HOLOS
ISSN 1807 - 1600

QUALITY MANAGEMENT DUAL TEACHING: A SPECIFIC CASE IN A PRIVATE MEXICAN UNIVERSITY

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Artigo submetido em 22/01/2019 e aceito em 13/03/2019

DOI: 10.15628/holos.2019.8224

ABSTRACT

Higher education in Mexico has been given the same the last 30 years in a system that shows a setback. The employers demand professionals with hard competences to create value to their firms. Therefore, the Industrial Engineering Faculty at a private Mexican University developed a dual teaching system (DTS). It considers formal lectures as well as practices in real operation environments. The study field selected was Quality Management which is taught to Engineering students. Thirteen companies of the Puebla-Tlaxcala region participated by receiving interns in projects related with the design, implementation, and improvement of their Quality Management System (QMS) based on ISO9001:2008 and ISO9001:2015 standards. As a result, the pupils spent at least 240 out of class hours in those projects. For the firms, the learning outcomes can be used for certification purposes. This DTS has been running for four years and the findings demonstrate that this academic scheme can be reproduced in other areas of knowledge in Engineering programs.

KEYWORDS: Quality Management, Education, ISO9001, Dual Teaching System, University.

GESTION DE CALIDAD ENSEÑANZA DUAL: UN CASO ESPECIFICO EN UNA UNIVERSIDAD PRIVADA MEXICANA

RESUMEN

La educación superior en México se ha impartido de la misma manera desde hace 30 años en un sistema que muestra un retrocesso. Los empleadores requieren profesionistas con competencias duras para crear valor a sus firmas. Por ello, la Facultad de Ingeniería Industrial de una Universidad privada mexicana desarrolla un sistema dual de enseñanza (SDE). Este considera clases regulares así como prácticas en ambientes reales de trabajo. El campo de estudio selecionado fue la administración de calidad, el cual se imparte a alunos de ingeniería. 13 compañías de la región Puebla-Tlaxcala participaron recibiendo internos en proyectos relacionados con el diseño, implementación y mejora de su Sistema de Gestión de Calidad (SGC) basado en los estándares ISO9001:2008 e ISO9001:2015. Como resultado, los alunos invirtieron al menos 240 horas adicionales a las clases en el desarrollo de los proyectos. Para las firmas, los entregables de aprendizaje pueden ser empleados para fines de certificación. Este SDE ha sido implementado por cuatro años y los hallazgos demuestran que este esquema acadêmico puede ser replicado en otras áreas del conocimiento en programas de Ingeniería.

PALABRAS CLAVE: Administración de calidad, Educación ISO9001, Sistema dual de enseñanza, Universidad.

1 INTRODUCTION

1.1 Higher Education in Mexico

Higher education, with 3.4 million students, covers 9.5% of total enrollment (Secretaría de Educación Pública, 2014). Nowadays, higher education in Mexico has been given the same the last thirty years in a system that shows a setback. Comparing the current teaching system against the way engineering was taught 30 years ago, there are two main differences. Before, an industrial engineering required a training period of 10 semesters. Today, the time lapse is of 7 semesters in a distance program or 8 semesters in a presence one. Additionally, college studies were realized in a presence form whereas they can be done via web now. This academic situation cannot guarantee that the students have the abilities required for the global industries.

On the other hand, the employers demand professionals with soft and hard competences in order to create value to the firms, see Figure 1. Unfortunately, the recently graduates do not achieve this requirement and represent a non-planned expense.

