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Implementing Management Systems and Demand Driven MRP concepts: A Project Based Learning experience in Industrial Organization Engineering

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Abstract

This research work presents an experience of the Faculty of Engineering of Mondragon Unibertsitatea using Project Based Learning (PBL) with the students of 4th semester of Bachelor's Degree in Industrial Organization Engineering (IOE).

The PBL delved into the concepts developed in the subjects of Management Systems and Production Logistics. The project was contextualized in a company that produced parts for the automotive sector. Teams of students implemented a management system that enabled the efficient management of materials and the production process using tools such as Demand Driven MRP (DDRMP). As a result, they had to solve the proposed problem, develop a simulation and choose the proposal that best met the needs of the company.

In order to assess PBL performance a survey was carried out. The results confirmed that the experience was positive since the achieved knowledge provided a meaningful learning experience for the students, while facilitating the development of both technical and transversal competences.

Keywords: *Project Based Learning; Management Systems; DDMRP; Teaching methods.*

1. Introduction

The current paradigm that surrounds us is increasingly dynamic and volatile, requiring the ability to predict future trends and adapt to them. Globalization in the information and knowledge society, has led us to acquire new skills, new ways of seeing the world, the use of new tools and languages, etc. Great efforts are therefore needed to adapt and deal with this complex and volatile environment (Castells, 1996).

In view of this situation, nobody disputes the need to support students in the acquisition of new competences for their proper insertion into the world of work, as the working environment has new requirements as well (EUROPEIA, 2014). The efficient performance of any profession needs the ability to solve increasingly complex tasks and the linkage of education with the professional career is therefore becoming more and more necessary (Gallo-Martinez et al., 2015).

In this regard, education requires new teaching-learning models that fulfil the demand of this new paradigm. Therefore, educational institutions should take into account the following three aspects to facilitate the transition to new models: First, it should be assumed that the formal environment will not always be the main source of knowledge. Secondly, in the era of mass data, new competences such as searching, evaluating, organizing, selecting are needed to make effective use of information. Finally, it should be considered that learning is a continuous process that develops throughout life and extends beyond the period of formal education (Pozo, 2006).

It is important to note that in the learning process, students are the real protagonists and that not only learning to learn is important, but learning to do, learning to be and learning to live together is also essential (Century et al., 1996).

The present work therefore, describes and analyzes how the Faculty of Engineering of Mondragon Unibertsitatea (MGEP), with the teaching-learning model based on projects, trains the students of the Bachelor´s Degree of Industrial Organization Engineering (IOE) so that they can satisfy the future demands of this new paradigm.

2. Project Based Learning

According to Laffey et al. (1998), Project Base Learning (PBL) is a modification of what was initially conceived as a methodology that drove students to generate knowledge and address issues in a previously raised context. PBL also presents an ideal opportunity to create simulated situations which can arise in the real world, enabling students to propose a collaborative solution (Thomas et al., 2005).

Moreover, PBL stimulates motivation of the students since they have meaningful goal to aim for (Green, 1998). This type of teaching encourages students to take on a dynamic role that leads to a deep understanding of the concepts worked on. This goal is hard to achieve with classic teaching models like information transmitted from a teacher, a computer or a book, which results in a rather superficial learning (Krajcik et al., 2006).

According to Arana-Arexolaleiba et al. (2017), PBL allows students to develop both technical and transversal competences. The technical competences are related to the technical section of the project and directly related to the worked subjects. The transversal competences enable working concepts such as thinking oriented to problem solving, decision making, effective communication, teamwork, global vision, leadership and learning to learn.

3. PBL in the Faculty of Engineering of Mondragon Unibertsitatea

The primary goal of MGEP is to prepare profiles with a markedly professional character in an industrial environment. In order to achieve this goal, in 2002 MGEP opted for the PBL methodology and nowadays it is implemented in all Bachelor and Master Degrees.

In the PBL model implemented in MGEP, each semester two tactics are merged: at the beginning of each semester teachers have an active role and teach essential knowledge in different topics. In the second part of the semester, the roles are reversed. Students take the active role and develop a project, putting into practice and investigating in greater depth the subjects worked on in the semester.

Depending on the semester the weight of the project will account for between 20% and 50% of the European Credit Transfer System (ECTS) of whole semester (Figure 1) (Arana-Arexolaleiba et al., 2017).

