

# AGRI ENGINEER PROJECT-BASED LEARNING

**Fernando González-Andrés<sup>1</sup>, Andrés Martínez-Rodríguez<sup>2</sup>, Beatriz Urbano-López de Meneses<sup>2</sup>**

<sup>1</sup>*University of Leon (SPAIN)*

<sup>2</sup>*University of Valladolid (SPAIN)*

## Abstract

Agricultural Engineer Degree students require a Graduation Project (GP) to complete the degree. The GP intends to be a real project that must be designed, described and solved, using the competences and skills acquired during the four years degree, by the student. Right now, the students wait to complete the four years degree to start thinking in the GP. Due to this reason after four years of engineer subjects, many of the students delay the presentation of the final Graduation project reducing the on time graduation index. The fear to face a complete engineering project, the need of time to think in their future and the offer of low quality jobs are some temptations to do not start the GP even during the last year of degree.

In the other hand the Bologna process and the European Credit Transfer System (ECTS), let to introduce project-based learning (PBL) activities at the degree subjects. The aim of the innovative education action presented is to incorporate the project-based learning methodology to work on real agricultural projects in which they will work during their studies. After the fourth degree year they could have plan and start to design the project that will become their personal GP. The development of the innovative education action includes the selection of the subjects in which PBL will be implemented, the organization of seminars to close the students to agricultural projects, the dissemination of the use of PBL for agricultural degree subjects and the assessment of the on time graduation index evolution.

The results will be, i) to give sense to the degree subjects by their application to real agricultural projects and ii) to help the students to face on time the GP.

Keywords: Innovative education action, Graduation projects, Engineering PBL subjects.

## 1 INTRODUCTION

### 1.1 Degree in agricultural engineer

Degree in agricultural engineer provides with the scientific and technological knowledge necessary, to design, plan, manage and organize processes related to agricultural and livestock production, quality control and food safety mechanisms, and the economic viability of agricultural businesses. Students receive multidisciplinary training in vegetable production techniques and their application to the management of agricultural and horticultural farms, in animal production techniques and their application to the management of livestock farms, and in the technological foundations of engineering for designing agricultural production facilities and agro-industrial buildings.

Degree in agricultural engineer specialization in rural engineering legally qualifies the holder to exercise the profession of Agricultural Engineer [1] (CIN Order 323/2009, Official State Gazette of 19th February 2009), in the corresponding field of the specialization. The most common career opportunities include: i) Agricultural engineering consultancy, project writing and management in public or private companies and technical departments or independent professional practice, ii) Government work (they are qualified to become State-Registered Agricultural Engineers), iii) Management and technical assistance in Agricultural and Livestock Farms, Food Industries, Irrigation, etc., iv) Professional studies and work related to the rural environment: land use planning, surveying and mapping, valuations and appraisals, v) Environmental impact assessment, vi) Technical and commercial employment in agricultural and agrifood supply companies, vii) Direction and management of farms or cooperatives, viii) Technical management and direction in companies, product development, research and experimentation and ix) Quality and process control: safety systems and environmental protection.

The degree in agricultural engineer load 240 European Credit Transfer System (ECTS) [1], one credit is equivalent to a study load of 25 hours, and is organize in four courses. Moreover, agricultural

engineer degree students require a Graduation Project (GP) to complete the degree. The GP intends to be a real project that must be designed, described and solved, using the competences and skills acquired during the four years degree, by the student.

## **1.2 Project-based learning (PBL)**

European Credit Transfer System (ECTS) [2] derive from the implementation of the European Higher Education Area (EHEA) [3] facilitates to introduce project-based learning (PBL) activities at the degree subjects to guide the learning process.

Project-based learning is a dynamic approach to teaching in which students explore real-world problems and challenges. With this type of active and engaged learning, students are inspired to obtain a deeper knowledge of the subjects they're studying. The Project-based learning allows students to learn by doing and applying ideas. Students engage in real world activities that are similar to the activities that adult professionals engage in [4].

