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GENERIC SKILL DEVELOPMENT AND LEARNING/ASSESSMENT PROCESS: USE OF RUBRICS AND STUDENT VALIDATION

Montserrat Iborra Urios, Eliana Ramírez Rangel, Roger Bringué Tomàs, Javier Tejero Salvador, Fidel Cunill García, Carles Fité Piquer

Universitat de Barcelona, Departamento de Ingeniería Química, Facultad de Química

Spain

miborra@ub.edu, eliana.ramirez-rangel@ub.edu, rogerbringue@ub.edu, jtejero@ub.edu, fcunill@ub.edu, fite@ub.edu

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Abstract

In order to fulfill the European Higher Education Area requirements in the subject "Chemical Engineering Experimentation II" (Chemical Engineering Undergraduate Degree, University of Barcelona), generic skills in teamwork, and both written and oral communication were developed and assessed with the help of rubrics. The methodological usefulness of rubrics in formative/summative assessment was tested by means of student validation. The students' perceptions of the teaching/learning process were collected, analyzed and compared to the academic marks.

The lack of students' knowledge of the use of rubrics, their lack of commitment and proactivity in the teaching/learning process, and their lack of adaptability and high resistance to the introduction of methodological changes make further work necessary on implementation. Because of the importance of the active participation of the students in the process of teaching/learning, the process of validation should be continued. The teaching experience indicates that rubrics are useful as an assessment tool, but in order to increase their utility as a tool in the process of learning, the future challenge is to modify some aspects of the validation queries and process.

Keywords **–** Generic skills, Rubrics, Validation, Communication skills, Teamwork.

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1 INTRODUCTION

The Chemical Engineering Undergraduate Degree offered by the University of Barcelona (Spain) was brought into line with the European Higher Education Area requirements by progressively revamping the teaching/learning methodology employed over three academic years (2009–2012). The main changes were the use of continuous formative assessment methodologies in order to increase feedback, to promote collaborative learning and to engage students in ethical commitment. Specific rubrics were drawn up to improve students' learning awareness. The results of student satisfaction surveys and their academic marks indicated that acquisition/development of transferable competences such as teamwork, professional ethics, written communication, personal autonomy and self-regulation (all necessary for a chemical engineer to achieve personal fulfillment and be employable in a knowledge-based society) improved (Iborra, Ramírez, Tejero, Bringué, Fité & Cunill, 2014). As a result, it can consider that the teaching/learning process has been improved.

In the previous work cited above, in order to discern clearly the evolution of worked aspects and due to time constraints, communication skills were only partially implemented and writing was the only aspect assessed. The new structure of the Chemical Engineering Undergraduate Degree restricts the development of

communication skills to a few subjects among which is “Chemical Engineering Experimentation II” and the development of oral communication skills became a priority.

A rubric is a statement that expresses the required level of achievement as demonstrated by various performance indicators, and it is useful to certify competence acquisition. In addition to providing fair and accurate assessment, the use of rubrics can provide a framework for self-evaluation, reflection and peer review, as well as fostering understanding and indicating a consistent way to proceed in the process of teaching/learning (Gómez, Aguirre, Posso, & García, 2002; Allen & Tanner, 2006).

Reddy and Andrade (2010) showed that:

- the use of rubrics may become a valuable element of the teaching/learning process, and
- the availability of rubrics before an assignment or their co-creation is the key to understanding students’ positive responses to them.

Therefore, in order to increase the active role of students in the teaching/learning process, a field validation process was conceived: the analysis of the appropriateness of rubrics from the students’ point of view (Huerta, 2005).

The aims of the current work, performed over the three academic years 2013-2014, were:

- To schedule oral activities and draw up the corresponding rubrics.
- To reinforce the use of rubrics as a learning tool by making them broadly available and questioning students with regard to their appropriateness (validation).
- To evaluate the usefulness of rubrics by contrasting surveys of student satisfaction and their academic results.

2 DESIGN/METHODOLOGY/APPROACH

The present work was developed within the subject “Chemical Engineering Experimentation II" (eighth curricular semester). Two groups, each comprising 30 students, 1 senior teacher and 1 teaching assistant, worked in daily sessions of 4h for 4 weeks. The subject aims to develop the specific knowledge and the teamwork and communication skills that are necessary to foster enhanced student adaptability. The general skills that are worked on within the subject can be defined as follows (Blanco, 2009; University of Kent (2009); Alsina Masmitjà et al., 2013):

- Oral communication can be defined as the exchange of information that occurs in all interpersonal relationships and the ability to communicate clearly and effectively using appropriate verbal and nonverbal resources. It also involves listening to others and respecting their ideas and the conventions of participation.
- Teamwork skills entail the development of collaborative work between people, aimed at achieving specific common objectives that are relevant to the areas and the organizations those people belong to or work in. Teamwork involves working confidently within a group, contributing your own ideas effectively, taking a share of the responsibility, being assertive—rather than passive or aggressive—accepting and learning from constructive criticism, and giving positive, constructive feedback to others.
- Written communication skills include expressing yourself clearly, using language with precision; constructing logical arguments; note taking, editing and summarizing; and writing reports.