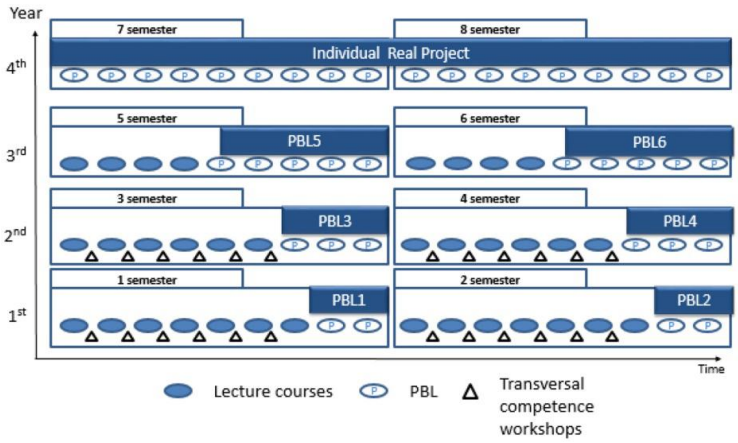

Figure 1: *MGEP curriculum structure. Source: Arana-Arexolaleiba et al. (2017).*

To ensure that students progress according to the objective of the project, each team of students has a tutor and experts for each topic worked on. The main objective of the tutor is to ensure that each group manages the project effectively and all tasks are carried out on time. In addition, the tutor supervises the active participation of each team member in the assigned tasks.

The role of the experts is completely different as they provide technical advice. In the case that a team derails, the expert group provides the corresponding feedback, so that the team members acquire knowledge and are capable of returning to the correct path. For this purpose, different milestones and meetings are planned throughout the project, so that students can present the work done and compare the results obtained so far.

4. PBL case study in 4th semester of Bachelor´s Degree in Industrial Organization Engineering

Mondragon Unibertsitatea has as its goal promoting the improvement and innovation of products, services and technological processes as well as organizational models (Mondragon Unibertsitatea, 2018). To this end, students who take the Bachelor's Degree in IOE acquire skills and knowledge to drive competitive and sustainable industrial activities and services. Specifically, in the 4th semester, the students undertake lessons in the topics of Production Logistics and Management Systems.

In addition to teaching and research, the staff of MGEP provide consultancy services to commercial companies. These collaborations means that the institution is well placed to understand real business needs and can transfer this reality to the classroom or even define multidisciplinary projects based on real cases. In this context, a multidisciplinary project (incorporating the subjects of Production Logistics and Management Systems) was defined and carried out in the 2016-2017 academic year.

At the commencement of the project the students considered that Production Logistics and Management Systems were two completely independent worlds, and that there was no relationship between them. However, in a business context these two fields are quite interrelated since the company uses these internal processes to contribute to the value chain of its customers. In other words, the goal of the Management System is to be able to maximize the contribution of value to customers through the sum and combination of innovation processes, operating processes and after-sales service (Zaratiegui, 1999). Within the operating processes, companies manage indicators such as the percentage of deliveries on time, time of the production cycle, productivity of people and machines, yields and costs (Zaratiegui, 1999). An efficient management of materials and production is necessary to

improve these indicators and thus the company is able to satisfy the requirements of the internal and external customer gaining competitive advantage (Lutz et al., 2003).

The objective of this project therefore, was to increase knowledge in both fields and to demonstrate how unilateral decisions in one field impact the other.

To this end, the teaching staff defined an industrial environment that provided complete solutions for the automotive sector. To simplify and make it a manageable project for students, the project was focused on a single product. The students had technical drawings of the product, its bill of materials, the detailed description of the companies that supplied each part, the description of the production process, as well as the management of materials that the company made using the Material Requirements Planning (MRP).

The project proposed developing a simulation where the company simulated its supply chain management, upgrading the Manufacturing Planning and Control (MPC) system to Demand Driven MRP (DDMRP). In this way the students could analyze the advantages and disadvantages of managing the flow of materials and information through the supply chain with this methodology, and analyze its impact on the Management System. At the conclusion of the project, the students had to decide if it was worth upgrading to DDMRP and justify the decision.