Project-based learning is a form of situated learning and it is based on the constructivist finding that students gain a deeper understanding of material when they actively construct their understanding by working with and using ideas. In project-based learning, students engage in real, meaningful problems that are important to them and that are similar to what agricultural engineers do. A project-based classroom could allow students to investigate questions to their own GP, propose hypotheses and explanations, discuss their ideas, challenge the ideas of others, and try out new ideas. Research has demonstrated that students in project-based learning classrooms get higher scores than students in traditional classrooms [5], [6] and [7].

Project based learning (PBL) is claimed to be a suitable approach to develop the Graduation Project which intend to be a real agricultural engineer project solved by students. Nevertheless, literature does not show the use of PBL to help the students to write their GP. Additionally the literature shows the benefits to include PBL at engineer degree learning outcomes. A study shows that all the graduates recognized the benefits of taking PBL subjects as well as internships, with success in communication attributed more to PBL [8].

The most significant challenges that must be face to implement PBL at the engineer curriculum is, the requirement for extra resources; the extra effort required from the lecturer in setting the tasks at the appropriate levels and the need to adopt novel methods of assessing students and providing feedback [9].

## **1.3 On time graduation Index**

Agricultural Engineer Degree has implemented a quality management system in order to assess the creation, development and evaluation of the degree. In this sense, the on time graduation index measures the number of students that finish the degree in the fourth year (as is program by the syllabus) or one year later.

The efficiency index means the relationship between the number of ECTS credits pass by the student in a year and the total number of credits signed up by the student. The global efficiency index calculates the percentage of credits ECTS signed up by the students in relation with the total number of ECTS credits that could be signed up by the students each year.

The assessment of the on time graduation revealed a low index. During the five years of implementation of Agricultural Engineer Degree by the European Higher Education Area (EHEA) at the Valladolid University showed that the students wait to complete the four years degree to start the GP. Due to this reason after four years of engineer subjects, many of the students delay the presentation of the final Graduation project reducing the on time graduation index. The fear to face a complete engineering project, the need of time to think in their future and the offer of low quality jobs are some temptations to do not start the GP even during the last year of degree.

The assessment shows that many students enrolled the GP although ceased on doing it, an average of the 62.5% of the students. Some of them even enrolled before have a project to work on, 12.5%. Few of them, passed the GP examination during the last year of the degree, 25% and usually spent more than one year more to finish it (Table 1).

Table 1. Number of students proposed GP, enrolled and passed or not presented (2013-2016).

	2013-2014	2014-2015	2015-2016
GP enrolled students	20	20	9
GP proposed	17	18	6
Enrolled and not presented	61.36%	63.64%	-
Passed GP first option	27.27%	18.18%	-
Passed GP second option	11.37%	18.18%	-

## 2 OBJECTIVES

The aim of the innovative education action presented is to incorporate the project-based learning methodology to work on real agricultural projects in which the students will work during their studies that could become the student Graduation Project.

To fulfil the general objective, the following specific objectives were proposed:

- Select and create and itinerary of subjects in which Project Based Learning could be implemented,
- Analyze the real engineering projects proposed by the students as Graduation Project,
- Design engineering subjects including PBL methodology to develop the GP,
- Assess the implementation of PBL methodology in an Agricultural Degree subject,
- Include the PBL methodology at the learning subject plan,
- Organize seminars to close the students to agricultural projects,
- Disseminate the use of PBL for agricultural degree subjects among the academic staff and
- Asses the on time graduation index evolution.

## 3 METHODOLOGY

The global methodology of the innovative education action was quiet linear including, i) diagnosis and selection of the subjects, ii) design of the subjects to include PBL methodology, iii) implementation of the PBL methodology to develop the GP, iv) assessment of the application of the PBL at the GP and v) the dissemination for PBL implementation and to close the students to the agricultural engineering projects (Fig. 1).

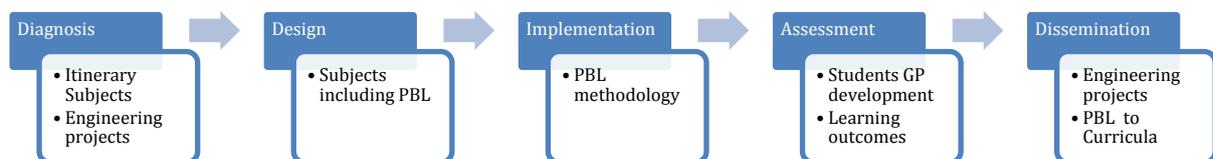


Figure 1. Phases of the methodology of the innovation education project to include PBL at Curricula to develop the GP.

