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## Competency training of students of the Faculty of Chemistry of the University of Barcelona by conducting internal audits

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### Abstract

This work deals with the competences and skills training of the students of the Faculty of Chemistry of the University of Barcelona (UB) through participation in internal audits at different laboratories in which different experimental subjects are taught. Students have been able to work cross competences related to ethics, the ability on oral and written expression, the ability to dialogue, the ability to leadership, the teamwork, the analysis and the data interpretation, among others.

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**Keywords:** Transversal competences and skills; Audits; Quality Management System; Analysis; Leadership; Creativity.

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## 1. Introduction

The fact that the Real Decreto 1393/2007, as amended by Real Decreto 861/2010, obliges all Degrees have a Quality Management System (QMS) [Real Decreto 1393/2007], also provides an opportunity to influence competency training of students. A QMS requires the completion of all processes in a scheduled manner and following previously established, documented procedures that allow, at all times, keep careful track of the development of different teachings [Compañó & Ríos, 2002, UNE-EN ISO 9001:2008]. Transfer to students this way of working provides scheduled and documented many possibilities ahead of their training because it allows them to assimilate new knowledge and attitudes and also helps them to be able to express integrated, systemic and continuous improvement visions.

An important tool of any QMS is to perform audits. Given the characteristics of the audit concept, and considering that the auditor has to demonstrate a range of skills, personal attributes necessary to apply knowledge and skills [Vélez & Vélez, 2008], audits provides a valuable opportunity for working acquisition of transferable skills by students. This work is described as implemented conducting internal audits in the labs of the Faculty of Chemistry in the context of the subject Quality and Prevention belonging to the Degree of Chemistry. Students who have participated in the experience, have had the opportunity to develop skills related to ethics, oral and written expression, the capacity for dialogue, leadership skills, ability to work in teams or the ability to develop integrated and systemic attitudes and visions. In addition, audits can deepen competency training of scientific and technical information that asks students in grades developed in the Faculty (Chemistry, Chemical Engineering and Materials Engineering).

Audits allow influencing basic aspects for a scientist or a competent engineer, among which stand out, analysis and interpretation of data, quality management, respectful work environment and safety. In general, also permit the student to take awareness of their responsibility within society, considering technical training and, somehow, lets analyze issues that are as important as all those related to health and sustainability. The audits allow integrating the dynamic of management systems for quality, safety and environment in their training, being a very good tool towards their professional future.

This type of task also encourages critical thinking and creativity of students and a greater understanding and integration of all the work that students develop while doing the labs, promoting teamwork. Therefore promotes critical and self-critical capacity of analysis, synthesis, overviews and application of knowledge, always from an ethical perspective to accompany the performance of any auditor. Moreover, audits also require interaction with audited, which means working communication skills and the ability to understand the work of others and adapt and understand situations and new attitudes.

It can be argued that all the tasks that students have made to conduct the audits have also contributed to assume a culture of continuous improvement, which adds value in their professional and skills training. It can also be considered that in surveys and external assessments made in any of the teachings of the Faculty, it became clear that graduates had a very good education, but had gaps in generic skills. Thus, the audits try to improve these aspects a little weaker in the formation of our students. All the above shows that this work is contextualized within the framework of QMS but its link with the teachings of the Faculty of Chemistry has been complete because it has been applied to almost all degrees of Faculty by, virtually, all departments of the Faculty [Gimenez et al. 2006; Gimenez et al. 2012].

It must be pointed out that the teachers responsible for this work belong to different departments of the Faculty and therefore this makes that this activity is a useful tool and acts as a unifying element in planning the management practices laboratory. The work is part of a teaching innovation project in which all authors have participated.

## 2. Methodology

The methodology for the development work has been based on three pillars: the training of students, conducting audits, obviously, and monitoring and evaluation of the whole process. First, the students have been trained to could develop their work as audit documentation. This documentation includes the questionnaire audit, the auditor manual procedures, the form of the audit report, the survey auditors, etc. The auditors are chosen among students of the subject Quality and Prevention of the Degree of Chemical and this activity has been part of the continuous

evaluation of the subject. A total of 53 students during the 2012/2013 academic year and 44 students during the course 2013/2014 have been selected.

Students have received a training session in which they have information about the quality system management (SGC) and also on the audits and the work of auditors. They also have all necessary to carry out their work as well auditors documentation: Environment and security quality policy of the Faculty, process map System Quality Assurance (SAIQU), the Quality System Management of Laboratories), list of procedures, list of laboratory audited, application for analysis of results and improvement of the system (PEQ 5745 130 SAIQU) proceedings for conducting internal audits (PEQ 5745 SAIQU 132), audit report, the auditor manual questionnaire, etc.

