPAIN

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ABSTRACT

New training methodologies and a new way of students participation are required to improve the educational results in Spain. Traditional studies are based on learning contents, and not on learning procedures, having a high theoretical load and low applied activities. The Universitat Jaume I in Castellón has implemented the Building Engineering degree using the Project-Based Learning (PBL) teaching/learning methodology. Students work on real projects which are used for the practical activities of several disciplines at the same time. This is the second year the programme has been running. The paper reports on the process of implementation, the benefits obtained and the aspects that require further improvement.

***Keywords**: Project-based learning, Building Engineering Education, Implementation of new degrees, Implementation of new teaching/learning methods*

1 INTRODUCTION

The educational methodology within the Spanish university has been for the last century based on theoretical lectures and has focused on an individual based learning. Studies are based on learning contents, and not on learning procedures. Studies are theoretical and with little professional application.

Nowadays, the university is looking for a change. New training methodologies and a new way of students' participation are required to improve the educational results.

The Spanish Building Engineering education must adapt to de European Higher Education Area as agreed in the Bologna Declaration [1] and the degree of Building Engineering should adapt to the global economy needs [2].

The Society demands that the knowledge gained during the university studies are applicable to professional practice. For this to happen, it is required more application of the theoretical knowledge on real production sectors during the studies.

The Building Engineer as a professional needs personal abilities and technical capabilities to develop coordinated projects on time according to economical and technical planning. Then more reflective learning is required by students.

Higher education programmes should respond to society's, students', and professional needs:

a) Society demands no to waste public resources.

- Dropout studies. There may be various reasons for students on technical studies dropping out of the course programme once enrolled, being many times due to difficulties in studying and working at the same time.
- Delaying the end of studies. This is a big problem nowadays. Some universities have settled down "permanence requirements" [3]. The mean percentage of students passing exams in some disciplines along the years is lower than 30% (e.g. physics applied to building engineering). Students who start working during the last year of studies do not always feel need for the graduation.
- Distance between university and employers. Universities in the Valencia Community have based their Policy on employability rates, e.g. Universitat Jaume I (UJI) 67%, Universidad Politécnica de Valencia (UPV) 87%, Universidad de Valencia (UV) 66 % [4].

b) Students demand the proper knowledge. According to a study carried on by Polytechnic University in Valencia, with longer experience in Technical Studies on Building Engineering than UJI, 53,6 % of the students considered that they did not get enough practical training, 93,48% of the students considered that they got enough theoretical knowledge. The 18,2% considered, that they do not have enough professional skills [5].
c) Employers´ demands. The national employers are changing their previous point of view and now start to look at the global international market and international cooperation [2].

In 2005, the Universitat Jaume I in Castellón was responsible for the implementation of the Building Engineering degree. A new learning methodology was planned from the beginning. The concept originated from teachers and students that had had previous experience in European mobility programmes. European Higher Education Institutions as Vitus Bering University College in Denmark, with more than 18 years of experience with Architectural Technology degree, where over 70% of the credits are following the Project Based Learning (PBL). Even though, they are still missing to implement the same methodology in the rest of degrees [5].
The study programmes in the Spanish university are not flexible in the sense that the number of core subjects is high. For example, in the Building Engineering degree, 66% of the credits are common for all national universities. All disciplines are divided between theoretical, practical activities, and laboratory credits. The example of the Building Engineering degree at UJI is shown in Table 1.

Table 1. Credit distribution in the Building Engineering degree at UJI

1st course				
Theor Cred	Pract Cred	Lab Cred		
	13	17	**Tot UJI Cred**	**ECTS**
34,5+ 5.5	**30**		70	60

2nd course				
Theor Cred	Pract Cred	Lab Cred		
	17	19	**Tot UJI Cred**	**ECTS**
34,5 + 9	**36**		79,5	60

3th course				
Theor Cred	Pract Cred	Lab Cred		
	21	11	**Tot UJI Cred**	**ECTS**
27,5 + 7	**32,5**		67	60

