OmniaScience

Journal of Technology and Science Education

JOTSE, 2017 – 7(1): 80-99 – Online ISSN: 2013-6374 – Print ISSN: 2014-5349

https://doi.org/10.3926/jotse.232

THE SURVEYS TO THE COMPANIES: A TOOL FOR THE IMPROVEMENT OF DEGREES

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† To our deceased colleague Ramon Companyo. In memoriam

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Received June 2016

Accepted January 2017

Abstract

In scientific and technical degrees, the opinion of the final employers on the given subjects is really important. For this reason, the Quality Committee (CQ) of the Faculty of Chemistry of the University of Barcelona prepared a survey for chemical, engineering and pharmaceutical companies asking about the academic training required by the companies. The survey consists of nine sections including items related to laboratory operations, chemical processes, calculation methods, management systems (quality, environment and safety) or general management information. In addition, at the end of each section, a question inquires the companies about the competences shown by students in the items of the section. The results were compared with those of a similar survey carried out in 2007. The scores obtained were between 2 and 3 for all the items (score: 1, not important; 2, less important; 3, important; 4, very important) and show that companies accept the training given to our students and the competences achieved by them. However, according to their opinion, it is possible to improve this training, especially in the subjects related to management (time, information, environment, quality, safety, etc.). Therefore, surveys are a good tool for the evaluation of the training achieved in our degrees and, consequently, for improving our teaching task, according to the Quality Management System implemented in the Faculty of Chemistry.

Keywords – Surveys, Skills, Competences, Quality management, Continuous improvement.

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1. Introduction

The implementation of a Quality Management System (QMS) of the degrees and masters was not mandatory at Spanish universities until 2008 (Real Decreto 1393/2007 and Real Decreto 861/2010, Spanish Government). As it is known, a QMS promotes the analysis of the system and introduces the required modifications and corrections. Nonetheless, the Quality Committee of the Faculty of Chemistry, University of Barcelona, has been working since 1996 for improving the quality of teaching in the labs, since experimental subjects play an important role in the academic training. It was very important for us that students acquire the appropriate competences, and particularly the experimental competences, at the end of the corresponding studies. During these years, surveys and audits have been carried out and helped to improve the quality in the labs.

The Faculty of Chemistry of the University of Barcelona has implemented a Quality Management System (QMS) for all the activities related to the three degrees taught there since 2009: Chemistry, Chemical Engineering and Materials Engineering, and also for the different masters belonging to the Chemistry area, as a consequence of the application of the European Space for Higher Education. Key elements of a QMS are the analysis and improvement processes to detect the weaknesses of the system (Companyó & Rios, 2002). These analyses lead to establish the necessary modifications and corrections to be introduced in all the degrees for their improvement. To develop a Quality Management System there are several actions to take such as corrective and preventive actions, audits, defining different indicators, surveys and so on.

In 2007, before the implementation of new degrees, the Quality Committee of the Faculty of Chemistry conducted a survey addressed to chemical and pharmaceutical industries (182 companies were contacted and 50 of them responded to the survey, 27.5%), to know what the companies expected for new graduates, mostly in reference to knowledge and skills in the laboratory work and other competences. The survey was very successful and valuable conclusions were obtained (Companyó et al., 2008; Sainz et al., 2008). Responses of the companies were very varied regarding the utility that laboratory skills can have in the development of the professional activity. These opinions were obviously related to the activity sector of each company. However, there was a high unanimity regarding the need for students to have competences and skills in subjects such as management of information and chemical documentation, quality management, environmental management, safety, work planning and time management. The information obtained from the companies through the survey was very useful and was taken into account in the design and application of the new degrees of the Faculty of Chemistry: Chemistry (started in 2008), Chemical Engineering and Materials Engineering (started in 2009).

A subject on Quality and Prevention has been introduced in the new degree of Chemistry; a course related to industrial safety and health has been maintained in the new degree on Chemical Engineering and specific sections on safety, quality and environmental management have also been included in the presentation of the experimental subjects of all the new degrees.

Now, graduates from these revised degrees are in the labour market and for this, it has been considered convenient to carry out a new survey to employers. The survey has been designed in similar terms to that carried out in 2007 but, this time, related to the degrees of Chemistry, Chemical Engineering, and Materials Engineering. This paper shows the results obtained in this survey, together with those obtained in 2007, which have been included for comparative purposes.

2. Results and Discussion

2.1 Profile of the companies included in the survey

The survey (2014) was sent to companies of different chemistry-related sectors: Basic Chemistry, Chemistry of Health and Chemistry for Industry and Final Consumption (see Figure 1). 118 companies were contacted and 30 of them answered the survey (25.4%). In order to have a great variety of polled companies, a wide range of commercial activity was also considered (see Figure 2). According to the size of the companies, the surveys responses are distributed as follows: 1-15 employees, 14.5%; 16-50 employees, 25.0%; 51-200 employees, 29.2%; and >200 employees, 31.3%. The 17% of companies that answered the survey were public companies whereas the 83% were private.

