

Quality and Evaluation in Higher Education

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Abstract. Quality is important in industrial production and all kinds of services. In particular, education is one very important service for our society. Since the Bologna process, European universities try to do their best using the resources the society has given them to satisfy the needs of the European citizens.

Quality is very important but it has no value without a well-established system of continuous improvement based on measurement and knowledge of our capabilities and the needs of the society. The best way to measure the results of a service is by the way of the evaluation. Evaluation always needs to consider two inputs: self-evaluation and external evaluation, but it is particularly interesting when evaluation is considered for improving, not when evaluation is considered as inspection.

During this paper, a review and comparative analysis between quality and evaluation in industry and in universities, based on the author's own experience, will be done. The experience of industries and other services implemented in our world is a source of knowledge for improvement, so the main part of this paper will be addressed to the review of what is done in industries and how to translate it into the European Higher Education Area. Finally, some proposals for daily activity in university education will be presented, based on the experience of the research group EduQTech.

Keywords: Evaluation · Accreditation · Quality evaluation

1 Introduction

Quality is a property of products and services very important in our life. It started in production of products, initially for the automotive industry because of the large amount of spear parts to be included in cars. Later, it was extended to other parts of the fabrication world. Industries are interested in produce their products with quality as a commercial way to sell more against the other companies. One of the meanings of Quality is doing things well. Therefore, Quality is important in Engineering.

Finally, service industries were included in the Quality philosophy as banks and other service companies are interested in using Quality as a tool for competitiveness. In parallel, the continuous improvement philosophy was extended as a way to do things as good as possible and better and better.

At the beginning, production companies were interested only in production and the Quality was only for controlling that the products maintain a level of quality in the

characteristics. All activities related with the quality were limited to inspection. No matter the product, the aim of the system was control the quality for assuring that the level of the product was the same nevertheless the quality were poor.

Later the companies changed to the assurance of quality in the way that they try to maintain a minimum of quality, not only a level but also a minimum level to guaranty this quality.

Finally, around the 90ties the evolution was for the continuous improvement. Companies must produce products with a minimum level of quality but they need to improve the product in a continuous way for reaching the excellence. This system is working today and the most popular method to do that is the PDCA process or Deming cycle (Plan, Do, Check and Act-Correct if needed) as it is shown in the Fig. 1.



Fig. 1. Typical Deming cycle.

The new version of the standard ISO 9001:2015 has updated the role of management to the more modern thought process of leadership. This change puts new responsibilities on the senior management, who must demonstrate commitment and take responsibility for the effectiveness of the quality system, while enhancing customer satisfaction. The new orientation of the standard and as well the way of doing Quality is that management's role has changed from focusing on things to focusing on people, and from doing things right to doing the right things. Also, instead of planning, doing and directing, the role of management has moved to inspiring, influencing and motivating. This part is very important because people must be motivated and the labor of the direction for companies or of the university managers is to motivate people to do the right things.

Education is one service more to the Society but is one of the most important services because the future of our Society depends on Education. Therefore, this philosophy of Quality has been introduced as well in our universities and in Colleges. Engineering has been related with Quality since the beginning because of the production of goods and services and in Higher Education Institutions (HEI) related with engineering, is where most strong the implementation of this Quality and continuous improvement philosophy is. United States was the first country to introduce this Quality system in their Engineering faculties for controlling the quality of the students [1]. Different programs were

established and with the evolution in the time, we know very well one of the most important accreditation system of the engineering. The Accreditation Board for Engineering and Technology (ABET) is probably the most prestigious accreditation board of the world.

For the Society and the European countries, we must do as best as possible with the resources we have received. Not the excellence. Excellence is a must. A product is manufactured in the factory and can be checked and tested relatively fast, but the product in university education is the technological knowledge transferred to the student and the abilities and skills obtained at the university. So, how to measure the quality? By the evaluation, but this is not an absolute measurement but a level that must be overpassed. Ranking is not the objective of a good quality system in higher education.

Quality in companies is measured by the method described in the standard ISO 9001 [2] or by other documents like the ones related with Total Quality Management (TQM) [3]. In higher education, quality is measured by Criteria described in documents belonging to institutions, for instance: Accreditation Board for Engineering and Technology (ABET) [1] mainly in United States or European Standard Guidelines (ESG) [4] in Europe.

Similar to the introduction of Quality (ISO 9001) in companies in the 80 –ties, that the accreditation of the fabrication process was before the certification of the product, now all degrees are accredited but in a short future only degrees/universities working with continuous improvement will survive.