	Total Cred:	**225**	**180**

The teaching methodology at the High Educational System in Spain has to adapt to the new learning challenge. Theories of learning as experimental learning, constructivism, learning styles, observational learning, and reflective learning have been found to be relevant to implement group project activities. The plan was to coordinate subjects and teachers from the different disciplines to define their practical and laboratory activities based on real professional activities. For this reason, it was proposed that the PBL methodology could be implemented in the 1st year of Building Engineering. The methodology aims to improve reflective student learning, as well as teachers applied contents coordination. This is the way students and teachers go in the same direction to develop real project documentation.
The 1st year project is based on a traditional building, which has to be analysed by students from different angles, according to the different disciplines involved: History of construction techniques, Construction I, Materials I, Geometry, Graphical Design, Surveying, and Physics. It will provide them with the knowledge and the experience to develop a professional real work.
The intention is to implement PBL in Building Engineering in the 1st and 2nd years of students studies (Figure 1) because first year programmes are based on general/basic concepts which could be seen as excessively theoretical by students. With the approach proposed, it is hoped that students get motivated from the beginning. Then, even beginners understand theoretical contents applicability on "real life" and aspects of their future profession [6]. The 3rd year programme includes credits for

practical placement. This is why we believe that it is not necessary to provide students with coordinated project-based learning activities. They already have to work for a company during a period of 2 months.

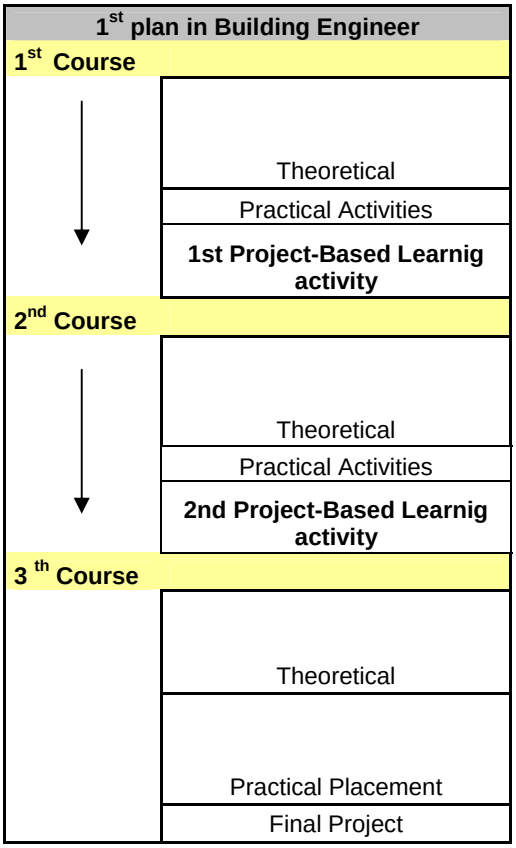


Figure 1. First proposal for curricula in Building Engineering including PBL

1 CASE STUDY

The PBL methodology used in the previous year and the current one for 1st year Building Engineering students and its process of implementation are used as case study in this paper. The implementation
The first thing was to organise a meeting for all teachers involved with the aim to apply for funding for a coordination project within the Educational Support Programme of UJI (USE). The application was useful to define the implementation process to adapt the traditional methodology to the Project-Based Learning methodology in UJI-Building Engineering (Figure 2).

Figure 2. Implementation process map

In each phase of the process, different aspects have been analysed:

- In the PLAN phase, responsibilities, resources, the project theme and the credits recognition are planned.
- In the DEFINE phase, goals and timing are defined.
- In the TRAIN step, professors, students are trained.
- In the CONTROL phase, subjects and project contents are controlled.
- In the DELIVERY phase, students deliver their project documentation and make a public defence of their work. In the 1st semester the defence is based on a powerpoint presentation and in the 2nd semester on a poster.
- In the EVALUATION phase, the students' documentation (including partial and final reports) the students public defence, and the process itself are evaluated.
- In the IMPROVEMENT phase the data obtained from the evaluation phase is analysed. A

periodic evaluation system is considered necessary [7].

1st Phase

PLAN-responsibilities

- The coordinator is the person in charge of teachers coordination; proposing programme arrangements to be adapted for a project based learning, timing, proposing group conditions, proposing project theme, updating guidelines for students and the virtual learning environment tool.
- Teachers are responsible for defining specific goals in each discipline. They have to define students working procedures (which aids students to get professional abilities), evaluation criteria, and monitor the development of the students' projects.
- Students are responsible for accepting project conditions, defining group members with a maximum of four per group, developing group project activities, helping other group members and self-evaluating their results for improvement.
- A jury, composed all teachers involved, is responsible for the evaluation of the project public defence.