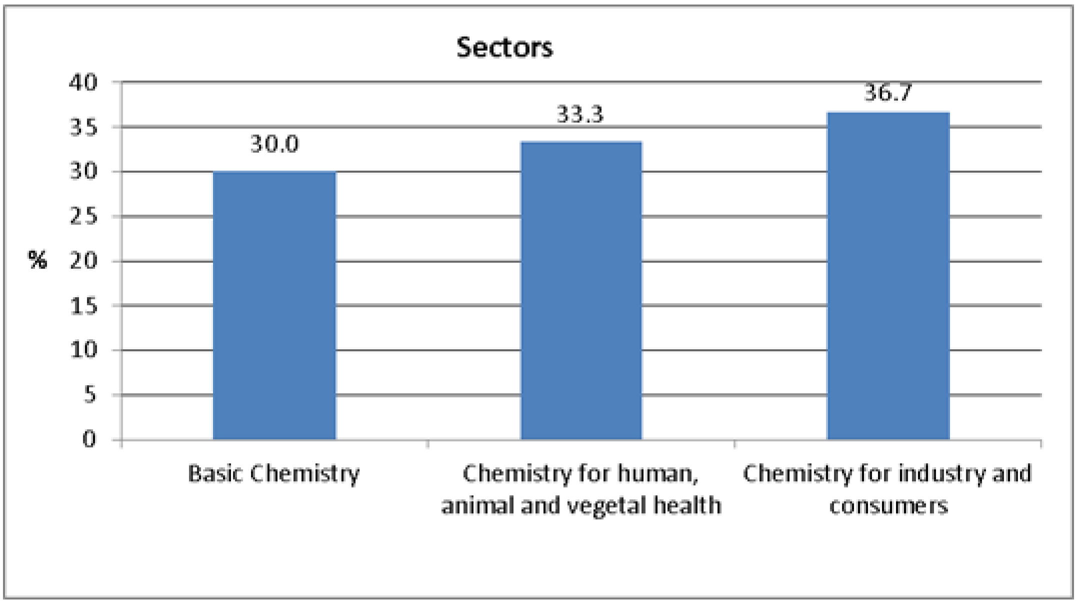

Figure 1. Distribution of companies in relation with sectors. Sectorial classification according to FEIQUE (Federación Empresarial de la Industria Química Española - Business Federation of the Spanish Chemical Industry): a) Basic Chemistry: organic products, inorganic products, industrial gases, raw materials plastics, synthetic rubber, fibres, fertilizers, dyes and pigments. b) Chemistry for human, animal and vegetal health: pharmaceutical raw materials, pharmaceutical specialties, animal health specialties, phytosanitary. c) Chemistry for industry and consumers: paints, inks, enamels, fried, adhesives, oils, explosives, detergents and soaps, perfumes and cosmetics

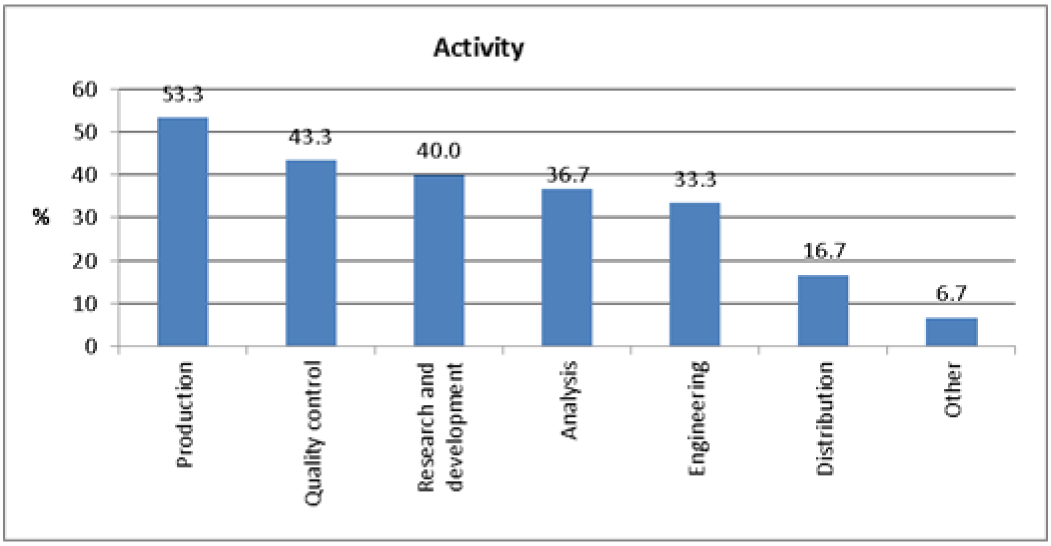

Figure 2. Distribution of companies with respect to their activity

2.2 Results of the surveys

The results obtained in the two surveys (2007 and 2014) are presented in Table 1. There are nine sections in the survey:

1. Laboratory operations,
2. Measurement and characterization techniques,
3. Chemical processes,
4. Calculation methods and data processing,
5. Management of information and documentation,
6. Quality management,
7. Environmental management,
8. Safety and health,
9. Other.

At the end of each section, the respondents can evaluate the level of competences that graduates have on the subjects concerning the section.

Each question was evaluated between 1 and 4, with the following score: 1, not important; 2, less important; 3, important; 4, very important.