Emphasis on the skills that the auditor must get: assertiveness, ethics, capacity for dialogue, analytical skills, oral and written expression, among others, have been carried out throughout the audits that have been conducted. It has been established that in each audit process two to four students must be involved and, therefore, several groups were formed. The audits have been conducted in different labs, in the morning and afternoon. Each group of auditors has made one or two audits. An initial meeting with the teachers of the laboratory to be audited has been done to specify different aspects of the audit related with the activities and what areas and aspects of the laboratory would be audited.

During the audit, the auditors interact with students and teachers of the laboratory chosen, focusing on specific areas to be audited in each turn. Students, teachers and team member accompanying auditors have filled scoring assessment surveys of the work performed emphasizing the extent to which the worked skills. From the information received, the evidence and data necessary to see the laboratory performance and to identify possible gaps and establish relevant improvement actions has been collected.

### 3. Results

Work results are consistent with the basic objectives that had been raised at the beginning of the work and were related to:

- To develop the competences related to the preparation and conduct of audits of the environment and safety quality system management of the Faculty of Chemistry of the UB.
- Improve the management of the labs from the analysis of the information obtained through audits.
- Capturing the degree of achievement and understanding of the tasks performed by all parties involved in the process (students and auditors students and teachers from audited laboratories).

30 audits were carried out during the year 2012/2013 which covered 19 turns corresponding to 14 different subjects. Each subject may have more than one turn of practice and, therefore, the number of subjects (14) is less than the number of audited turns (19), also some subjects and some turns have been several audits, This explains why the number of audits (30) exceeds the number of audited turns. The different subjects audited correspond to the three degrees of the Faculty (Chemistry, Chemical Engineering and Materials Engineering) and the various departments of the Faculty. 53 students and 30 teachers have also participated as partners of audited laboratories. For the year 2013/2014, 20 audits were performed in 11 laboratories from 10 different subjects; in which 40 students and 10 teachers participated.

Students were supervised, throughout his performance as auditors, by one of the teachers involved in this work, which have developed a dual task training and observation of student work. The students have prepared the reports, with the help of one of the authors of this work after the audit. These reports include the following sections: general data of the audited laboratories, audited aspects, results of observations with regard to the quality system management, environment and security relationship strengths, ratio of non-conformities and establishing opportunities for improvement.

Teachers have reviewed the audit reports prepared by the students, checking that are rigorous and well structured. These reports are well founded and documented and make a proper assessment of the evidence collected in the questionnaire internal audit. In the questionnaire itself, students are not limited only to point out the answer they consider most appropriate according to the responses of the partners, but aim a number of comments and clarifications (objective evidence) that are valuable for the performance of their report and are also a source of important information to carry out further analysis of the task of the laboratory and the satisfaction of its users (students).

Internal audit reports submitted by students as well as their educational and evaluative character have enough quality and rigor to, upon review of the authors of this paper, provide additional useful element for the assessment and the implementation of corrective actions in the laboratories of the Faculty of Chemistry, allowing affect the continuous improvement of practice laboratories, always bearing in mind that this is an exercise carried out by students, whose main objective is learning methodologies audits rather than detecting deficiencies in the management of laboratories. However, reports have served to acquire detailed information about how the labs of the Faculty work as well as the satisfaction of its users (students). The work has also allowed understand the level of development of respectful behavior to the environment and safety. From there, we have developed proposals for improving the audit process and, obviously, proposals for improving the operation of laboratories.

It should also say that the work done by students, aimed at training in aspects of quality, allow the implementation of quality management practices in the laboratories of the Faculty of Chemistry and, in general, in all Degrees of the Faculty.

The experience has contributed to the formation of technically competent, ethically responsible professionals with a commitment to preserving the environment, with the ability to ensure the health and safety of people and bearing the culture of continuous improvement. The auditor students have shown a very good level of involvement and, for them, the experience has been very useful and helpful, as is clear from the analysis of satisfaction surveys. Finally, it is important that this work has shown that the system of quality management is not just generating element bureaucracy but provides useful tools for continuous improvement of teaching.

#### 4. Conclusions

From the analysis of the reports and audit questionnaires, it can be concluded that the students (2012/2013 and 2013/2014) have improved the skills related to the analysis and interpretation of data, the ability to oral and written expression, the capacity for dialogue and leadership, and the ability to search and integrate new knowledge and attitudes. They have improved their ability to learn and collaborate with others. They have shown ability to understand the work of others and ability to adapt and understand situations and different attitudes. Moreover, it has also helped them to be able to acquire a critical attitude towards the established systems.

Moreover, the link of the audit with improving the laboratory tasks shows that the students have also reached responsibilities concerning the quality management, safety and respect for the environment. Therefore, they have been able to grasp and integrate the dynamics of systems of quality management, safety and environment in their training very useful tool towards their professional future.

All this information with the one from monitoring the students, directly, during audits leads to the conclusion that the level of competence acquired by students was more than acceptable compared to what was proposed.

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