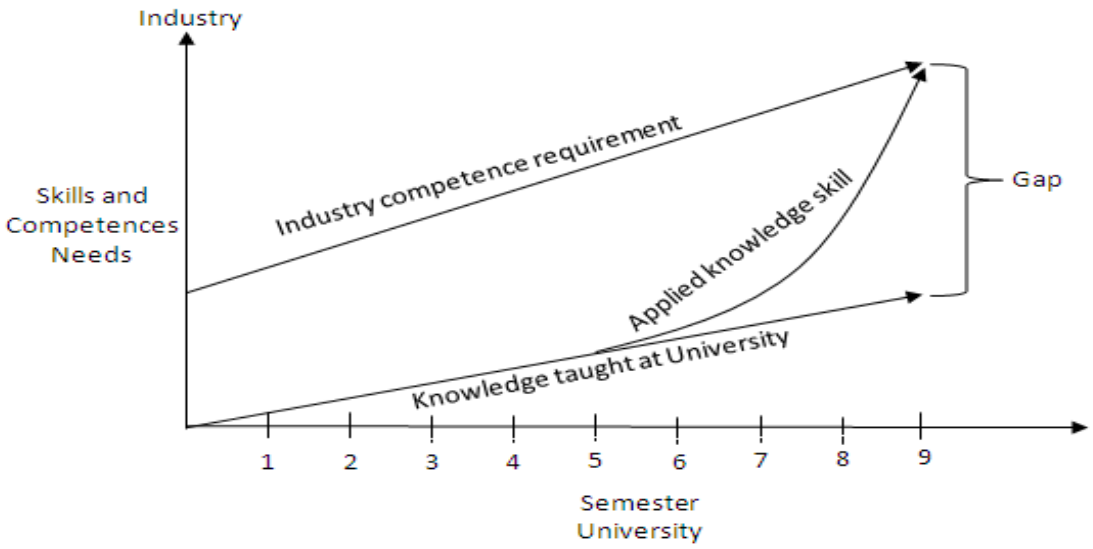

Figure 1. University – Industry Gap

1.2 Dual Training

One of the approaches that fosters students' employability is industry-based learning. In order to fulfil the increasingly competitive job market, universities have to prepare their students with necessary skills and practical working knowledge. Industrial oriented methodology is an approach to learning from an industry perspective (Ahrens, Melnikova and Zaščerinska, 2018).

By taking time out of academia, academics can improve their knowledge and understand the real-world problems faced by industry, and the complex production environments and constraints systems must operate in (Barker, 2018).

Dual education is a modality of teaching and learning that takes place in two different places: educational institutions and industrial companies, which are complemented by coordinated activities (Araya, 2008).

Meanwhile, courses that have reduced face time in the classroom that is replaced by time spent outside the traditional classroom are called hybrid courses. These category combines online learning and experiential learning that takes place in an organization without the presence of a teacher (Caulfield, 2011). Additionally, hybrid learning environments allow students to have more options about when they can study, a wider variety of study materials to use, and a larger range of learning experiences to participate in (Linder, 2017).

The roots of dual training date from the Middle Age in Europe when learning was under master guidance. In terms of technical training out of the traditional classroom, the first attempt was made in France with Ecole des Ponts et Chaussées, which educate urban engineers. In 1869, the German North Confederation formalized the dual teaching center with the Commercial and Industrial Regulations. Currently, this system offers training in 355 occupations. The procedure to fund the dual teaching is through agreements between the business sector and the State. In 1970, dual teaching emerged in United States as response to a need to help ease the transition between high school and college, to develop vocational readiness and to reduce the time it took to obtain a college degree. In Latin America, this modality is diverse among the countries. Some proposals involved technical education at middle school and higher education based on the German model (Araya, 2008).

Mexico introduces the dual training due to the need to generate qualified personnel; companies such as Volkswagen, Mercedes Benz, and Siemens implement this scheme according to manuals established in the main offices located in Germany. Meanwhile, others look for local adaptations. The principal areas implementing this model are automotive, chemical, electrical, and electronic.

To succeed in the implementation of a hybrid course, the instructors should establish learning objectives and decide which acceptable evidence will meet those objectives (Stromie and Baudier, 2017). To ensure program rigor, university instructors should develop assessments to make sure students are performing their own work and are putting forth the required effort (Chumbley, 2015).

1.3 Quality Management Systems

Quality management is defined as the way how a firm can comply the requirements of its customers and other stakeholders affected by its work. Also, a quality management system is built to be flexible enough for use by several types of organization (ISO, 2015).

On the other hand, the new model of the ISO 9001: 2015 standard brings significant changes to generate impact and results on customers and interested parties, taking on importance the study of context, strategic planning, change management and risk management (Fontalvo et al., 2018).

1.4 Process Mapping

The flowchart is fundamental for the standardization and subsequent understanding of the process and consists of registering a process in a compact manner, in order to make possible its better understanding for later improvement. It is a graphic that represents the different steps or events that occur during the execution of a process (Cury, 2017). For the construction of a flow chart or process map, it is necessary that the logical sequence of the productive activities that constitute the process (Batista et al., 2006).

2 METHOD

The methodology used in this case study is the Plan-Do-Check-Act cycle. First, the Industrial Engineering Faculty at the Mexican Private University developed a dual teaching system focus to close the gap among University and industry. This system should impact in the following issues:

a) Begin the dual teaching system in the fifth semester of the engineering major.

b) Align the course syllabus to the employer's requirements. See figure 2.

c) Create applied knowledge skills with formal lectures as well as practices in real operation environments,

d) Allow the engineering students to detect chance areas in the companies and produce improvement projects to eliminate them. The improvement team will be integrated by one firm's representative and one UPAEP professor, in this case the course instructor.