The average scores obtained in each item are indicated in Table 1 and also in Figure 3, where a direct comparison can be made. In addition, the standard deviations are indicated. As expected, deviations are relatively large due to the number of samples and the low range of scores (1 to 4). The standard deviations pointed out the different interests of each company in the studied items. It can be seen, that in seven of the nine sections, the score is lower in 2014 than was in 2007. Only in the sections 1 and 2 the score is higher in 2014.

Items	Surveys scores			
	2007 Average	2014 Average	2007 Standard deviation	2014 Standard deviation
1. Laboratory operations, average score	**2.50**	**2.88**		
1.1. Basic Operations (sampling, materials grinding, drying, weighting, preparation of solutions, extracts purification, evaporation, freeze-drying, precipitation, calcination, acid and basic attacks, working in anhydrous media, working in controlled atmospheres, electrolysis, etc.)	2.5	3.2	0.7	0.9
1.2. Separation techniques (extraction, distillation, filtration, crystallization, sublimation, centrifugation, etc.)	2.5	2.6	0.9	1.1
Evaluation of competences in this section		2.6		0.8
2. Measurement and characterization techniques, average score	**2.24**	**2.33**		
2.1. Physical properties (melting point, boiling point, refractive index, …)	2.6	2.4	1.1	1.0
2.2. Particles (size distribution, area, surface analysis, …)	2.4	2.7	1.0	1.0
2.3. Characterization (volummetry, gravimetry, differential thermal analysis, organic elemental analysis, mass spectrometry, ,..)	2.2	2.8	0.8	1.0
2.4. Chromatography (gas, liquid, thin layer)	2.9	2.8	0.9	1.2
2.5. Electrophoretic techniques (gel electrophoresis, capillary electrophoresis)	1.9	1.6	1.1	0.7
2.6. Optical techniques (atomic absorption, molecular absorption, atomic emission, fluorescence, IR, NIR, NMR, polarimetry)	2.3	2.7	0.9	1.1
2.7. Radiochemical techniques (gamma spectrometry, alpha spectrometry, liquid scintillation)	1.4	1.5	0.7	0.7
2.8. Electrochemical techniques (conductivity, potentiometry, voltammetry)	2.3	2.3	1.0	1.0
2.9. Microscopy (optical microscopy, electronic microscopy)	2.4	2.4	1.0	1.1
2.10. Techniques related to X-rays	2.0	2.0	1.0	1.0
Evaluation of competences in this section		2.7		0.6
3. Chemical Processes, average score	**2.76**	**2.51**		
3.1. Mass and energy balances	2.6	2.4	1.2	1.1
3.2. Flow sheets preparation and interpretation	2.8	2.6	1.2	1.0
3.3. Unit operations	2.9	2.5	1.2	1.1
3.4. Control and instrumentation	2.9	2.8	1.1	1.0
3.5. Basic design of facilities	2.5	2.2	1.2	0.9
3.6. Materials for chemical industry	2.8	2.5	1.1	0.8
Evaluation of competences in this section		2.4		0.7
4. Calculation methods and data processing, average score	**2.95**	**2.57**		
4.1. Statistics	3.3	2.8	0.7	0.9
4.2. Multivariable data analysis	2.8	2.5	0.9	0.8
4.3. Results uncertainty	3.1	2.7	0.8	0.9
4.4. Properties estimation	2.6	2.3	0.9	0.9
4.5. Experimental design	2.9	2.6	0.9	1.0
Evaluation of competences in this section		2.4		0.7
5. Management of information and documentation, average score	**3.51**	**3.11**		
5.1. Literature search	3.5	2.9	0.6	0.9
5.2. Register of primary data	3.4	3.1	0.7	0.8
5.3. Computerized systems for information management	3.2	3.0	0.8	0.9
5.4. Critical analysis of results	3.6	3.3	0.6	0.8
5.5. Presentation of results	3.7	3.2	0.4	0.8
5.6. Reporting	3.6	3.2	0.8	0.8
Evaluation of competences in this section		2.7		0.7

Items	Surveys scores			
	2007 Average	2014 Average	2007 Standard deviation	2014 Standard deviation
6. Quality management, average score	**3.56**	**3.11**		
6.1. Preparation of SOPs (Standard Operating Procedures)	3.5	3.1	0.8	0.9
6.2. Implementation of SOPs	3.7	3.3	0.7	0.8
6.3. Maintenance and calibration of equipment	3.5	3.2	0.8	0.9
6.4. Validation of methods	3.6	3.1	0.6	1.0
6.5. Design and implementation of quality control activities	3.5	3.0	0.7	1.0
6.6. Knowledge/Implementation ISO 17025 (accreditation)	--	2.1		1.2
6.7. Knowledge/Implementation ISO 9001 (certification)	--	2.6		0.9
6.8. Knowledge/Implementation GLP	--	2.1		1.0
Evaluation of competences in this section		2.5		0.6
7. Environmental management, average score	**3.06**	**2.53**		
7.1. Waste management: minimization, handling, treatment, recycling	3.4	2.9	0.7	0.9
7.2. Recovery of by-products	2.8	2.4	1.0	0.8
7.3. Environmental impact assessment	2.9	2.3	1.0	0.9
7.4. Knowledge/Implementation ISO 14001 (certification)	--	2.4		1.0
7.5. Knowledge/Implementation EMAS (certification)	--	1.8		0.7
Evaluation of competences in this section		2.3		0.7
8. Safety and health, average score	**3.60**	**3.17**		
8.1. Knowledge of safety regulations	3.6	3.2	0.6	0.7
8.2. Chemicals: labelling, properties, handling emergencies	3.7	3.3	0.5	0.8
8.3. Risk assessment	3.4	3.0	0.8	0.8
8.4. Actions in emergency	3.6	3.1	0.6	0.9
8.5. Knowledge/Implementation OSHAS 18001	--	2.2		1.0
Evaluation of competences in this section		2.5		0.8
9. Other, average score	**3.08**	**2.86**		
9.1. Basic knowledge on economy	2.5	2.3	0.8	0.7
9.2. Planning work	3.4	3.1	0.6	0.7
9.3. Time Management	3.3	3.2	0.6	0.6
Evaluation of competences in this section		2.5		0.6
10. Comments				