PLAN- Theme proposal

The first year project can not be excessively complex. Students should be able to learn basic concepts at the same time as they analyse the building proposed. The PBL proposed for the 1st year is based on a traditional construction system. Each construction element is analysed during the 1st and 2nd semesters.

This year the theme proposed was a "traditional family house". The intention is that a new theme is planned between the participating teachers and the coordinator each academic year.

The coordinator responsibility is that the PBL theme motivates students and teachers. Students are interested in studying buildings with historical value, which are close to them for proximity. They make suggestions of buildings that they would like to study, and their proposal is accepted if they reach certain conditions. The teachers' interest is also required. To make them interested in participating, a book is edited at the end of each year. It includes the most interesting group projects.

Teachers assess the adequacy of the traditional building proposed by students before the former embark upon the realisation of the project. Not always students have access to buildings that fulfil the project objectives, and two or three loops of building proposal and adequacy assessment are required.

PLAN-resources

The new working methodology requires new infrastructure for students to work in groups, new computer facilities as WIFI connections, virtual learning environment tools and virtual tutorial access. The university provides this service to the whole community.

PLAN-credits

The number of credits that can be obtained by doing the PBL activity depends on teachers (Table 2). This year the students obtained 9,2 subject credits and 2 additional free-choice subject credits, representing a total of 11,2 UJI credits (about 14 ECTS credits).

Table 2. PBL credits

DPT	AREA CONEIX.	ASIGNATURES	PROFESSORS	CREDITS	Nº PRÀCT.
MAT	Anàlisi Matemàtica	Fonaments matemàtics			
MAT	Matemàtica Aplicada	Estadística			
F	Física	Fonaments físic	Marcel Aguilella	0,2	1
E	Exp graf arq	Expressió Graf.	Alba Soler Beatriz Saez	0,6	3
E	Exp graf arq	Geom. Desc	Manuel Cabeza	0,3	3
E	Exp graf arq	Topografia	Mª Jesús Mañez Teodoro Garcella	0,2	1
EMC	Construc Arq.	Historia de la Cons.	Belinda Lopez Mesa	4,5	3
EMC	Construc Arq.	Construcció I	Teresa Gallego	3	6
EMC	Construc Arq.	Materials de Cons.	Angel Pitarch Juan J. Palencia	0,4	2

2nd Phase

DEFINE-goals

1- The goals are defined according to the required professional skills of building engineers. According to Accreditation Board for Engineering and Technology (ABET), the new criteria for engineering competences can be divided into two categories [8]:

a) Hard skills

- An ability to apply knowledge
- An ability to design and conduct experiments, as well as to analyse and interpret data.
- An ability to design a process to meet desired needs, within realistic constraints such as economical, environmental, quality, safety.
- An ability to identify, formulate, and solve engineering problems.
- An ability to use the techniques, skills and necessary engineering tools.

b) Professional skills

- An ability to work within multi-disciplinary teams.
- An understanding of professional ethical responsibility.
- An ability to communicate effectively.
- An abroad education necessary to understand engineering solutions global impact.
- An ability to keep lifelong learning.
- An ability of contemporary issues.
- An ability of critical analyses.

2- Project goals will be defined on the students guidelines, students should learn:

- To apply theroretical knoglede on a real case study.
- To use the necessary tools to improve results.
- To work on teams to analyse complexes tasks.
- To pay and defend decisions.
- To fulfil requirements according to contents and time.
- To learn the professional know-how
- To keep lifelong learning.

3- Specific disciplines goals are defined by teachers on the PBL guide. Teachers and students learn the professional know-how (working procedures) to reach the final result required.

DEFINE-timing

One of the first aspects to consider in a project-based learning activity is to define project work parts. Once defined, a control programme is established between the coordinator, teachers and students to plan the delivery of partial and final reports. This should be programmed taking into consideration the dates of the theoretical exams, otherwise it may cause time stress during exams period.