Based on the diagnostic testing in previous works (Ramírez, 2011; Iborra et al., 2014), the activities planned to develop general skills through the use of rubrics were:

- A problem-based learning (PBL) exercise (Hmelo-Silver, 2004) to construct specific knowledge using the Aronson puzzle technique (Aronson, 2000), allowing the development of teamwork and both written and oral communication skills. Furthermore, as noted by Elliot Aronson (2002), this technique promotes empathy between students and creates a more ethical environment.
- Experimental work undertaken by groups of 4 students with role assignments (Belbin, 2012) to foster adaptability and teamwork. Because of the characteristics of the experimental work, only implementer, coordinator, resource investigator, team worker, finisher and thinker roles were assigned.
- An oral presentation to develop mass communication abilities.

- Technical reports written by means of wikis, in order to continue the work with communication and teamwork skills.

The rubrics for written communication and teamwork skills were elaborated previously using consolidated rubrics as a guide (University of Baltimore, 2010; University of Wisconsin, 2010; Auburn University, 2010). In the present work, the oral communication rubric was elaborated to include level descriptors of body language, visual aids (using Power Point or similar), structure, language and content (See Table 1).

BODY LANGUAGE	***NONVERBAL SIGNALS***	
	Appearance: clean, good, dressed appropriately for the occasion and audience / Dirty or neglected, too formal or informal.	
	Facial expression and smile matches the content / Flat expression or mismatched with the content or audience	
	Visual contact with the audience: with everyone / with most of the audience / with a fraction / with no one	
	Occasional gestures, hand movements that complement and enhance communication /gestures excessive or deficient, unusual mannerisms	
	Occasional motion to the audience, and side to side / Occasional motion but misadjusted / continuous motion / absolute immobility	
	Balance and posture: standing / posture bent or inclined	
	Confident and relaxed in front of the audience / only initially anxious and / or shy / anxious at some point and / or shy / Anxious and / or shy	
	VOICE	
	Volume is sufficient; entire audience can hear / mostly incompatible volume making it difficult for some in the audience to hear / it is difficult for the public to hear	
	Vocalization and speed is enough for all the audience to understand / mostly incompatible vocalization making it difficult for some of the audience to understand / it is difficult for the public to understand	
	The voice inflection (emphasis, pauses and vocal changes) are constantly used to help communication / often / sometimes / never (monotone)	
VISUAL SUPPORT	***VISUAL AIDS***	
	Appropriate selection and use of digital tools to communicate with the public (Yes / No)	
	Confident demonstration of use of digital tools to communicate with the intended audience / Inappropriate / Insufficient	
	Original and appropriate presentation for the assigned purpose/Inappropriate/ Insufficient	
	TEXT	
	Font type and size is adequate / Inappropriate/ Unsuitable for viewing	
	Text length is adequate / somewhat excessive / excessive	
	Variety of slides is suitable / Inappropriate for the target	
	Size and quality of graphs and tables is excellent / Inappropriate/ Unsuitable for viewing	
	ANIMATION	
	Animation creates connections and helps the public understand the concepts. / Does not always help / never helps	
	Animation is / is not always / is not related to the content	
	Amount of animation is suitable / not always appropriate / excessive and does not distract audience / sometimes distracts / always distracts from the text.	
	BACKGROUND	
	The background color allows/does not always allow/ interferes with the reading of the text	
	The background is not distracting and reinforces / somewhere distracts / detracts from the message.	
	ARRANGEMENT	
	Design arrangement is adequate and the result is visually pleasing to the audience / inappropriate	
	Proper use of headers / at some points could be improved / inappropriate	
	Appropriate use of blank / at some points could be improved / inappropriate	