Table 1. Comparative between the answers of the two surveys carried out at 2007 and 2014

Average of items 7, 8 and 9 were made considering the same items in 2007 and 2014. That means, items 6.6, 6.7, 6.8, 7.4, 7.5 and 8.5 have not been considered in the averages to make the surveys completely comparative, because they did not appear in the survey of 2007. The last item of each section, that it is the evaluation of competences made by the companies, has not been either included in the averages for the same reasons.

In all cases, the average score was higher than 3 in five sections of the survey conducted in 2007 and in three sections of that made in 2014. The aspects related to management (information, documentation, safety, quality, time, etc.) seemed to be clearly more important for industries in 2007. This trend continues in 2014 but less clearly, especially on issues related to the environment.

An important data to be considered is the evaluation of the competences that graduates have in each section. This evaluation was carried out also by the companies. Results are shown in Figure 3 and all scores for competences are between 2 and 3, which show that graduates can usually meet with the expectations of the companies. The two surveys carried out show that the interests of the companies can also vary along the time. Thus, in Figure 4, the differences in the answers obtained in 2007 and 2014 are shown.

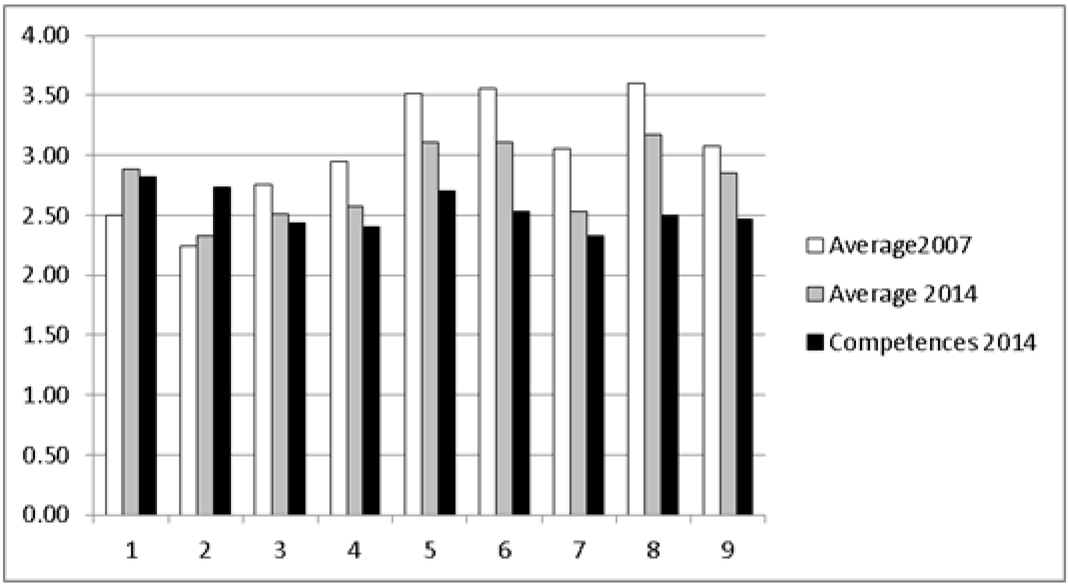

Figure 3. Averages pointed out by the industries and competences displayed by the graduates in each item