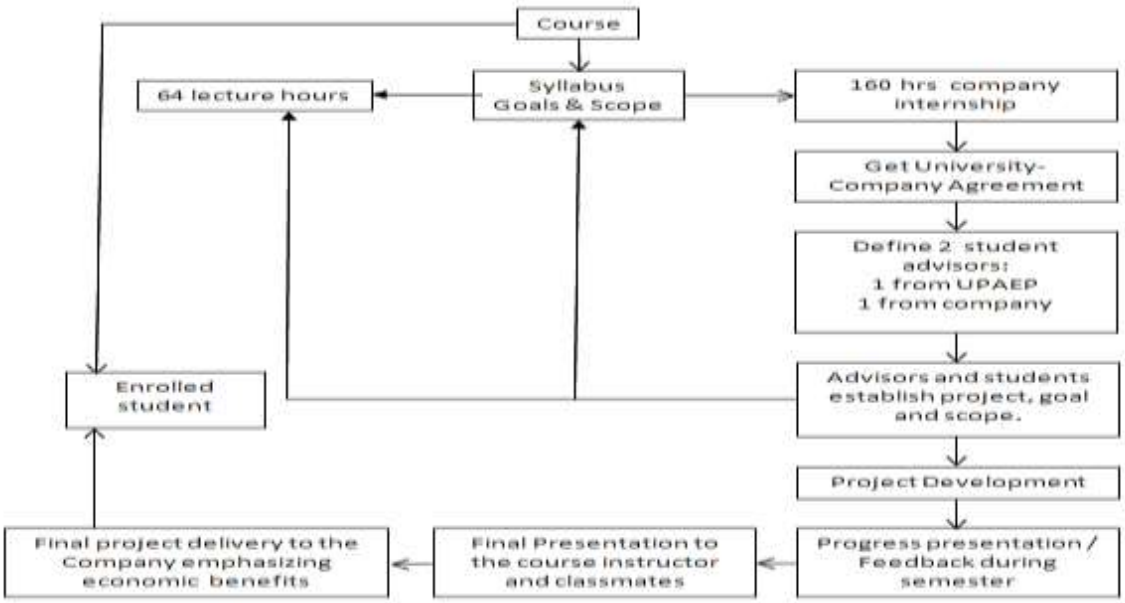

Figure 2. Syllabus alignment

Then, the study field selected to start the process was Quality Management mainly two courses: Quality Engineering II and Certifications. These subjects are taught to Chemical,

Automotive Manufacturing and Industrial Engineering students. Thirteen companies of the region participated by receiving interns in projects related with the design, implementation, and improvement of their Quality Management System (QMS) based on ISO9001:2008 standard. Some of these companies have already a QMS and others not. See Table 1.

Table 1. Participating companies

Industrial Sector	Area	Supplier Type	ISO Certificates
Automotive	Plastic Injection	Tier 1	ISO/TS16949
Automotive	Metallurgical	Tier 1	ISO/TS16949
Automotive	Plastic Injection	Tier 1	ISO/TS16949
Automotive	Mold Manufacturing	Tier 2	None
Automotive	Metallurgical	Tier 2	ISO9001
Government	Health	NA	ISO9001
Water & Energy Conservation	Ozone equipment	NA	None
Furniture	Furniture Manufacturing	NA	None
Dressmaking	Garments manufacturing	NA	None
Textile	Fabric Manufacturing	NA	None
Environmental Laboratory	Water & Environmental Management	NA	None
Construction	Construction Structures	NA	None
Trade Consultant	Electric equipment	NA	None

Besides, the pupils at their companies execute several quality tools. Mainly, they elaborated process maps and turtle diagrams for factories that do not have a quality management system (QMS), see Fig. 3.