3th Phase

TRAIN-professors

Coordination meetings help teachers to learn to define and apply professional activities. From meetings teachers learn to propose specific goals to develop during the project based learning activities. Teachers learn to define professional procedures that will help students to apply the discipline on the different project assignments.

Teaches adapt the discipline credits planning to the project based learning methodology.

TRAIN-students

First year students present advantages and disadvantages to be involved in project based learning activities. There are several disadvantages, coming from the traditional learning methods they are used to. They do not know each other when they have just enrolled up, thus complicating the definition of group members. Concerning advantages, they are willing to try new experiences, and they are open to accept any new learning methodology. Moreover, they have not yet been stressed up with a lot of contents and subjects.

A training period should be considered during the use of any PBL methodology. The first thing proposed is to have information meetings where the methodology is explained. However, students require continuous training. Students must be guided to reach specific and general goals.

4th Phase

CONTROL-partial subject-related work delivery and control

All teachers should plan specific project work controls, otherwise the final work will not fulfil minimum requirements.
The bad experiences from some of the teachers show the disadvantages of missing partial subject-related process control. Monitoring of subject-related works is, therefore, recommended, even though a final report is required.

CONTROL-partial project-work delivery

Project control is planned in two times, the first semester and the second one. In the first semester the control is based on the students' public defence and report. In the second semester the control is based on a summarising poster and a report.
When there are a previous project-work deliveries, teachers can monitor if general and specific goals are being fulfilled. Teachers guide students to follow working procedures to get information and to analyse it, before developing the final project report.
The coordinator guides students regarding the organisation and structure of the complete project, and advises regarding how to do the public defence.

5th Phase

DELIVERY- final project report

Guidelines for students define project conditions: context, order, and layout. The report has to be presented using standard software (for text, for calculation, for drawings and pictures). In this stage, students learn one from each other, they share knowledge and they show their computer resources abilities.
Teachers help and teach students to improve their computer abilities to improve the final report delivery.
The jury analyses the content of the delivered final project report.

DELIVERY-final presentation work

In the first semester, students carry out a public defence in groups. Then, the jury can really appreciate if students understood the project content and aim.
The coordinator and teachers have previously advised students that a public presentation needs preparation time. They have to share the preparation time between PowerPoint presentation and oral time coordination.
In the second semester, the final presentation is based on a poster.

6th Phase

EVALUATION- partial and final project document

The project evaluation takes care of different aspects as technical and personal skills [8]. Teachers evaluate specific goals and the jury evaluates if students have reached the general goals to become a future professional.

EVALUATION- partial and final presentation work

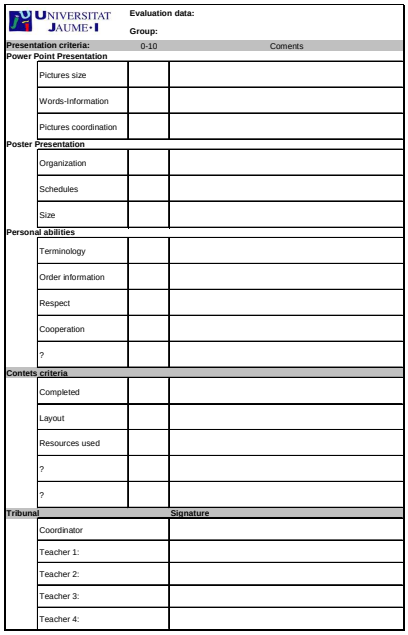
The jury analyses the project defence according to previously defined criteria. Each teacher uses his/her own criteria, using a predefined criteria sheet (Figure 3). For example the criteria used by one of the teachers was

- Power point presentation
    - Pictures quality
    - Text
    - Pictures-text coordination
- Personal abilities
    - Terminology used
    - Information order
    - Manners
    - Cooperative with team mates
    - Others:
- Contents criteria
    - Completeness
    - Layout
    - Resources used

The project evaluation is used for 2 UJI credits.

EVALUATION- process

With this project not only students are evaluated, also the PBL implementation process should be analysed and criticised to be improved for following years. Teaching and coordination are put in doubt. For this, a questionnaire was proposed to 1st semester students and 3rd semester students (students that have passed the 1st year of study and are currently involved in the 2nd PBL year).