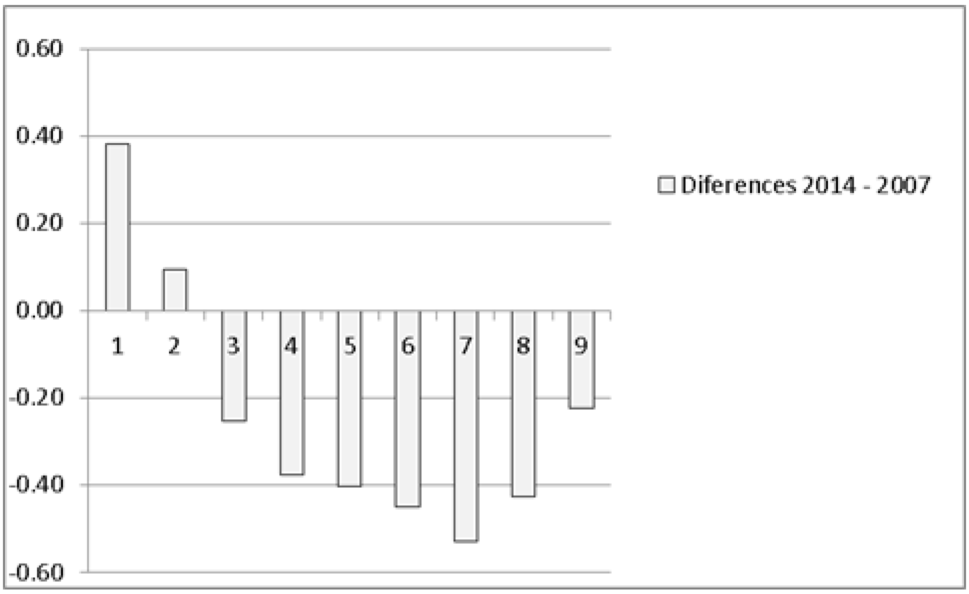

Figure 4. Differences observed in the answers of the companies between the years 2014 and 2007

As discussed above, with the exception of Sections 1 and 2, it seems that the expectations of companies are lower in 2014 as in 2007 (see Figure 4). However, in all the cases scores are higher than 2. Sections related to management (5-9) have decreased in their scores, but they continue to be the more interesting for the companies. In this way, the differences between the importance of the item for the companies and the level of competence assumed for the graduates is higher just for these items related to management (see Figure 5).

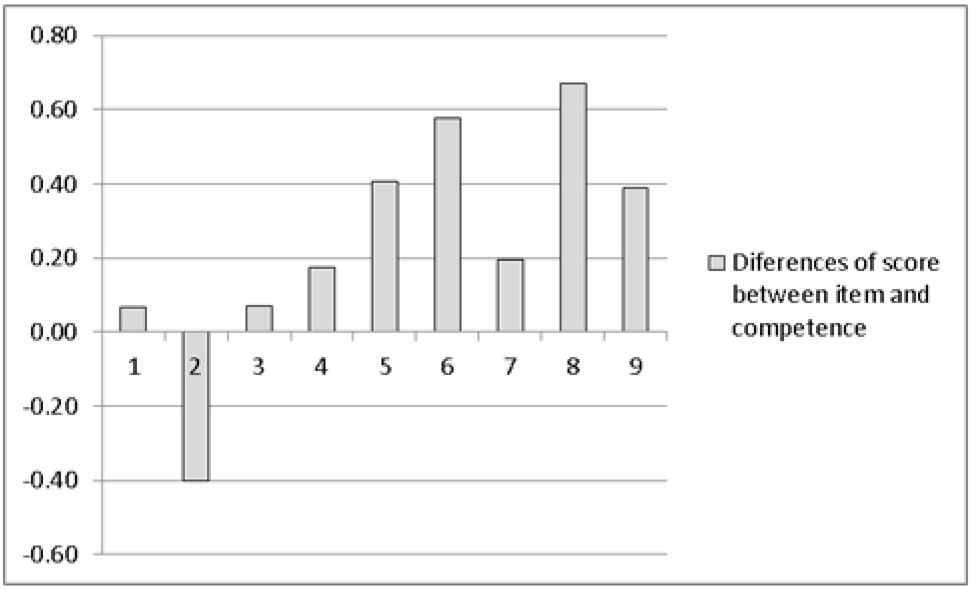

Figure 5. Differences between the importance of the item for the companies and the level of competences achieved by the graduates in this item (2014 survey)

As observed in Figure 5, only in one item the level of competence shown by the graduates is higher than the level of importance that companies give to each item. This is the case of the item 2 (measurement and characterization techniques). In the other cases, the competences of the students are below the level of importance that companies give to each item. In addition, as commented before, in the items related to management (5-9), considered the most important for the companies (see Figure 3), the differences between the competences and the expected score are the highest.

In the survey done in 2007 companies were not asked to assess the skills of students in each item and, therefore, it is not possible to make this comparison between the importance that companies give to a question and the students' competence on that issue. However, it was found that companies gave great importance to the issues of management, as evidenced in Figure 3. Following this perception, subjects related to these issues were introduced in the updated degrees. Therefore, after 7 years and in view of the results, somewhat seems to have improved in this respect. However, issues related to the management remain the most requested by companies and differences with the competencies achieved in these matters are the greatest. As a consequence, we must continue stressing these issues, ensuring that our students work over these issues and, if necessary, introducing new subjects related to them in the degrees.

2.3 An assessment of the surveys

It is not easy to make an overall assessment of the surveys' results, because the polled companies answering the surveys are centred in diverse activities, with very different interests. Moreover, the questions of the surveys also cover diverse capacities at several levels, being of different interest for the companies.

However, as stated before, the surveys revealed that companies are very interested in the fact that future professionals have fluent skills related to management of information, quality management, environmental management, safety, work planning and time management. These results are not surprising, because currently all these issues are of great interest for the industry and, most particularly, for the chemical industry.

In the next paragraphs, a short analysis of the different items is presented.