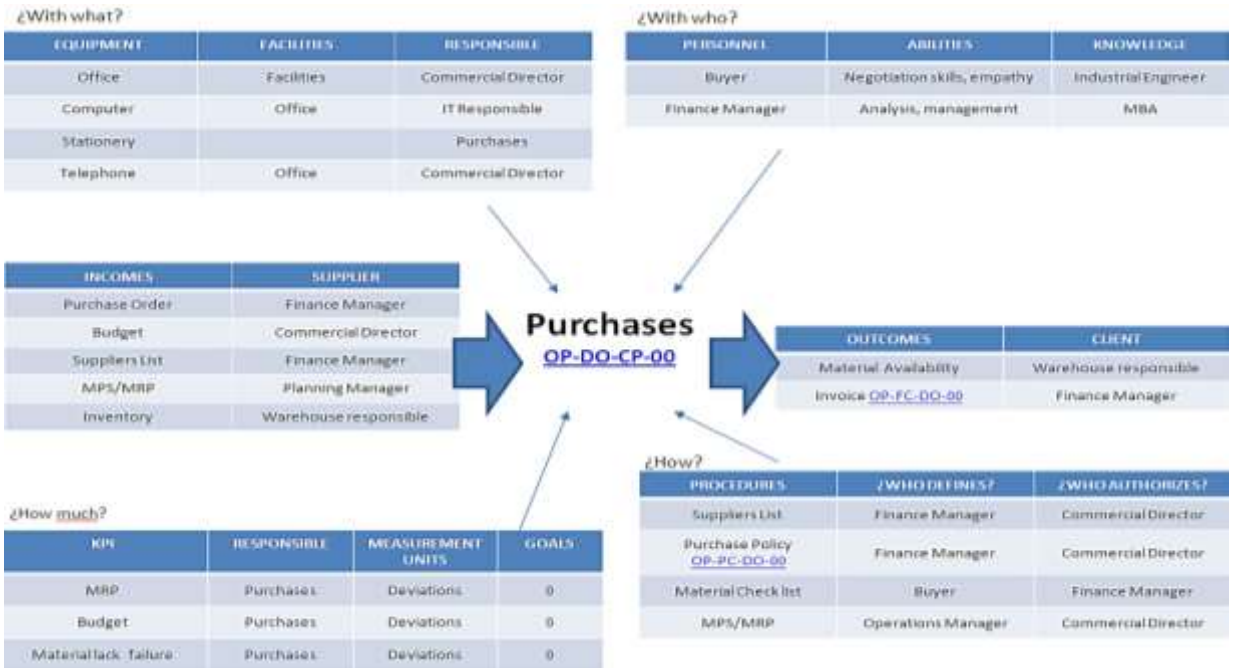

Figure 3. Purchase process turtle map (Developed by the students)

On the other hand, the students proposed new process maps or list of improvements, see figure 4.

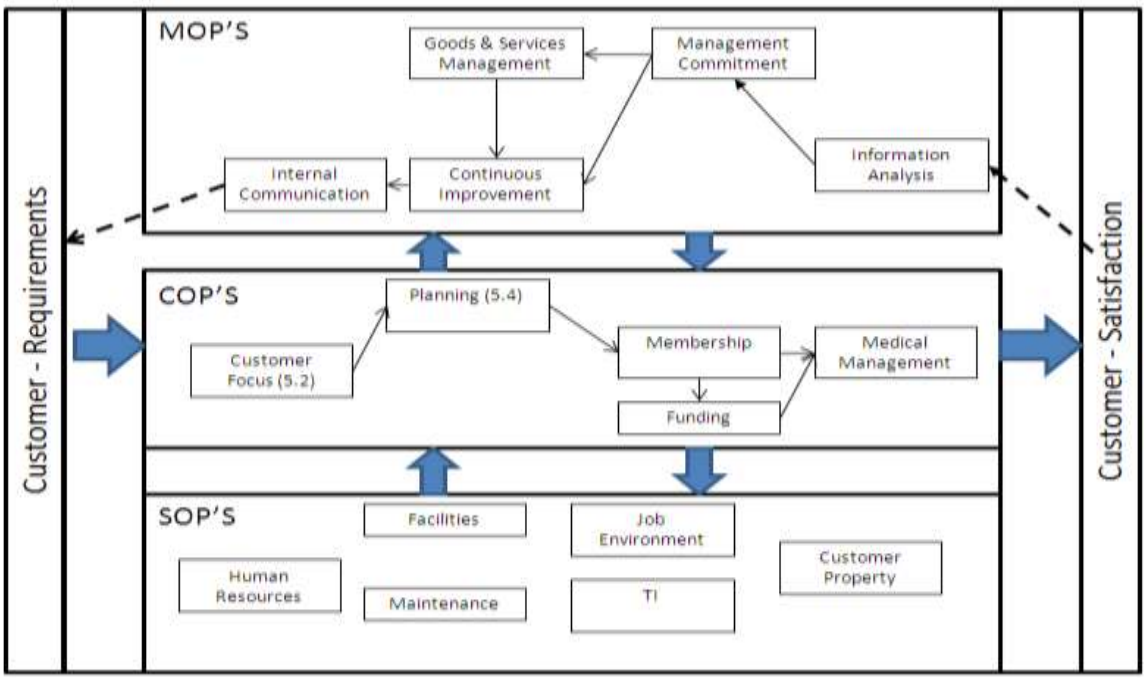

Figure 4. Seguro Popular process map (Modified by the students)

In order to evaluate the performance of the students, the faculty designed a rubric. It measures 3 mains aspects: nonverbal skills, verbal skills, and content. This instrument served as a reference during the final presentations of the projects.