	STRUCTURAL MECHANICS	
	Nonexistent / occasional / continuous grammar errors	
	Appropriate / could be improved / inappropriate capitalization	
	Correct / could be improved / poor spelling	
STRUCTURE, LANGUAGE AND CONTENT	*The ordered and clear sequence of presentation inspires a high level of audience thinking / The sequence of presentation (organized and clear) helps the public to follow the content / The sequence is logical with enough details for the audience to understand / The sequence of events is insufficiently detailed for understanding of the content (disorganized and confusing)*	
	Attractive and appropriate introduction / background, context or uncertain significance	
	Arguments and evidence support the key points / present some "personal opinion" and/or lack of evidence / missing arguments and/or evidence / lack of arguments and evidences	
	Clear transitions from point to point / The changes are somewhat abrupt / Many changes are abrupt and ideas are left hanging / Overall transitions are abrupt.	
	Clearly identifies and summarizes correctly / Identifies but not quite correctly summarizes / Summarizes but not quite correctly identifies / Neither correctly identifies nor summarizes	
	Proper time management: needless or over / inadequate time management: lack or surplus	
	Use of graphs and tables in a clear, legible and attractive way at appropriate times and consistently to support the description properly	
	Graphs and charts are necessary information and allow connections to help understand the concepts	
	Charts and tables do not repeat information	
	Use of complex sentences (grammar and syntax) with the selection of appropriate and accurate words for the content	
	Vocabulary appropriate for the audience experience and denotes growth due to the learning process of the subject / suitable / adequate but not always consistent / simplistic	
	Demonstrates through presentation that thoroughly understands the content	
	Answer all questions / some / rudimentary / no	
COMMENTS		
FINAL MARK		

Table 1. Learning and assessing student oral communication skills rubric

Once this work was complete, in order to increase the students' active role, the new challenge was the field validation of the rubrics as an important part of the teaching/learning process. The stages of the process were:

- Based on deep analysis of the rubrics by the teaching team (2 senior teachers and 2 teaching assistants) and two students (one who had previously passed the subject and another who had not (both with a peer-mentoring grant)), validation queries were elaborated (see Table 2). The validation criteria chosen were: rubric component suitability, previous skill development and identification of achievements, as well as the contribution to the final mark.
- The rubrics were introduced to students in order to explain their usefulness as a tool for training/assessment.
- Performing the planned activities according the timetable shown in Table 3.
- Student validations. The rubrics and validation queries were made available through the Virtual Classroom, but the validation process was performed as an off-line activity. The use of the personalized follow-up procedure was designed to help students understand the process and learn from it. Finally, the process was summarized in final questionnaire responses.
- Collection of evidence(results from the knowledge construction using the Aronson puzzle technique, written scientific reports, presentations and final validation questionnaires).
- Evidence analysis and usefulness assessment by comparing student satisfaction survey (Figure 1) and academic outcomes.

The following aspects must be evaluated for each item and subitem of the oral communication rubric								
	Average suitability mark* (1 to 10)	***Average weight in the final mark (%)***	***Previously worked***		***Level***			***Subject?***
			Yes	***No***	***High***	***Middle***	***Low***	
Body language								
Nonverbal signals								
Voice								
Visual aids								
Visual support								
Text								
Animation								
Background								
Disposition								
Structural mechanisms								
Structure, language and content								
Presentation sequence								
Time management								
Suitability of graphs and tables								
Vocabulary								
Answering								
Total								
Comments and suggestions								
**How appropriate do you consider the inclusion of this item in skills assessment?*								

Table 2. Example of rubric validation questionnaire

1st day	2-3rd day	4th day	5-18th day			19-20th day	2 weeks later
Stages of the learning sequence							
Initial phase	Development phase	Closing step	Initial phase	Development phase	Closing step	Oral presentation	Summary
Diagnostic testing Introductory presentation Learning contract Design of teamwork through role definition and task distribution according roles Assignment of laboratory work Collaborative work start-up	Problem-based learning mixed with Aronson puzzle technique to build "Experimental Design" concepts	Brainstorm of summary (formative assessment and feedback) Individual written composition (10% summative assessment)	Experimental proposal by groups (formative assessment and feedback) Opening of experimental question available in virtual environment (formative assessment) Experimental start-up Creating a google account	Conduct experiments Preliminary experimental results (formative assessment with feedback) Written down the reports using wikis (formative assessment with feedback)	Final reports handling-over (50% summative assessment with feedback)	Handling-over of audiovisual material via virtual environment Individual oral presentation (15% summative assessment with feedback)	Written test (10% summative assessment with feedback) Teacher-, self-, and co-evaluation of students teamwork (15% summative assessment with feedback) Subject survey
Validation Process							Validation quest

Table 3. Timetable and learning/assessment activity descriptions

The aim of this survey is to collect the assessment of students on teaching in the experimental teaching to make improvements, so it is important that you answer honestly and objectively.