Engineers are working all over the world and it is important that all Engineering Schools reach a level of quality understandable for all companies in Europe and in the World. In Europe, all the quality system is based in the Bologna declaration [5] but the model is quite similar to the models based in international criteria and used in different countries in the World. The skills and competencies are oriented to the enterprise (customer).

The objectives of the Bologna process are [5]:

- Mobility, students must be able to work in different countries
- Transparency, the knowledge reached by students must be clear to employer and to the Society
- Employability, the knowledge must be oriented to the needs of the companies
- Competitiveness of the students, they must be able to develop their career in a competitive world

Finally, the Bologna declaration looks for improving the quality of the European Higher Education Area (EHEA).

The main advantages of implementing a Quality Systems in Education are that:

- There is more control and repeatability of the teaching actions
- The academic work is measurable
- It is easier to establish an horizontal and vertical coordination
- The education is oriented to the results, not to the knowledge per se.

2 What Is Accreditation?

Accreditation is a certification (of a school, college, diploma, or the like) as meeting all formal official requirements of academic, curriculum, facilities, etc. So a certification of his quality Accreditation is based on three legs: Personnel, Facilities and Procedures.

The accreditation can be granted by an independent organisation as third party, in general, with some dependence of the Administration and following rules or international standards.

Evaluation is the verification process where the accreditation body confirms the quality of the diploma by means of an internal evaluation done by the team of the diploma and an external evaluation by an external team that study the documentation, visit the university and the facilities where the diploma is given and interview the different actors of the diploma: academic, other personnel and students. Finally, the team reports about the diploma and this report is evaluated by a committee of the independent organization that accredits or not the diploma.

In other European countries, there are agencies of accreditation like:

- ASIIN [6] in Germany.
- CTI [7] for engineering or HCERES [8] (Haute Conseil pour l'Evaluation de la Recherche et l'Education Supérieure) in France.



Fig. 2. Spanish regional accreditation agencies [11].

The coordination of the European accreditation of diplomas is carried out by ENQA [9] (European Association for Quality Assurance in Higher Education). The list of accredited or recognized agencies is controlled by EQAR [10] (European Quality Assurance Register). All the European accreditation is based in the European Standard Guidelines (ESG), last edition of 2015 [4].

In Spain, there are regional agencies responsible for the accreditation of the HE diplomas and one national agency (ANECA) [11]. Some Regional agencies are: ACPUA (Aragón) [12], ACSUG (Galicia) [13], AQU (Cataluña) [14], Madri+D (Madrid) [15], between others. Some agencies develop other activities moreover the accreditation activity. In the Fig. 2, it can be seen several regional agencies. All the accreditation activity, developed by the agencies, is coordinated by the network of regional agencies (REACU) [16] in a similar way as in Europe there is a coordination by EQAR.

3 Accreditation Requirements

Accreditation in Spain is compulsory. All higher institution diplomas must be accredited before the start of the teaching activity (Verifica Program: Verification at the beginning) [17] and renewed after 4 years of activity if it is a master and 6 years if it is a degree (Accredita Program) [18]. The accreditation is based in 7 criteria. In Spain, this process has started in 2014 for masters and, in 2015; degrees started the process of accreditation. As six years is a long period, there is an intermediate program to check the follow up of the accreditation called Monitor Program [19]. This program checks in a documentary way that the diploma is working properly in accordance with the conditions given in the Verifica program at the beginning.

This process of accreditation needs, like a stable chair, three legs: personnel, installations and procedures. For good procedures, the best is to have a Quality System implemented in the University or in the Faculty. More and more Spanish universities have an Internal Quality System implemented and the same organization that checks the Quality of the programs check the quality of the management system (Audit Program) [20] and, as well the quality of the academic personnel (Docentia Program) [21]. In a short future, universities with a certified Audit Program will not need to accredit all the diplomas, only a part of them, or all of them with a reduced accreditation evaluation.

The seven criteria for the Spanish compulsory accreditation program are [18]:

- Organization & curriculum implementation. The curricula is actualized and has been implemented in accordance with the conditions accorded at the beginning when the implementation.
- Public information & transparency. The university has the mechanisms for communicating effectively to all the stakeholders the characteristics and the processes to guaranty the Quality.
- SGIC, The Institution has an Internal Quality System well established and implemented that guaranties the continuous improvement of the diploma.
- Academic staff is in accordance with the characteristics and the number of students of the diploma.