The diagnosis analyzed in one hand the most common projects proposed by the students to guide the itinerary of subjects liable to implement the PBL, and in the other hand the prospect of the agricultural engineer syllabus to detect those subjects capable to implement PBL to realize the GP of the students according to the demand of the students. A sample of 45 students, who proposed GP was analyzed to find the students agricultural engineer projects interests. The sampling corresponds to 2010-2015 years. The 30% of them proposed an agricultural engineering project in their own region, the 20% proposed engineering projects in their own province and the 50% of the students proposed projects in

other regions in Spain. The main agricultural engineering projects were proposed in crops production, irrigation, livestock management, construction and farm management.

Then, an itinerary of subjects was designed to include PBL from the GP student interests. According to the students interests an itinerary of syllabus subjects were proposed to include PBL. The Curricula was analyzed and contents separated to include PBL activities oriented to work on real agricultural projects that will help the students to write their personal GP.

For the implementation, the subject of Commercialization was chosen. The commercialization subject included the Project Based Learning to develop the student's graduation project. The total subject is divided in fundamentals (60%) and practical in agricultural products commercialization (40%). The students were proposed to work, during the course, applying the fundamentals in the commercialization of the products obtained at the engineering graduation projects. The students solved the commercialization problem of a real project. The students wrote a report with the commercialization solution that they would use for the GP. All the fourth course students participated at the PBL.

For the dissemination, two target groups were proposed, students and teachers. For the students, the task was to close the students to agricultural engineering projects to improve self-confidence to face the Graduation Project on time. For the teachers, the task was to promote the use of real agricultural projects to apply the fundamentals of the subjects during the degree.

For the assessment of the on time graduation index evolution, the data of GP enrolled students, enrolled and not presented for examination, students that passed at the first and second time were analysed from year 2013 and the present year.

#### 4 RESULTS AND DISCUSSION

The diagnosis revealed that students proposed to study engineering projects in crop production (26.8%) like: grapefruit (4.5%), horticulture (4.5%), olive's tree (2.2%) and fruit trees (15.6%). Irrigation projects were proposed by the 22.2% of the students. Rural construction is interested by the 20.0% of the students. Livestock engineering projects were proposed by the 22.2% of the students. Farm management was proposed by the 8.8% of the students. It is concluded that crop and livestock production subjects of the syllabus could include PBL methodology to help the students to develop GP. Moreover, irrigation and rural construction subject can propose real projects based on students own GP. Rural management additionally can work on students GP (Table 2).

Table 2. Engineering projects proposed by 45 students as Graduation Projects in percentage.

Topics	Percentage
Crop production	26.8
Irrigation	22.2
Livestock management	22.2
Rural construction	20.0
Farm management	8.8
Total	100.0

According to the students interests an itinerary of syllabus subjects was proposed to include PBL and work on real engineering projects (Table 3). The syllabus includes a total of 36 subjects that must be completed by the students. The syllabus comprises a basic module of 8 subjects totalled 66 credits ECTS, including Maths, Physics, Chemistry, etc. Ten common compulsory engineering subjects are part of the second module that totalled 75 credits ECTS of generic engineering subjects. Another 17 subjects takes part of a specific module totalled 54 credits ECTS including the agricultural engineer profile like Farm management (Table 3), Machinery and rural management or Landscape and gardening. The rest 27 credits ECTS are chosen by the student according to his interests.

Taking into account the graduation projects proposed by the students, nine subjects of the syllabus were initially proposed to include PBL in the graduation projects. Three of them belong to crop production and two of them to animal production. Farm engineering, irrigation, commercialization and construction were also proposed to develop the GP as PBL (Table 3).

Table 3. Agricultural Engineer itinerary for the implementation of the PBL to the GP according to the student interest.