2.3.1 Items 1 and 2: Laboratory operations, measurement and characterization techniques

A lot of operations and techniques were analysed in this field. It is normal, therefore, that not all those operations or techniques are used in all the companies. However, the answers have revealed which ones are the most used and common for them. From the results of the last survey (2014), companies gave the highest scores to the items related to the basic operations of laboratory (item 1.1 in Table 1), characterization (2.3) and chromatography (2.4). These results could be expected because such operations and techniques are widely used in almost all the chemical companies and, therefore, they consider important its knowledge by the graduates. Based on these results, it is clear that the line followed by the Faculty, concerning the lab training, is in agreement with the needs of companies. However, this should not prevent that, in regards to the future curricula, new actions will be carried out putting emphasis on operations that are considered basic for companies and being always open to incorporation, if possible, of new technologies.

2.3.2 Item 3: Chemical Processes (pilot and industrial plant)

Different aspects of chemical processes were evaluated in the section 3 of the survey. The scores were 2.76, in 2007, and 2.51, in 2014 (see Table 1). Thus, a little decrease is observed but the score is still good, by considering that the questions corresponded to basic aspects needed to understand the operation of a chemical process and know the keys of its design.

Therefore, it is logical that companies demand that the graduates have knowledge on these issues. The skills that students may have regarding the chemical processes are very varied depending on the degree that they have completed. Thus, they are quite complete in the case of chemical engineers and also for materials engineers, but not so with the other degrees. In any case, a good knowledge of these operations ensures a good understanding of the processes and allows a better handling thereof in order to improve productivity and product quality. As observed in the evaluation of the students' competences by the companies in this issue, the score is quite satisfactory.

2.3.3 Item 4: Calculation methods and data processing

With regard to section 4 of the survey (see Table 1), the best evaluated issues, both in 2007 and in 2014, are related to the knowledge of statistics (point 4.1) and to the results uncertainty (point 4.3). Statistics is an essential tool in knowing the reliability of some data, which is an important tool in the interpretation of experimental results.

Concerning the determination of the results' uncertainty, the knowledge of the data reliability is essential for proper interpretation of the obtained results, as mentioned above. From these data, it is possible to design new experiments, if we are working in research and development, or to modify certain parameters of the production process, in the case of industrial facilities. In either case, the goodness of the decisions will be conditioned by a good interpretation of the data and a good knowledge of its reliability.

The decisions concerning the future of the companies are always conditioned by the goodness and reliability of baseline data. It is clear that companies are knowledgeable about it and so it is expressed clearly in the survey. Note that, during the studies, although with different intensity depending on the degrees, these aspects, which were pointed out by the score assigned in the evaluation of this competence by the companies, are highlighted. As an example, it can be said that a course dedicated to statistics is taught in the degrees of Chemical Engineering and Materials Engineering.

2.3.4 Item 5: Information management and documentation

With regard to the section of management of information and documentation (see section 5 in Table 1), both in the 2007 and 2014 surveys, companies highlighted three items, corresponding to the analysis and presentation of results (items 5.4 and 5.5) and reporting (item 5.6). It is clear that, in the fields of chemistry, chemical engineering and materials engineering, companies need people with a critical view to be able to go quickly and certainty to the most appropriate sources of information, finding the necessary elements to develop the task entrusted to them.

For instance, data from production or from the R&D departments have to be interpreted. This is a key step to decide on changes or improvements in production processes leading to higher quality products or to savings of raw material. These aspects drive to the costs reduction for the company and therefore to higher profits. In addition, environmental burden can be reduced. That is why companies require people, who are able to do this type of analysis and, based on a good knowledge of the production process and a good understanding of data thereof, can introduce the mentioned improvements.

Similar considerations would apply concerning data and results obtained from R&D centres of the companies. Thus, companies need people able to understand, operate and exploit these R&D centres, who knowing production and market data can design the research lines of the company. From the results, they can redirect research or think about how to implement these results in the production process. Obviously, this requires people prepared to correctly interpret the data that are obtained throughout the entire research process.

It is not enough to make a good interpretation of data; also it is necessary to explain the interpretation that has been done. This connects with the last question of the survey in this section, concerning to reporting. Therefore, a chemist, a chemical engineer or a materials engineer have to be able to perform the technical and/or scientific tasks entrusted and must also be able to explain what he has done. Not many years ago, a lot of professors of some faculties or scientific-technical schools considered everything related to the preparation, writing and reporting a minor task. Fortunately, that point of view is changing and the preparation of documents is gaining and increasing in importance. It is obvious that a chemist or engineer need solid scientific-technical training. However, that is not inconsistent with acquiring, throughout the degree, of competencies and skills necessary to express themselves clearly, correctly and concisely, both orally and in writing abilities.

In this way, students prepare different reports during their degree studies. For example, the students prepare reports on chemical industries visits or on their work in laboratories. Even, in the course of "Projects" (degrees in Chemistry, Chemical Engineering and Materials Engineering), students made a report, including oral presentation, on a project related to the chemical industry. We must also add that in chemical engineering practices, in addition to the corresponding report, each student makes an oral presentation of one of the practices that he has developed. All these actions are kept in graduate studies in part for the support received by the results of the 2007 survey.