UNIVERSITAT JAUME·I	Evaluation data: Group:	
Presentation criteria:	0-10	Coments
Power Point Presentation		
Pictures size		
Words-Information		
Pictures coordination		
Poster Presentation		
Organization		
Schedules		
Size		
Personal abilities		
Terminology		
Order information		
Respect		
Cooperation		
?		
Contets criteria		
Completed		
Layout		
Resources used		
?		
?		
Tribunal	**Signature**	
Coordinator		
Teacher 1:		
Teacher 2:		
Teacher 3:		
Teacher 4:		

Figure 3. Public defense criteria sheet

Thanks to the evaluation process, corrective actions and preventive actions can be planned for next year projects.

Questionnaires have been sent to 1st year students and 2nd year students. The aim of these questionnaires is to assess several aspects regarding the information resources provided, the teachers help, their effort, and team work.

The 1st year students data analysis follows next:

- Concerning information resources:
  - 60% of students prefer to follow a document of project guidelines, whereas 40% of students prefer to follow the project virtual environment.
- Concerning teachers help:
  - 70% of the students appreciate teachers help during the learning process and project presentation.
- Concerning personal effort:
  - 40% of the students highly value learning new technologies and 30% consider that was good.
  - 30% of students consider very positively that they can help each other and 40% consider that it is good.
  - 80% of the students agree that the PBL methodology provides them with abilities to speak and communicate with other technical people.
  - 50% appreciate getting used to publicly defend their work.
- Concerning team work: 80% consider positively learning to work in groups.

Students were also asked to freely comment on the positive and negative aspects of PBL. The responses can be found in Table 3.

The 2nd year students data analysis follows next:

- Concerning information resources:
  - 64% of students prefer virtual environment resources and 41% of the students prefer the students guidelines.
- Concerning teachers help:
  - 38% of students consider that teachers have to improve initial information and process description.

    - 52% of students would like to increase the teacher supervision during project development.
    - 51 % declare to need further help for project defence.
- Concerning personal effort:
    - 72% of the students appreciate the fact that they put great effort on speaking with other people (building agents).
    - 66% appreciate the fact that team mates can teach each other
    - 52% appreciate learning to use new technologies.
- Concerning team work:
    - More than 66% consider than team work is based on data analyses proposal and more than 60% are related with taking decisions.

Students were also asked to freely comment on the positive and negative aspects of PBL. The responses can be found in Table 4.

Table 3. Records of 1st year students. Positive and negative comments.

Positive comments on PBL:	**Negative comments on PBL:**
- Real professional application - Team work - Learn how to do a public defence - Shearing responsibilities - Practical work - It is helpful to understand the theoretical concepts - A fun way to learn	- Dedication time - Drawing training too late - Organisation of theoretical teaching and PBL - We miss some concepts being taught - Non reached goals - Different levels of students - Different opinions in the group - Dependence between group members - Missing time - Not sufficiently valued in some subjects - Different backgrounds from previous studies

Table 4. Records of 2nd year students. Positive and negative comments.

Positive comments about PBL:	**Negative comments about PBL:**
- Team work - To get to know people - To plan activities - To improve public defence of own work - Practical activities, practical knowledge, to visit sites - To research - To pass without written exam - To learn to write and present a report - To share ideas/opinions between students - Self-study	- Missing time - Missing concrete description, little information - It is not possible to evaluate the personal work - Missing clear goals - All tasks are concentrated at the end - Missing knowledge - Stress situations for which there is no need - Badly oriented - Not sufficiently valued in the subjects - Due to work division, they do not learn everything - Difficult to coordinate time disposal between members - No coordination - Teachers do not follow planning - Digital layout

7th Phase

IMPROVEMENT- project based learning

The 1st and 2nd year students' opinion about PBL has been used to propose future corrective actions to improve the methodology. Table 5 shows the improvements considered for next years PBL.

IMPROVEMENT- Subject questionnaires

The subject History of Construction techniques offers the possibility to students to pass by means of passing an exam or by passing the Project Based Learning activity. This means that students can pass 4,5 credits following this methodology. The teacher asked the students to complete another qualitative questionnaire, whose answers regarding the PBL are presented in Table 6. The questionnaire was not specifically referred to PBL. Therefore, only the answers that make reference to the PBL have been selected for Table 6.