The project milestones were defined as follows:

- First the students defined the strategic objectives based on the strategic map, developed the processes map of the organization and established the objectives. Once all tasks were undertaken, the students defined the quality policy of the organization.
- Secondly, the students designed different process files as well as supplier/customers tracking records.
- In parallel, the students designed a simulation that allowed them to analyze the flow of materials and information of the defined industrial environment, using MRP and DDMRP, to make a comparison of the obtained results.
- To finish the project, the students ran the simulation for a specific period of time. Thus, they were able to model and manage daily demand, compare this with forecast demand and propose purchasing orders according to the available inventory. In addition, they were able to see the impact of the uncertainty created by forecast in the supply chain.

  Considering the results of the simulation, students had to 1.- fill in the records of suppliers / customers, 2.- feed the indicators of different processes, and 3.- propose improvements in line with the previously defined strategic map.

5. Results

Once the project was completed, the knowledge that the students had acquired with this project as well as their perception of the concepts learned was analyzed and measured.

The analysis was carried out based on the methodology used by Ibáñez et al. (2017). Two aspects were considered: general aspects of the PBL (Section A) and developed skills (Section B). The aspects of section A are the following:

- A1: The project was adapted to the competences.
- A2: The students required technical concepts to develop the project.
- A3: The project added value to the knowledge acquired in the classroom.
- A4: The duration of the project was adequate.
- A5: The available materials and resources were adequate

As can be seen in Table 1, the students positively valued the general aspects related to the PBL since all aspects are above the mean. A1 and A3 received a particularly positive assessment because the project was directly related to the concepts worked on in class.

The students reported that as a consequence of working on this project they were able to understand the relationship between Production Logistics and Management Systems. Moreover, the experience clearly demonstrated the importance of defining processes and indicators well to define actions aligned with strategy.

A2 and A5 were also well-valued however some areas for improvement were identified. In particular students had difficulties developing the simulation model due to lack of experience. In future projects this issue should be addressed.

Aspects of section B were also assessed between 1 and 5:

- B1: Achievement related to teamwork.
- B2: Achievement in terms of continuous learning of technical concepts.
- B3: Achievement relative to autonomous work.
- B4: Achievement related to communication (reports and presentations).
- B5: Achievement related to the ability to plan.
- B6: Level of motivation during the project.
- B7: Level of satisfaction with the attention provided by the teaching staff.
- B8: Level of recommendation for this type of experience for the learning process.

Table 1: Results of the survey regarding general aspect of the PBL (Section A).

Question	Mean	Question	Mean	Question	Mean
A1	4.11 ±0.48	A3	4.05 ±0.90	A5	3.29 ±0.92
A2	3.35 ±1.05	A4	3.41 ±1.06		

Table 2: Results of the survey regarding the developed skills in the PBL (Section B).

Question	Mean	Question	Mean	Question	Mean
B1	3.71 ±1.05	B4	3.82 ±0.80	B7	3.59 ±1.17
B2	4.12 ±0.78	B5	3.53 ±0.80	B8	4.06 ±0.96
B3	3.71 ±0.92	B6	3.29 ±1.21		

As shown in table 2, the mean of all aspects are between 3 and 5. The score given to the aspects B2 and B8 indicated that students prefer this type of teaching method. However, points to improve are also identified. B6 assesses the motivation of the students during the project, and although the mean is 3.29 its deviation is quite high. In future projects therefore, actions during the definition of the project as well as in its development should be considered to increase motivation.

6. Conclusions

Since 2002 MGEP has based its teaching methodology on PBL. This methodology involves considerable effort however, as teachers require specialize training and need to interact at all times with the students to reach the course objective. In addition, PBL is an active learning methodology that must adapt to the needs of the environment, and thus is necessary to implement a continuous improvement process, in which the teaching model is updated.

PBL methodology is quite well consolidated in MGEP and to date several research works have been carried out in this field. We are well aware however, of the necessity to continuously work on our teaching methodologies and improving our model so as to prepare profiles with a markedly professional character for the industrial sector.

The results obtained in the survey demonstrate that students positively value this teaching model. A further benefit of this methodology it that it places students center stage, and promotes active and dynamic participation in the classroom. Students acquire the skills

required to solve real world problems autonomously, searching for different alternatives/solutions, analyzing them and choosing the most appropriate in a well-argued manner. PBL can therefore be considered an appropriate strategy in the training of engineers, working on both transversal and technical competences through active methodologies. MGEP remains committed to pursuing a strategy of continuous improvement in this field.

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