Sex	☐	Male	☐	Female					
My degree of punctuality	☐	Low	☐	Medium	☐	High			
My degree of initial interest in this subject	☐	Low	☐	Medium	☐	High			
Number of times I have registered for this course	☐	1	☐	2	☐	3	☐	More than 3	
Number of times I've submitted for consideration	☐	0	☐	1	☐	2	☐	3 or more	
Hours of study / work not protected devoted to this subject a week	☐	1-2	☐	2-3	☐	3-4	☐	5-6	

Valued each item from 1 to 5:				
1	2	3	4	5
Very unsatisfied	Unsatisfied	Moderately	Satisfied	Very satisfied

	1	2	3	4	5
Environmental conditions (temperature, lighting, comfort, cleanliness, etc.					
Equipment (equipment condition, operation, etc.)					
Usefulness of Virtual Campus as a tool for teaching support					
Training received					
Care provided					
It is reported clearly the plan of the course (program, objectives, bibliography, evaluation)					
Feedback is provided					
The feedback was constructive					
The size of the working group					
The ability to apply knowledge to practice was developed…					
Independent critical thinking was developed…					
Building capacity for analysis and synthesis was developed…					
Information management capacity was developed…					
Self learning ability was developed…					
Ethical commitment was developed…					
Ability to provide facilities and equipment was developed…					
Ability to plan and execute experimental work was developed…					
Ability to communicate in writing the results of a job was developed…					
Ability to communicate orally the results of a job was developed…					
Interpersonal skills were developed…					
Teamwork capacity was developed…					
The didactic contract has been useful to clearly establish your objectives and commitments?					
The rubrics have been useful (it have provided enough information) for the development of skills worked?					
Overall satisfaction was…					
Comment:					

Figure 1. Student satisfaction survey

3 RESULTS AND ANALYSIS

The process of gathering evidence, learning and validation allows the following results to be established:

- The number of validation queries collected was less than the total number of students for the course (60); participation was 73%.
- Not all the collected queries were completed correctly (See Figure 2).

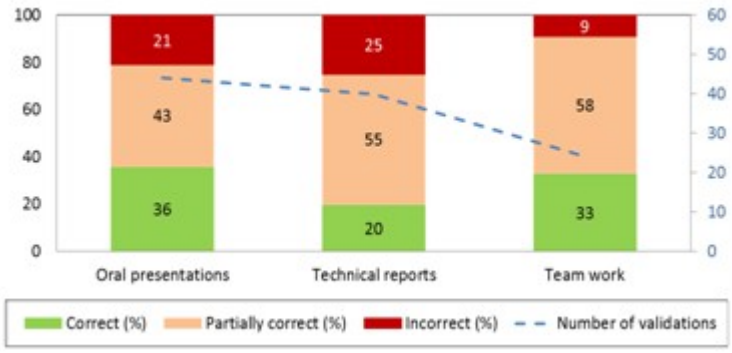

Figure 2. Number of validations collected and percentage of correctly/partially correctly/incorrectly completed ones for the three rubrics used (oral communication, written communication and teamwork)

- Tables 4 to 6 summarize the information gathered in the validation process.

Item	***Subitem***	***Average suitability mark***	***Average weight in the final mark (%)***	***Average weight of subitem (%)***	***Previously worked (%)***		***Level***		
					Yes	***No***	***High***	***Middle***	***Low***
Body language	*Nonverbal signals*	*7.0*	*13*	*6*	*51*	*49*	*32*	*42*	*26*
	Voice	*7.6*		*7*	*54*	*46*	*32*	*47*	*21*
Visual aids	*Visual support*	*8.2*	*33*	*4*	*80*	*20*	*50*	*43*	*7*
	Text	*7.7*		*6*	*80*	*20*	*54*	*32*	*14*
	Animation	*6.0*		*6*	*69*	*31*	*42*	*33*	*25*
	Background	*7.0*		*4*	*77*	*23*	*52*	*37*	*11*
	Disposition	*8.0*		*4*	*77*	*23*	*52*	*41*	*7*
	Structural mechanics	*8.5*		*9*	*71*	*29*	*58*	*29*	*13*
Structure, Language and Content	*Presentation sequence*	*8.4*	*54*	*14*	*86*	*14*	*43*	*50*	*7*
	Time management	*7.7*		*10*	*83*	*17*	*52*	*37*	*11*
	Suitability of graphs and tables	*8.2*		*10*	*91*	*9*	*52*	*42*	*6*
	Vocabulary	*8.4*		*10*	*29*	*6*	*57*	*36*	*7*
	Answering	*8.4*		*10*	*91*	*9*	*55*	*35*	*10*

Table 4. Analysis of the results of the validation of the rubric for oral communication skills