Table 5. Suggestions to improve PBL

1st year students improvement proposals:	**2nd year students improvement proposals:**
- Learning AUTOCAD from the beginning - Provide more time for the project - Teach the specific contents of the PBL activity - Better adapt project contents to subjects programme - Evaluate more the individual work - Improve teaching on terminology and concepts - Value students' work higher	- Provide more time for the project or reduce the amount of work - Compulsory tutorial plan, define a tutor per group, number of group tutorial classes - To explain demands clearly - Improve didactical methodology - Improve subjects coordination - Improve management processes - Combination of team work and individual work - Compulsory theoretical exams - Balanced group sizes and background - Improve the value of PBL - Develop a module on how to do public defences - Better define the goals and work procedures - Instructions for the public defences - Process control

Table 6. Qualitative evaluation of PBL from the subject of History of Construction Techniques

1st year students' answers to the question "What did you like the most?"	**1st year students' answers to the question "What did you like the least?"**
- The possibility of choosing how to pass the subject Exam/PBL (5 students) - The learning process (2 students) - Real work application (2 students) - The PBL has been helpful to research some questions and get deeper in some contents (1 student) - It is not necessary to learn things by heart (1 student) - The content of the PBL activity (1 student)	- The PBL delivery and goals not clear (4 students) - Spent time, amount of work (3 students) - Low valuation of the PBL effort of students (2 students) - Public defence (2 students) - Too much content (1 student) - The need to investigate to carry out some activities - Lectures not related with the PBL activity - Little initial information - PBL is difficult to understand - Results do not depend on the student's amount of work

IMPROVEMENT- Teachers participation

The teachers were also sent questionnaires to analyse how they personally perceived certain advantages and disadvantages of PBL that had been commented along the whole process. The advantages and disadvantages considered were:

Advantages for students

1As- Learn to coordinate oneself with other team mates.

2As- Possibility of helping and learning from each other.

3As- Students develop self study.

4As- Students can improve their knowledge by means of individual study. This will assure that they will learn how to update their information.

5As- They are motivated because they feel responsible.
6As-They can see the application of what they study to their professional future.

Advantages for teachers

1At- They coordinate the programme with contents more easily.
2At- Teachers from non applied disciplines can be supported to implement applied activities.
3At- Teachers have to prepare less theoretical lectures.
4At- More tutoring hours and less lecturing.
5At- Motivated when seeing students highly interested in projects.
6At- Work on real examples, as if students were real professional.

Disadvantages for students

1Ds- They depend on somebody else.
2Ds- They spend some time teaching basic knowledge to somebody else.
3Ds- They can spend much time until they get on the right way/information.
4Ds- They need a great effort to understand specific concepts.
5Ds- They have to assume all kinds of responsibilities, even when things are not going well.
6Ds- They have to make an effort to understand the professional point of view.

Disadvantages for teachers

1Dt- They have to adapt their subject programme to somebody else's subject
2Dt- They have to learn to propose new applied activities
3Dt- They are not sure that students can get through information, if they concentrate more on learning procedures and less on content.
4Dt- They can not help in the learning process.
5Dt- They have to convince students when they do not take their responsibilities.
6Dt- Not always all teachers come from applied disciplines.

Analyses of teachers' agreement with the mentioned advantages and disadvantages

The degree of agreement is expressed with a number from 0 to 10. In the analysis of advantages (Table 7), a high level of agreement is found. All degrees expressed are 5 or higher. In the analysis of disadvantages (Table 8), the agreement is not high in all respects. For example, the degree of agreement for the following statements is considerably low:

- 2Ds- Students spend some time teaching basic knowledge to somebody else
- 6Ds- Students have to make an effort to understand the professional point of view
- 2Dt- Teachers have to learn to propose new applied activities
- 3Dt- Teachers are not sure that students can get through information, if they concentrate more on learning