- Support staff, resources and services. The Institution has the support staff, resources and services to fulfill the needs of the diploma in order to assure the skills and abilities to be obtained by the students.
- Learning outcomes. By the time of graduation, graduates have the knowledge and skills defined in the verification process at the beginning when they started the diploma.
- Satisfaction and performance indicators. The results are adequate to the needs of the Society and the satisfaction of the stakeholders is clear in all the sectors: staff, students and employers.

A part from this compulsory accreditation, there is another volunteer accreditation, that it is named EUR-ACE for Engineering [22] or EUR-INF for Informatics [23]. This accreditation is based in 9 criteria, the 7 criteria for compulsory accreditation plus two more criteria that for engineering are related with the engineering character and the institutional support for the program.

In a similar way, in the United States there is ABET Accreditation that is volunteer and is based in 10 criteria. For the accreditation, the diploma must be running and has to have several promotions of graduates.

The ten criteria for the ABET volunteer accreditation program are nine general and one particular to the family of degree accredited [1].

- **Students** - Student progress must be monitored to foster success in attaining student outcomes, thereby enabling graduates to attain program educational objectives. Students must be advised regarding curriculum and career matters.
The program must have and enforce policies for accepting both new and transfer students, awarding appropriate academic credit for courses taken at other institutions, and awarding appropriate academic credit for work in lieu of courses taken at the institution.
- **Program Educational Objectives** - Program educational objectives (POE) are broad statements that describe what graduates are expected to attain within a few years of graduation. Program educational objectives are based on the needs of the program's constituencies.
- **Student Outcomes** - The program must have documented student outcomes that prepare graduates to attain the program educational objectives. There must be a documented and effective process for the periodic review and revision of these student outcomes.
- **Continuous Improvement** - The program must regularly use appropriate, documented processes for assessing and evaluating the extent to which the student outcomes are being attained. The results of these evaluations must be systematically utilized as input for the continuous improvement of the program. Other available information may also be used to assist in the continuous improvement of the program.
- **Curriculum** - The curriculum must effectively develop the following subject areas in support of student outcomes and program educational objectives
 - Mathematics
 - Physics
 - Technical content

- **Faculty** - Each faculty member teaching in the program must have expertise and educational background consistent with the contributions to the program expected from the faculty member. The competence of faculty members must be demonstrated by such factors as education, professional credentials and certifications, professional experience, ongoing professional development, contributions to the discipline, teaching effectiveness, and communication skills.
- **Facilities** - Classrooms, offices, laboratories, and associated equipment must be adequate to support attainment of the student outcomes and to provide an atmosphere conducive to learning. Modern tools, equipment, computing resources, and laboratories appropriate to the program must be available, accessible, and systematically maintained and upgraded to enable students to attain the student outcomes and to support program needs.
- **Institutional Support** - Institutional support and leadership must be adequate to ensure the quality and continuity of the program.

Both programs ABET and European are quite similar but focus is stronger in students and in institutional support in ABET. Institutional support is only taken into account in volunteer EUR-ACE and EUR- INF.

ABET focus on POE's, results and knowledge of the students several years after finishing the diploma. In European system, only the results at the end of the studies are considered.

EUR ACE program is more similar to ABET including more focus on institutional support and in engineering and technology and both are volunteer.

The panel composition depends on each system. In Spain, the chair of the panel is always academic. There are several academic members (1 or 2) depending on the number of diplomas to evaluate and one student, plus the Secretary that represents and belongs to the agency of accreditation. In EUR-ACE or EUR-INF there is one more member, representing the Engineering professionals.

The panel composition in ABET is as follow: The president is a member representing the agency and there are so many members as diplomas to evaluate. Each member evaluates his diploma, but there is coordination between all the team. Members can be academics or professionals.

Students take part in the evaluation panels (teams) for the accreditation in Europe, but not in the ABET system

In ABET panels, the Team chair is the link with the Agency in Spain panels, the link is the Secretary of the panel.

Team members in Spain evaluate all diplomas assigned to the panel. In ABET only one diploma by each team member.

4 My Experience

4.1 In Accreditation

In my experience, evaluation and assessment of quality system in industry and in university follow the same pattern. The speed and the needs in both places is different

but, as universities are delayed with respect to the industries, looking at the experience in industries, it can be introduced faster and better in universities.

The three main aspects to be taken into account in the accreditation of diplomas are: The continuous improvement, establish good procedures or documented processes and obtain good information through surveys to students, staff and mainly employers.

Sometimes it is difficult to change some things because there is some inertia in the staff and even in students. For instance, names of some activities, and their significance, are difficult to modify (modify final year project to final year work) and the need to measure the time devoted by the student to this work and how to measure the skills obtained by the students.