Item	Subitem	Average suitability mark	Average weight in the final mark (%)	Average weight of subitem (%)		Previously worked (%)			
				Yes	No	High	Middle	Low	Do not know
Format	Identification	8.4	8.8	96	4	65	21	13	4
	Visual appearance	8.3		89	11	65	23	12	7
	Vocabulary and verbal tenses	8.6		64	21	70	13	17	18
	Order	8.6		93	7	56	32	12	14
Introduction	Complete and contextualized	8.1	8.0	79	21	48	26	11	15
Justification and objectives	Experimental setup and design variables	8.6	11.6	43	57	35	17	0	48
	Aim of the work	8.9		86	14	43	39	4	14
Set up and experimental procedure	Setup diagram and description	8.3	14.2	75	25	41	26	4	30
	Experimental design	8.7		39	61	29	7	7	57
Results	Experimental results and error	9.1	16.7	89	11	54	35	0	12
	Figures, charts and tables	9.2		89	11	62	19	8	12
Discussion	Comprehension and discussion of the results	8.9	20.3	96	4	64	25	7	4
Conclusions	Clarity and understanding	9.0	15.5	89	11	18	4	0	79
Bibliography	Appropriate and enough references	7.6	4.9	75	25	48	30	11	11

Table 5. Analysis of the results of the validation of the rubric for written communication skills

Item	Subitem	Average suitability mark	Average weight in the final mark (%)	Average weight of subitem (%)	Previously worked (%)		Level		
					Yes	No	High	Middle	Low
Contribution	Number	6.9	11	5	47	37	16	47	37
	Quality	7.95		6	63	11	26	63	11
Interactions quality	Communication	8.3	15	5	58	32	11	58	32
	Help, listen and respect	8.9		5	68	21	11	68	21
	Intervention and recognition	8.3		5	58	26	16	58	26
Collaboration quality	Sharing	7.9	16	5	47	37	16	47	37
	Contribution	8.2		7	47	42	11	47	42
	Persuation	7.7		4	47	42	11	47	42
Task compliance	Clarity and Efficiency	8.8	14	14	47	21	26	47	21
Adoption role	Understanding and implementation	6.7	7	7	21	37	42	21	37
Attitude	Commitment and responsability	9.2	13	13	68	16	16	68	16
Adjustment capacity	Resetting plans	8.2	11	5	53	26	21	53	26
	Faults detection and correction	8.5		6	47	32	21	47	32
Temporary compliance	Motivation	8.75	13	6	89	32	5	89	32
	Delivery time	8.85		7	68	21	11	68	21

Table 6. Analysis of the results of the validation of the rubric for teamwork skills

- Different aspects and levels of the skills worked on some previous curriculum subjects were identified (Chemical Engineering Experimentation I, Projects, Chemical Kinetics, Chemical Reactors and Chemistry Laboratories).
- Figure 3 shows the students' marks in the assessment of oral and written communication and teamwork skills, as well as the final mark.

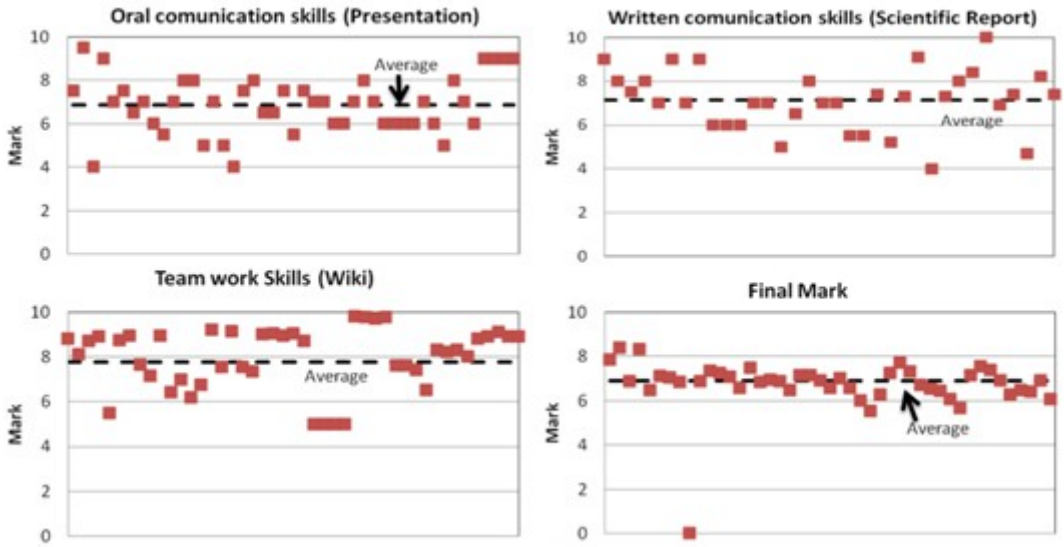

Figure 3. Students' marks in the assessment of oral and written communication and teamwork skills, as well as the final mark

- Figure 3 shows the frequency distribution of the academic marks obtained (number of times that a mark was assigned).