1 <sup>st</sup> Year (ECTS)	2 <sup>nd</sup> Year	3 <sup>rd</sup> Year	4 <sup>th</sup> Year
Edaphology and climatology (6) Physics (10) Chemistry (9) Technical drawing techniques (9) Biology (10) Mathematics and Computer (10) Business administration (6)	Agricultural Botany (6)	Topography (9)	Genetics (6)
	Statistics (6)	<b>Herbaceous crops (6)</b>	Machinery design (6)
	Environmental Science (6)	<b>Woody crops (6)</b>	Land use planning (6)
	<b>Construction (6)</b>	Phytopathology (6)	<b>Comercialization (6)</b>
	Rural engineering (6)	Ruminant production (6)	Project management (6)
	<b>Animal production (12)</b>	<b>Animal nutrition (6)</b>	Monogastrics (6)
	<b>Crop production (12)</b>	Agricultural mechanization (6)	Etnobotany (3)
	<b>Hydraulic (6)</b>	<b>Farm engineering (6)</b>	Landscape restoration (3)
		Geo Information systems (3)	Internship (6)
		IT for Agriculture (3)	Graduation Project (12)
	Conservation Machinery (3)		
9Total Credits 1 <sup>st</sup> year (60)	Total Credits 2 <sup>nd</sup> year (60)	Total Credits 3 <sup>rd</sup> Year (60)	Total Credits 4 <sup>th</sup> Year (60)

For the implementation, the commercialization subject was selected to include the Project Based Learning to develop the student's graduation project, in 2015-2016 academic course.

Initially, students were asked to think about the Graduation Project. The teacher proposed the students to organize and design the real commercialization of the products obtained at the project that could become their graduation project. All the students chose to work on real engineering projects that could become their Graduation Project. The students worked on the question: how to solve the commercialization of the products obtained at my GP?. Where, how, to whom and when to sell the products of a real agricultural engineering project proposed by the students that will become the student GP were the questions to be solved by the students using the fundamentals of the subject. The logistic of the commercialization, transportation, storage, distribution were designed, calculated and solved by the students as they were really producers that must sell their products.

Additionally, the methodology was included at the learning plan of the commercialization subject (Fig. 2). The subject competences included the proposal to work on the commercialization of a real agricultural engineering project that could become part of the student GP during the course. At the learning process, was stated that the students would work during the course designing and solving the commercialization of a real agricultural engineering project that could become part of the student GP, answering the questions:

- How commercialize the products obtained at the real agricultural engineer project?
- Where commercialize the products?
- Which is the real logistic to be use?
- When commercialize the products?
- Is it convenient to storage the product?
- Which are the costs of products transformation and profitability?
- Which are the best strategies and markets for the products?

The learning outcome stated was to learn how to face and report the commercialization of a real engineering project that could become part of the student Graduation Project.

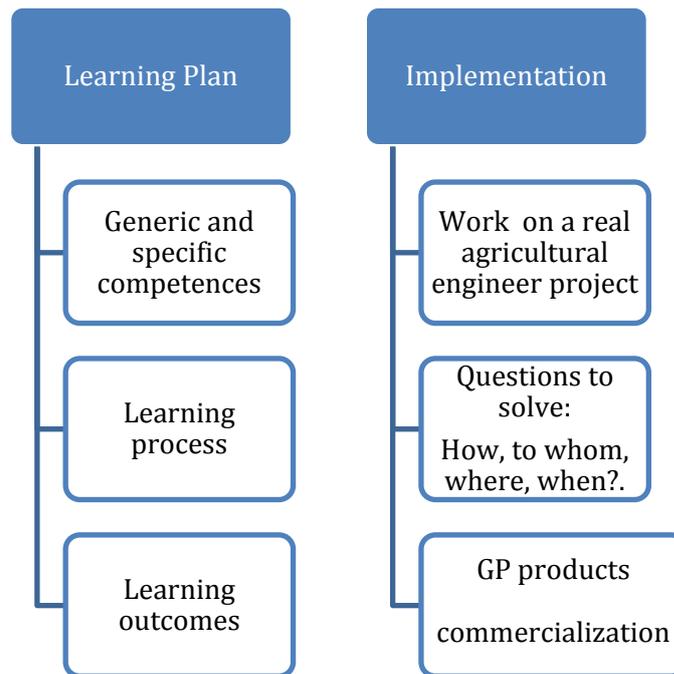


Figure 2. Implementation at the learning plan the PBL methodology for the development of the GP, the case of the commercialization subject at the Agricultural Engineer Curricula at Valladolid University.