HOLOS ISSN 1807 - 1600

Oral Presentation Rubric Presentor's Name: _____

TRAIT	4	3	2	1
Nonverbal Skills	Advanced	Proficient	Developing	Emerging
Eye Contact	Holds attention of entire audience with the use of direct eye contact, seldom looking at notes.	Consistent use of direct eye contact with audience, but still returns to notes	Displayed minimal eye contact with audience, while reading mostly from the notes	No eye contact with audience, as entire report is read from notes
Poise	Student displays relaxed, self-confident nature about self, with no mistakes	Makes minor mistakes, but quickly recovers from them; displays little or no tension	Displays mild tension; has trouble recovering from mistakes	Tension and nervousness is obvious; has trouble recovering from mistakes.
COMMENTS: _____				
Verbal Skills				
Enthusiasm	Demonstrates a strong, positive feeling about topic during entire presentation.	Occasionally shows positive feelings about topic.	Shows some negativity toward topic presented.	Shows absolutely no interest in topic presented.
Delivery	Student uses a clear voice; all audience members can hear presentation; Student does not read any of the slides to the audience	Student's voice is clear. Most audience members can hear presentation; Student reads some slides to the audience	Student's voice is low. Audience members have difficulty hearing presentation. Student reads most of the slides to the audience	Student mumbles, and speaks too quietly for a majority of students to hear. Student reads all the slides to the audience.
COMMENTS: _____				
Content				
Subject Knowledge	Student demonstrates full knowledge by answering all class questions with explanations and elaboration	Student is at ease with expected answers to all questions, without elaboration.	Student is uncomfortable with information and is able to answer only rudimentary questions	Student does not have grasp of information; student cannot answer questions about subject.
Organization	Student presents information in logical, interesting sequence which audience can follow	Student presents information in logical sequence which audience can follow	Audience has difficulty following presentation because student jumps around	Audience cannot understand presentation because there is no sequence of information.
Mechanics	Presentation has no misspellings or grammatical errors. Slides are readable from any where in the room (Font size is at least 20 pt)	Presentation has no more than two misspellings and/or grammatical errors. Most slides are readable (Most font is 20 pt)	Presentation has three misspellings and/or grammatical errors. A few slides are readable (Font size is less than 20 pt)	Student's presentation has four or more spelling and/or grammatical errors. Most of the slides are not readable (Font size on all slides is less than 20 pt).
COMMENTS: _____				

Figure 5. Oral presentation rubric

Finally, in the act phase the course professor sent an email to the companies' representative to ask about the students' performance, economic feasibility of the project and general feedback.

The professor summarized all the answers received and made a presentation during faculty meeting in order to identify strengths and weakness of the dual teaching system.

3 RESULTS AND DISCUSSION

The project generated benefits to the students and the private Mexican University as well as to the participating companies. Among the results observed in the academic field, the authors highlight the following:

1) Two professors and 120 students participated in the execution.

2) An assessment rubric was created and implemented thru the final exams.

3) The students spent at least 240 out of class hours in the projects they participated.

4) The students show more confidence while they realize job interviews due to the experience and competences gained during the Dual Teaching System program.

5) 100% of the graduates of the last two semesters have a job immediately.

6) Academic confidence to replicate the Dual Teaching System in other industrial engineering courses.

7) The enrolment rises 20% in the Engineering majors involved.

In terms of companies, the feedback showed the following:

1) 25 training courses developed for the internal personnel.

2) The learning outcomes were well received and can be used for certification purposes.

3) 80% of the participating companies have been collaborating since kick-off. The rest of the firms are not convinced of the quality management systems benefits.

Once the dual teaching system has been implemented for four years, it can be concluded that there are a series of steps that allow the student to obtain the expected result from the academy. The methodology includes the following phases: induction, team integration, development, presentation and tuning. This confirms the findings in students of electromechanical engineering by implementing a methodology of active university teaching on a specific theme of an integrating nature (Angarita, Fernández and Duarte, 2016).

Besides the implementation of quality management systems should be based on carefully selected strategy to assure their efficiency and effectiveness (Zimon, 2017).

4 CONCLUSIONS

The dual model can be implemented in university engineering courses. Of vital importance is the accompaniment of the professor to ensure the objectives of this initiative. Finally, the academy, the students and the companies involved are convinced of the benefits.

The Mexican private university has more professional careers so the authors want to replicate this methodology in them as well as the possibility of considering a public university where administrative and academic issues are not ideal for this type of projects.

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