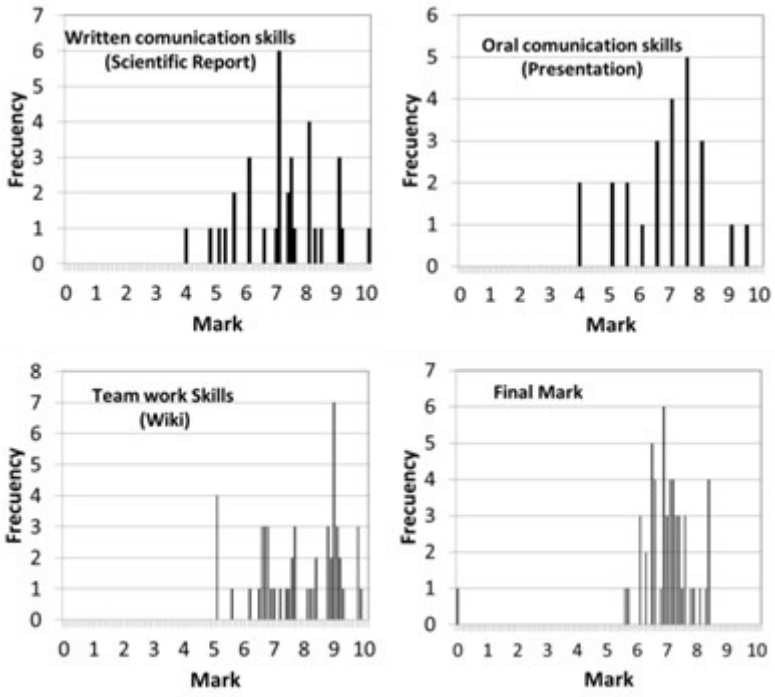

Figure 4. Frequency distribution of academic marks

- Figure 5 shows the results of the student satisfaction survey.

Figure 5. Results of student satisfaction survey (average results)

Based on these results, our analysis was as follow:

- Although the overall percentage of validations collected may seem satisfactory, the percentage of only partially answered questionnaires was relatively high. Consequently, the conclusions inferred from the analysis could be biased and therefore caution should be taken in extrapolating the results to other subjects of the curriculum.
- A lack of student knowledge of the use of rubrics was detected and it was necessary to remind them of their use throughout the process.

- As seen in Figure 2, the number of validations collected for each rubric and the percentage of correctly/partially correctly/incorrectly completed validation sindicated that the students showed little interest in taking an active role in the process of teaching/learning.
- Students gave contradictory answers regarding where and how skills are worked on. These contradictions showed that the development of the skills was unstructured, performed independently by teachers and without any coordination.
- As for oral communication skills in their own language (see Table 4):
    - Students considered that the structure/content aspects were more important (54%) than body language (13%) and visual aids (33%) during an oral presentation, which indicated poorly developed and incomplete competences. In fact, oral communication should not be seen as limited exclusively to “the talk", but should include aspects of interpersonal relationships.
    - It should be noted that no item was considered extremely suitable; body language was not considered very important; and there are inconsistencies in the students’ answers. Consequently, it can be deduced that a percentage of them did not assimilate the work.
    - Chemical Engineering Experimentation I, Projects and Equipment Mechanical Design were the subjects where oral communication skills were developed without the use of rubrics.
- In the assessment of written communication skills (see Table 5):
    - Students consider that the written content (69%) and format (9%) is more important than literature (5%), that is, the number and quality of references. This is in total agreement with the summaries written by students which demonstrated a high degree of disinterest in this aspect, including little or no literature cited in the text, with poorly organized or inappropriate references.
    - Students stated that writing skills are only developed in practical subjects (they simply copy the literature cited in the lab manual) and in some tasks similar to a report. Accordingly, students considered that the most relevant aspects to develop when writing a report are the experimental results, discussion and conclusions, and they leave aside, surprisingly, the objectives, the justification of the experimental work, and the introduction and format of the written report.
- As for the assessment of teamwork skills (see Table 6):
    - Students considered that the quality of the collaboration and interaction between members of the team was the most important (31%), followed by the completion of the tasks, the timing, and the number and quality of the contributions. The attitude, the capacity to adjust and role assimilation were considered less relevant.
    - Students showed a preference for freely building groups and made negative comments on the use of role assignments. This rejection by students can be explained by the fact that it constituted a completely new feature for them.
    - Chemical Engineering Experimentation I, Projects and Equipment Mechanical Design were the subjects where teamwork was developed without the use of rubrics.
- Considerable resistance among the students to the introduction of methodological changes that involve working on generic skills in accordance with the requirements of the European Higher Education Area was observed.
- As for the academic marks, Figures 3 and 4 show the distribution around the average value of the individual marks assigned to the pupils in the evidence of learning:
    - In all of them, a wide distribution can be observed around the average mark.
    - The analysis of the self- and peer-assessment marks of the teamwork showed a clear trend to higher marking according to the culture of misunderstanding "partnership", which is demonstrated by the mark given by the teacher. This indicated a need to improve self-analysis.
    - The narrow Gaussian distribution of final mark was due to the large number of pieces of evidence evaluated.