The implementation of the methodology arose up that all the students were glad to work on a real agricultural engineering project chosen by them during the course. The students found useful to apply the fundamentals on a real agricultural engineering project. The students agreed to face at the classroom the graduation project. During the practical presentation of the students report, the classroom asked the student questions that must be solved for the commercialization, helping each others to complete the GP. Finally, the students have faced real agricultural engineering projects and fulfil the competence of solving a real commercialization problem using the fundamentals learned at the subject (Fig. 3).

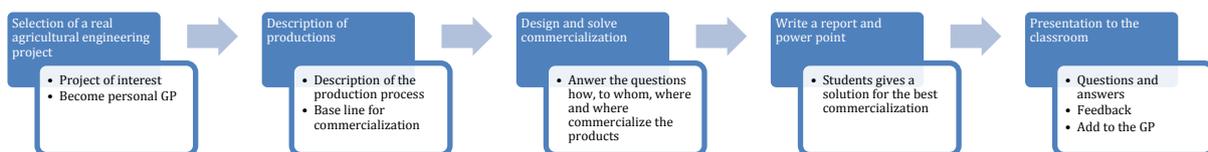


Figure 3. Steps of the implementation of the PBL at the Commercialization subject in Agricultural Engineer Degree at Valladolid University.

For the dissemination, a seminar to close the students to agricultural engineering projects was organized. The seminar lasted eight hours and construction, irrigation and agricultural farm management were taught. The seminar was specially focussed on the use of Innovation Technology to design and solve engineering projects that could be needed by the students to write their personal graduation project. A comprehensive overview of the approach to face agricultural engineering projects and the present tools to use would guide the students to achieve their personal Graduation Project. The seminar aim was to meet the student interests and the skills to solve the graduation project.

Moreover, the dissemination of the use of PBL for agricultural degree subjects was promoted among the academic staff. In this sense, the teachers committees, degree responsible and co-ordinators, directors meetings and other management instruments knew and followed the progress of the education innovation action. The educational action was supported by the innovation education activities department of the Valladolid University and a report will be published for the dissemination among the university community.

## 5 CONCLUSIONS

- The assessment of the on time graduation revealed a low index.
- The students need motivation to face the GP and increase the on time graduation index in Agricultural Engineer Degree at Valladolid University.
- Farm management, crop and livestock production, irrigation and rural construction topics were proposed as real engineering projects by the students to work on GP.
- Taking into account the graduation projects proposed by the students, nine subjects of the syllabus could include PBL in real agricultural engineering projects that could become the student graduation projects.
- For the implementation, the commercialization subject was selected to include the Project Based Learning to develop the student's graduation project. The students worked on the question: how to solve the commercialization of the products obtained at my GP?
- The implementation of the methodology arose up that all the students were glad to work on a real agricultural engineering project chose by them during the course.
- The implementation revealed that students have faced real agricultural engineering projects and fulfil to solve a real commercialization problem using the fundamentals learned at the subject.
- The PBL methodology was included at the learning plan of the commercialization subject: i) competences included to work on the commercialization of a real agricultural engineering project that could become part of the student GP during the course, ii) the learning process stated that the students would work during the course designing and solving the commercialization of a real agricultural engineering project that could become part of the student GP, iii) the learning outcome stated to learn how to face and report the commercialization of a real engineering project that could become part of the student Graduation Project.
- For the dissemination, a seminar to close the students to agricultural engineering projects was organized.
- The seminar aim was to meet the student interests and the skills to solve the graduation project.
- The dissemination of the use of PBL for agricultural degree subjects was promoted among the academic staff.
- The innovative education action has given sense to the degree subjects by the application of real agricultural engineering projects to the learning process and has helped the students to face on time the GP.

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