2.3.5 Item 6: Quality management

Quality management has proved to be very important for companies (see section 6 of the survey in Table 1). Currently, the quality management is a concern and a goal for most of the companies. In some cases, the existence of a quality management system (QMS) is mandatory or a legal requirement (food industry, water drinking sector, etc.). In other cases, the QMS is not mandatory but represents an advantage for the organization, because it assures an improvement in production and guarantees the quality of the final product. Moreover, a QMS represents a distinctive and positive marketing element relative to the other companies. It is therefore not surprising that companies positively assess that our students aware of these issues.

Until now, it has not been an easy task to introduce issues related to quality management in the scientific and technical degrees. Some professors consider that is as minor matter. Perhaps this opinion comes from a misconception according to which management of quality is identified with unlimited generation of a large number of documents whose applicability and usefulness is uncertain.

It is obvious that the preparation and implementation of a QMS requires the generation of procedures, instructions, indicators and other elements that involve time. However, when a QMS is implemented in a company, all processes and procedures are documented and all the people know what their responsibilities are and how to develop their tasks, meaning a better use and a gain of time. In addition, a QMS implies a simplification and better structuring of all tasks to be performed within the company. Moreover, working in this way causes changes in the mental structure of workers and improves their efficiency. For all these reasons, companies look favourably that our students have already experience in QMS.

Currently, Spanish legislation requires that all degrees and masters have implemented a QMS, as commented before. This has been a hard task, which is not yet finished, but has forced to enter into new dynamics. In our Faculty, there is a considerable progress in the implementation of QMS. From an academic point of view, the quality management is highly beneficial for the proper training of students and for a better development of the teaching task. It is positive and beneficial that the student learns to work within a system where all tasks are perfectly documented. Moreover, a quality management system also requires establish a process of analysis and improvement. That is, it is established a systematic to detect possible faults or errors in the system and to correct the defects detected. Therefore, this leads to enter into a process of continuous improvement, which is the goal of any organization.

Finally, as mentioned before, considering the results of the 2007 survey, a course named Quality and Prevention was introduced in the degree in Chemistry. In this way, the Quality Committee of the Faculty has prepared questionnaires to audit the quality management system in teaching laboratories of the Faculty. Thus, in collaboration with the teachers of the course Quality and Prevention, some students have been selected and trained in this subject to carry out such audits. At the end of it, students have prepared the corresponding audit reports. Surveys have shown a high degree of satisfaction of students and teachers with this activity. This activity is also one of the consequences of the results of the 2007 survey and is also justified by the results of the 2014 survey.

2.3.6 Item 7: Environmental management

Environment is undoubtedly the main concern. However, the significance of this field for the companies has decreased from 2007 to 2014, as it is clear from the answers in the survey (see item 7 in Table 1). It is difficult to find a reason that explains this fact, perhaps the crisis has contributed to the decrease in the interest of the companies, with more liability due to economic issues. In addition, environmental management is not collected on all current qualifications because, for some professors in our Faculty, this seems to be a minor issue. However, it is clear that is not the case, due to that the chemists, the chemical engineers and the materials engineers can play an important role in this area. As already indicated above, the environment is today a concern for the society, which is compelling to take important decisions if we want to continue enjoying a good standard of living in the future. Therefore, this will be an area to develop in the new curricula. In addition, the courses in this field have a global character, including knowledge and skills that students have acquired during the degree studies. This certainly represents a very beneficial effect regarding to students training because they have to drive different subjects in an integrated manner and treating it as a whole.

As commented before in the case of the quality management, and following a similar procedure, audits have been carried out in order to test the goodness of teaching laboratories from an environmental point of view. Again, students of the course Quality and Prevention carried out the audits and prepared the corresponding reports. As in the case of the quality management, this activity was highly considered by students.

2.3.7 Item 8: Safety and health

The score related to questions concerning safety and health (item 8 of the survey) has decreased from 2007 to 2014. However, in 2014, it is the item with the highest score, showing the concern of the companies with this subject. It is logical because respondent companies are related to the chemical industry and, therefore, they use many substances that can potentially be dangerous and they work in conditions that may also involve certain risks (high temperatures, high pressures, etc.).

It seems obvious that industrial safety and the occupational risks should take a prevailing role in the degrees on chemistry, chemical engineering and materials engineering. However, only the degree on chemical engineering contains an obligatory course on safety and health (this course is optative in the Materials Engineering degree). In the degree on chemistry, the aspects of safety and health are treated only as a part of a course devoted to occupational health and small brushstrokes are given when performing laboratory training. From this point of view, the survey has highlighted the need to introduce or improve these subjects in the future degrees.

One important aspect in the courses on safety is the high content in regulations and legislation. This is a key matter in the training of students because they can understand the key role of legislation in the real world of the chemical industry. In addition, the reading and interpretation of legal texts is not an easy task but can provide good training because it forces the student to be able to extract the technical part of these texts, which will be very formative for him and useful in his professional future.

As expected, industrial safety has own concepts, methodologies and techniques, but also requires the use and integration of knowledge previously acquired by the students. Thus, to solve problems related to industrial safety, students should properly mix safety tools and other tools acquired in different subjects of the degree. Therefore, these subjects have an integrative character, which is enormously educational for the student.

In any case, safety is clearly an issue for the future since it is expected that the regulations in this regard will be increasingly restrictive and, therefore, companies will be increasingly forced to improve their safety level.