Table 7. Analysis of advantages of PBL according to teachers

	Advantages for students	Teacher 1	Teacher 2	Teacher 3	Teacher 4	Mean	Deviation
Coordination	1As	7,5	7	8	8	7,6	0,5
Social abilities	2A	10	10	7	10	9,3	1,5
Physic abilities	3As	10	7	8	6	7,8	1,7
Technical Knowledge	4As	10	10	7	8	8,8	1,5
Motivation	5As	10	10	7	10	9,3	1,5
Motivation	6As	10	10	8	10	9,5	1,0

	Advantages for teachers	Teacher 1	Teacher 2	Teacher 3	Teacher 4	Mean	Deviation
Coordination	1At	10	7	8	6	7,8	1,7
Social abilities	2At	10	10	7	10	9,3	1,5
Physic abilities	3At	5	8	5	8	6,5	1,7
Technical Knowledge	4At	5	10	7	8	7,5	2,1
Motivation	5At	7,5	10	7	10	8,6	1,6
Motivation	6At	10	10	8	7	8,8	1,5

Another observation made is that in some respects the appreciations of teacher are quite similar. However, those with a high deviation denote a high degree of disagreement between teachers. This could be due to real disagreement or to different interpretations. This second possibility is discarded since the coordinator discussed the meaning of the sentences with the teachers who participated in the evaluation. For this reason, the high degree of disagreement between teachers in the following respect should be used to question whether further improvements should go in that direction or not:

1Ds- Students depend on somebody else
2Ds- Students spend some time teaching basic knowledge to somebody else
6Ds- Students have to make an effort to understand the professional point of view
2Dt- Teaches have to learn to propose new applied activities
3Dt- Teachers are not sure that students can get through information, if they concentrate more on learning procedures and less on content.
4Dt- Teachers can not help in the learning process.
5Dt- Teachers have to convince students when they do not take their responsibilities.
6Dt- Teachers always all teachers come from applied disciplines.

Table 8. Analysis of advantages of PBL according to teachers

	Disadvantages for students	Teacher 1	Teacher 2	Teacher 3	Teacher 4	Mean	Deviation
Coordination	1Ds	7,5	10	7	2	6,6	3,4
Social abilities	2Ds	0	7	6	2	3,8	3,3
Physic abilities	3Ds	10	10	7	4	7,8	2,9
Technical	4Ds	7,5	10	6	6	7,4	1,9
Motivation	5Ds	7,5	10	5	4	6,6	2,7
Motivation	6Ds	0	8	8	0	4,0	4,6
	Disadvantages for teachers	Teacher 1	Teacher 2	Teacher 3	Teacher 4	Mean	Deviation
Coordination	1Dt	7,5	7	8	2	6,1	2,8
Social abilities	2Dt	0	7	8	0	3,8	4,3
Physic abilities	3Dt	0	8	8	0	4,0	4,6
Technical Knowledge	4Dt	0	10	4	5	4,8	4,1
Motivation	5Dt	10	10	7	2	7,3	3,8
Motivation	6Dt	10	10	6	0	6,5	4,7

2 CONCLUSIONS

The information provided by students will be useful for the PBL coordinator to propose corrective actions on the program for next years. At least the following aspects will be considered for improvement:

1. Improve evaluation
2. Reduce practical activities non included in PBL
3. Clear definition and initial training to students and teachers on the methodology

4. Measure the student time investment during PBL, to define in the future a student-based credit system (according to ECTS).

The study has faced the teachers implication on the project, they all see positive the PBL methodology but they see difficult to fulfil actual program requirements and the new methodologies. They also need to learn the basic concepts of PBL. The coordinator should provide the specific knowledge to teach based on working procedures.

The main disadvantages from the point of view of teachers derived from the previous study are:

- 3Ds- Students can spend much time until they get on the right way/information.
- 4Ds- Students need a great effort to understand specific concepts.
- 5Ds- Students have to assume all kinds of responsibilities, even when things are not going well.
- 1Dt- Teachers have to adapt their subject programme to somebody else's subject.

A solution for 3Ds and 4Ds could be to increase the tutoring time of students. However, the inconvenient that teachers see in this respect is concerning the number of students (especially those participating in PBL), which was about 70 student distributed in 17 groups this year. The disadvantages 1Dt denotes that teacher also require training. The coordinator could provide specific knowledge regarding how to adapt subjects to the PBL as well as how to adapt the PBL activity to the incorporation of new subjects.

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