    - The average mark in the previous equivalent subject in the Chemical Engineering Undergraduate Degree was one point higher.
- As for the satisfaction survey (see Figure 5):
    - The level of student satisfaction is acceptable and corresponds to the academic results achieved (about 7).
    - The global satisfaction level in the previous equivalent subject for the Chemical Engineering Undergraduate Degree was one point higher.
    - Student appraisals and comments on the development of oral communication skills were low; which leads us to believe that students considered this competency to be underdeveloped.
    - The development of teamwork skills received a better rating, even though the observations indicated a non-acceptance of working roles.

4 CONCLUSIONS

The main difficulties encountered during the development of this work were:

- the students' lack of knowledge of the use of rubrics;
- their lack of commitment and proactivity in the teaching/learning process; and
- their lack of adaptability and high resistance to the introduction of methodological changes.

The answers given by students were contradictory, so it may be deduced that the skills tested were developed in an unstructured way, without any coordination and independently by teachers. Also, a change in the typical student profile seems to be relevant and the simplification of the Chemical Engineering Undergraduate Degree has paradoxically decreased the level achieved in the aforementioned skills, compared with the previous undergraduate program, where the mark for the overall process was one point higher than the present one.

These factors allow us to conclude the following.

- It is necessary to keep working on the implementation of rubrics in the subject "Chemical Engineering Experimentation II" and throughout the Undergraduate Degree program.
- Because of the importance of active student participation in the process of teaching/learning, the process of validation must be continued.
- More work is required on developing aspects of learning such as body language, because in meetings with superiors, peers or subordinates, or in the discussion session, these skills are needed in order to be able to express a point of view, to listen to different points of view and to process the global interaction.

Although in certain areas, oral communication is directly associated with "oral presentation" or "the talk", it should not be forgotten that in professional practice, communication skills are not restricted exclusively to mass communication. It is crucial to consider three key factors in effective oral communication: knowing how to speak, listen and process the whole communicative activity, which requires the use of emotional intelligence. 4) More work is needed on developing teamwork through the assignation of roles, because teamwork and adaptability are essential professional skills for a chemical engineer (see the White Book of Chemical Engineering, Agencia Nacional de Evaluación de la Calidad y Acreditación, 2005).

The teaching experience points out that rubrics are useful as an assessment tool, but in order to increase their utility as a tool in the process of learning, the future challenge is to modify some aspects of the validation process and queries.

Finally, it should be noted that full implementation by university teachers is limited under present conditions, since the proper management and analysis of the information is very complex and time consuming. However, it is essential to continue with the implementation of the methodologies and issues involved (such as the use of rubrics) to develop the skills required under the current European Higher Education Area framework.

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AUTHOR BIOGRAPHY

Montserrat Iborra Urios

Montserrat Iborra Urios has been a Senior Lecturer in Chemical Engineering at the University of Barcelona (Spain) since 1995. She graduated (1984) and was awarded her PhD (1989) in chemistry (specializing in Technical Chemistry). Her research focuses on catalysis and applied kinetics. She has taught under graduate courses in chemistry and chemical engineering including: Technical Chemistry, Chemical Engineering, Heterogeneous Catalysis, Chemical Reactors and Chemical Engineering Laboratory. She was responsible for bringing the subjects Chemical Reactors, Multiphase Reactors and Experimentation in Engineering II into line with the requirements of the European Higher Education Area and drafted the syllabus for the experimental matter in the new Masters in Chemical Engineering at the UB. She has been a member of the consolidated teaching innovation group (2008, 2010, 2012, 2014)"Chemical Engineering Reaction" since its formation and is currently responsible for the group. She has been an academic tutor since 2004-5, is a tutor in the inter-university program (ENGINYCAT), is a mentor in the Master training program for new teachers and a mentor of senior students through scholarships for collaboration in the Chemical Engineering department of the University of Barcelona. She has become part of the monitoring committee of the Master in Training Junior Teachers at the University of Barcelona since 2012 and has been on the academic committee since 2013. She has participated in 14 educational innovation projects, almost all them in the context of adaptation to the EHEA, and has been responsible for4 of them. These activities have led her to participate in various national and international conferences on teaching innovation, and have resulted in the creation of teaching materials and publications. She has also worked on the implementation of formative assessment supported by the Moodle platform and the development of transferable skills. She has participated in the publication of six text books(on paper and digital) and educational out reach articles.