In this way, audits on safety and health were also carried out in the teaching laboratories following the same procedure used for quality management an environment, as already explained. As in the other cases, the students prepare the audit reports and showed a high degree of satisfaction with the activity carried out.

2.3.8 Item 9: Other aspects

Paragraph 9 of the survey (see Table 1) collected three general aspects concerning economy (item 9.1), work planning (item 9.2) and time management (item 9.3). The last two have high scores in 2007 and 2014 and are vital for a good job performance. Maybe they are issues that, until now, have not a large impact in some degrees. However, these issues will become more important because the personal work of students is a key element in the new degrees. Consequently, teaching tasks related to the management of time and works have to be developed and all the competences related to the improving of these items have to be strengthened.

As commented before, the work in this subject is developed in some courses of laboratory, the course Projects and the audits, with the teamwork, report preparations, oral presentations, etc.

2.4 Surveys results and the upgrade of the degrees

It is obvious that, although the number of companies responding the survey can be considered satisfactory, it does not represent an in-depth analysis of the chemical industry in Catalonia. However, the surveys are a good tool for the analysis of the degrees taught in the Faculty of Chemistry at the University of Barcelona. It can also be said that the ideas coming from the surveys can be useful for the Chemistry, Chemical Engineering and Materials Engineering degrees in any country, because they give basical results on these subjects (Van Loo & Semeijn, 2004; Woods, Briedis & Perna, 2013; Headrick, 2001; Lucas, Coca Sanz, González Benito, Cartón López & Garcia Cubero, 2011).

The surveys show that the experimental training in the laboratory meets in a general way the needs of virtually all companies. That said, it would be necessary to point out that, since some of techniques are widely used, care should be taken that all students understand such techniques. The results obtained may lead us to introduce some changes in the planification of these subjects, reducing the number of hours in some cases, and thinking about the possibility of introducing new techniques and operations according to the progress of science and technology.

Another question pointed out by surveys is the interest of the companies in the items related to the information management and documentation, quality management, environmental management, safety, work planning and time management. Therefore, in order to meet the demand of enterprises, which are the main employer of our students, the Faculty should pay attention to these issues, without detriment of the specific activities related to chemistry and engineering. It is clear that a Chemistry Faculty must provide scientific and technical knowledge to the student, which is essential in the training of future chemists, chemical engineers or engineers of materials. However, this does not prevent that companies are heard and students receive training in subjects related to management. This still acquires more consistency if those other skills also have a strong technical and scientific component, as is the case. Just consider what has been discussed in the preceding paragraphs regarding the issues related, for example, with safety or environmental management.

As stated before, after the first survey (2007), some actions were carried out according with the answers of the companies: it was introduced a course on Quality and Prevention in the degree on Chemistry, the course related to industrial safety and health was maintained in the degree on Chemical Engineering and this subject was proposed as an optative course in the Materials Engineering degree. Moreover, issues, related to quality and safety, were widely discussed in the courses on laboratory training. However, more work is needed, including the task of raising awareness among teachers about the importance of these issues. This is not an easy task and should be made many efforts in this regard because part of the teachers consider some of these issues as minor subjects, and this means an added obstacle.

In addition, survey of 2014 shows that the level of competences, except in the first two items, is always below the level required by companies (see last item in each section of Table 1). Therefore, the survey highlights that it is not enough that students acquire knowledge but also that they must be able to assimilate and apply them. This is a turning point because the degrees should ensure that students acquire a range of skills and competences needed for further professional activity. Thus, it is a hard task to do in development of the degrees in the future.

The last aspect to note is the enormous interest of the information provided by the surveys in the preparation of the new curricula, taking into account that it is providing a new reform of the degrees in the Spanish university system (Real Decreto 43/2015). As stated above, given the limited initial dissemination of the surveys, we could not expect that their results were an essential tool in preparing the curricula. However, it should be considered as an emergent picture of the needs of the Catalan chemical industry. Companies should not be the only organizations that draw the trajectory of the university, but, given its social function, it is highly desirable that the opinion of companies is heard and weighted. Thus, it seems acceptable that issues related to the management of information and documentation, quality management, environmental management, safety, work planning and time management should be reflected in future curricula for all degrees.

Perhaps the new degree structure in three years may suggest that the introduction of these new subjects should be more complicated. However, this new structure also implies a new teaching methodology. This necessarily involves better coordination between courses, use of lectures for the teaching of basic ideas, etc. If the process is properly done, a considerable reduction in the number of classroom hours of student can be achieved. Therefore, the door is open to the introduction of new subjects, which, like the classical items, not only they have to be developed in the lectures but also in small groups with the professors' support.

3. Conclusions

From the survey results, it can be said that the training required by the companies is quite in accordance with the training given to students in our Faculty. The same can be said concerning the competences and skills achieved by our students.

However, surveys show that it should be made improvements on issues related to management of time, information, quality, environment, safety, etc. Thus, surveys serve to point out the weaknesses in our degrees and, as a consequence, it can be made improvements to address the identified deficiencies, as it has already been done based on the results of survey carried out in 2007. From this point of view, we can say that the surveys are a good tool for the progress of our teaching task.

Finally, the contact between companies and universities is an interesting tool to improve the training of students and can help us in updating the degrees and in fitting the needs of the industries.

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