Introduction of Quality concepts in Higher Education is very difficult and it takes a lot of time and explanation to the staff [24]. Some teachers are not involved in the quality aspects neither procedures of the Faculty. Some staff is not well used to work with skills, abilities, and the way to measure them, so they are not happy with the system. As well, students are not involved in the committees for improving; they are only interested in passing the exams and not in the quality of the education that they are receiving.

Support staff is not involved in the quality system. They are reactive to change. There is some feeling between staff that quality means bureaucracy.

Changes and modifications from one curriculum to another is very difficult and they are limited by the Administration. In the contrary, the change from teaching to learning has been very fast, in particular for teachers that have modified the content and adapted it to the new situation with some facility. An important number of staff have found interesting the changes for introduce the innovation activities in Higher Education.

Not the same for students that they continue with the former system of studying before the exams and they do not like to work during all the academic year.

To have good quality it is important to have a good institutional support but a good management can improve the budget and optimise it. The problem in Spanish system is that employers are not involved in Committees in the diplomas and only a small amount of them takes part in the definition of skills and abilities to be reached by the students. As the ISO 9001 standard has incorporated in his last version, motivation is very important in the process and it must be incorporated in the management. In this way, in universities the participation of the different stake holders is very important and for that they need to be motivated and they need to know the importance of all of them in a good diploma and the best results in the students and in the Society.

The activities to be done by academic staff for a good quality system are:

- Coordination with other peers to assure that no duplication is in the content of the curricula and which activities need to do in each subject in order that at the end all students reach the same skills and abilities.
- Take different data every day and store them in the appropriate place for a good information for the manager of the diploma

4.2 Our Activities

In our research group, EduQTech [25], we are working in two big areas: Software for the management of the daily activity [26–29] and the measurement of the time of study [30].

With the management software, we try to give the teachers tools for facilitating his academic and management work in the quality system. For that, we have designed and implemented several processes based on accreditation criteria and in quality standards. This software is applicable to all kind of subjects of degrees or masters or even to all other subjects of other kind of courses demanded by the industries. These processes are based on quality criteria and are a very good guide for applying quality concepts in the academic activity.

Three kinds of processes have been designed: Basic, Strategic and Support Processes. The Table 1 shows the main groups of processes developed and implemented.

Table 1. Some processes implemented.

Basic processes	Strategic processes	Support processes
Planification	Management	Resources
Teaching	Planification	Documentation
Evaluation, exams	Improvement	Problem solving
End of the academic year	...	Quality
...		...

With the time of study we try to measure the time that one average student devotes to learning one subject. The main basic research has been a survey done to all the students of the Engineering School during the three academic years from 2005 to 2008. Every week during the two semesters a survey through internet, in a special web page, has been launched, allowing the access only to registered students. The software had a system for self-detection of errors like too much hours of study in a day.

The survey collects all kind of activity in the classroom and at home. A 20% of all registered students had good and full answers during all the period surveyed.

Some general comments about the results obtained in the survey were [30]:

- The duration of the work in the laboratory is lower than expected. The students finish before of the two hours expected.
- They use only an average of half an hour for reading the notes and theoretical information.
- The time for writing the intermediate reports of the laboratory work is about 1 h per report
- The time for writing the final report is about 7.5 h

The big amount of information obtained with the survey, allowed each teacher to analyze his subject and adjust it to a more realistic situation in accordance with the effort done by students for learning the subject.

This work has allowed obtaining information of the time devoted by the average student to learn a subject, but as well other information has been obtained about when

the activities are done or the links between different activities and the influence in the results. It has been possible to check the evolution of the effort of the students in every subject in function of the number of the week. The correspondence of the time devoted by the students with reports that student need to fill and present to the teacher it has been clearly seen. The correlation between time of study and difficulty for passing an exam has been shown too.

5 Conclusions

The application of the Quality in Higher Education follows the Industrial experience. As products are global, engineers and degree holders must travel and work into a global market, so their skills and abilities must be global and well known by the employers.

Universities are changing, but there are some questions that need to move faster in the process of the introduction of a quality system:

- Introduction of Quality concepts to all levels of partners in the teaching and learning process.
- Orientation to the needs of the Society (Companies and Industries in the case of Engineers)

The application of the quality system in Higher Education in different countries follows a similar process to the convergence and finally, as it has been in industry; multilateral agreement will arrive between different countries to recognize the different academic diplomas and skills of students.

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