Eliana Ramírez Rangel

Eliana Ramírez Rangel is a Lecturer at the Chemical Engineering Department of the University of Barcelona, Spain. She obtained her BSc in Chemical Engineering from the Universidad Industrial de Santander, Colombia, in 1999 and her PhD from the Universitat Politècnica de Catalunya, Spain, in 2005. Since 2009, she has performed research at the Chemistry Faculty of the University of Barcelona in catalysis and applied kinetics. She has taught courses on basic chemical engineering (Introduction to Chemical Engineering, Heat Transfer, Biochemical Engineering and Microbiology, Chemical Reactors and Chemical Engineering Laboratory) for the Chemical Engineering and Chemistry degrees. She is currently a member of the Chemical Reaction Engineering teaching innovation group. She has participated in9 teaching innovation projects, almost all them in the context of adaptation to the EHEA, and published several papers on teaching/learning innovation.

Roger Bringué Tomàs

Roger Bringué Tomàs is a Lecturer at the Department of Chemical Engineering of the University of Barcelona. He received his PhD in 2007 from the University of Barcelona. His research in the Chemistry Faculty of the University of Barcelona focuses on catalysis and applied kinetics. He is a member of the Chemical Reaction Engineering teaching innovation group and responsible for the subjects Biotechnology and Chemical Engineering Experimentation II (BSc in Chemical Engineering) and Basis of Technology (BSc in Food Science and Technology). He has been involved in some teaching innovation projects at the University of Barcelona which has led him to participate in conferences and publications on chemical engineering teaching innovation.

Javier Tejero Salvador

Javier Tejero Salvador is a Professor of Chemical Engineering in the Faculty of Chemistry of the University of Barcelona (Spain). He was awarded his MSc (Chemistry, 1981) and PhD (Chemistry, 1986) by the University of Barcelona. At present is the coordinator of the Catalysis and Applied Kinetics research group. He has taught undergraduate courses in Chemistry and Chemical Engineering in successive years from 1980 to the present, including: Technical Chemistry, Introduction to Chemical Engineering, Heterogeneous Catalysis, Chemical Reactor Engineering and Catalysts Design. He is member of the consolidated teaching innovation group "Chemical Engineering Reaction" (2008, 2010, 2012, and 2014) at the University of Barcelona, and was the

coordinator of the group until 2012. He has been the coordinator of the BSc in Chemical Engineering (2004-2012) and the MSc in Chemical Engineering (since 2013), and responsible for tutorial programs in Chemical Engineering (University of Barcelona) and in the inter-university program ENGINYCAT (2012-2014). He has collaborated in14 educational innovation projects, almost all them in the context of adaptation to the EHEA. This activity has led him to present work at national and international conferences on teaching innovation, and to the creation of teaching materials and publications, as well as to his participation in the publication of six text books (on paper and digital) and educational outreach articles.

Fidel Cunill García

Fidel Cunill García is Professor Emeritus of Chemical Engineering at the University of Barcelona, Spain, where he was the leader of the Catalysis and Applied Kinetics group in the Chemistry Faculty. He spent periods visiting Groningen University, Netherlands, and Twente University, Netherlands. His main area of research is acid catalysis by ion-exchange resins in reactions such as the etherification of alcohols with olefins, dehydration of linear alcohols and oligomerization of linear and branched olefins. He has published more than 125 research papers, two books on Chemical Engineering and has collaborated in teaching innovation projects. He has supervised 10 PhDs and has been Secretary, Vice-dean and Dean of the Chemistry Faculty at the University of Barcelona.

Carles Fité Piquer

Carles Fité Piquer is an Assistant Lecturer at the Department of Chemical Engineering of the University of Barcelona. He earned his PhD in Chemistry in 1996 in the applied kinetics of heterogeneously catalyzed reactions. Besides chemical engineering, he has a strong background in numerical methods and programming. He has taught, and teaches, courses on basic and advanced chemical engineering (Introduction to Chemical Engineering, Chemical Engineering Lab, Fluid Mechanics, Applied Kinetics and Catalysis, Advanced Unit Operations, Optimization and Operations Research, Physical Properties Estimation) for Chemical Engineering, Chemistry, Biotechnology and Environmental Science degrees. His research is mainly focused on heterogeneous catalysis, specifically on the kinetics of etherification and oligomerization reactions catalyzed by ion-exchange resins, and on chemical reactor modelling. He has coauthored more than 50 scientific papers, published in international peer-reviewed journals, and two textbooks, and he has presented more than 70 communications at international conferences. He is a member of the Applied Kinetics and Catalysis research group and of the Chemical Reaction Engineering teaching innovation group at the University of Barcelona.

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