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SKILL DEVELOPMENT IN EXPERIMENTAL COURSES

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Abstract

Experimental courses offer a good opportunity to work with competences, promoting the incorporation of strategies oriented towards motivating students to actively involve in the learning process, promoting reflexive learning and developing generic skills. This study presents different ways of developing and evaluating some important general skills, settle on four specific objectives:

- to increase student motivation using samples of potential interest to students and explaining real-live application of their samples analyses;
- to assist students' self-regulation and learning autonomy by using the portfolio;
- to promote group work through experiments in pairs and small-group discussions;
- to develop communication skills through small-group discussions and oral presentations.

Results show that the type of sample used and real-life application has important influence on motivation. The portfolio is a good tool to promote reflection and to evaluate both specific and generic skills in experimental courses, the dynamics of a laboratory course permit students to develop their group-work and communicative skills, and peer evaluations both improve students' communication skills and promote metacognitive reflection. Finally, the project demonstrates that it is possible to train students in general skills using the specific course content and that the incorporation of participatory methodologies encourages students to become actively involved in the teaching-learning process.

Keywords **–** Cooperative grouping, Critical thinking, Laboratory science, Lifelong learning.

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1 INTRODUCTION

The European Higher Education Area (EHEA) has defined a new educational paradigm with the central concept of learning-focused education (Altbach & Knight, 2007; Ministerio de Educación, Cultura y Deporte, 2003; The European Higher Education Area, 1999). This change of focus, which prioritises students' learning over teachers' teaching, implies that in addition to disciplinary knowledge, students need to acquire generic or transversal skills that permit them to develop professionally, personally, and socially (Ballantine & Larres, 2007; Bennett, Dunne & Carré, 1999; Clanchy & Ballard, 1995; Gilbert, Balatti, Turner & Whitehouse, 2004; Sin, Jones & Petocz, 2007; Smith, Mcknight & Naylor, 2000; Sung, Ng, Loke & Ramos, 2013; Yorke, 2006).

In today's world, where knowledge not only increases more rapidly every day but also becomes obsolete very quickly, it is essential for professionals to be able to constantly update their knowledge and adapt it to new and rapidly changing situations. They must learn how to learn, and they must learn throughout their lives (Black,

McCormick, James & Pedder, 2006; Cornford, 2002; Crebert, 2000; Rawson, 2000; Simons, 1989; Wingate & London, 2007; Zeegers & Martin, 2001).

Universities must accept the relativity of knowledge and assume the challenge of offering their students training that allowing them to function in the environment of uncertainty and complexity that characterises the knowledge society (Barber, 2000; Fullan & Ballew, 2001; Hargreaves, 2003; Monereo & Pozo, 2003).

In this context, one of the most important changes promoted by the EHEA is a change in teachers' and students' roles (Barr & Tagg, 1995; Cañado, 2010; Sursock & Smidt, 2010). The learning process is now considered a collaborative task between students and teachers in which students must be thoughtful apprentices (meaning that they must take responsibility for their own learning processes) and teachers must become counsellors or guides (Bienefeld & Almqvist, 2010; Boekaerts, 1997, 1999; Corno, 1992; Morales Vallejo, 2008; Shepard, 2000).

It is not surprising that learning ability is one of the most important general skills. To develop this skill, teachers must provide students with tools and areas for reflection that help them to be accountable for the development of their own learning processes so that they can self-regulate and become autonomous learners (Brockbank & McGill, 2007; Kolb & Kolb, 2005; Parker & Heywood, 2013).

To reach the objectives of the European convergence process, a fundamental strategic question arises: how can a teacher attain the pedagogical knowledge necessary to provide effective and high-quality instruction (Dierking & Fox, 2012; Gibbs, 2001; Michalsky, 2012; Miguel Díaz, 2003; Vázquez-Bernal, Mellado, Jiménez-Pérez & Leñero, 2012)? According to Cruz, *today, quality university teaching is impossible without specific training that provides the knowledge, skills, attitudes, values, and virtues needed by university-level teachers* (De la Cruz Tomé, 2003).

For this reason, academic institutions should promote training policies for their teachers that provide them with specific training in teaching skills and help them to advance in their professional careers (Bricall, 2000; Torra et al., 2013).

The University of Barcelona's teacher-training program offers a *Master's in University Lecturing for New Lecturers*, in which young teachers begin a process of professionalisation that will expand and improve throughout their academic careers. In this initial process, they are mentored by senior teachers with extensive teaching and research experience who advise, guide, and motivate them to innovate in their classes (Amador Campos, Carrasco Calvo, Díaz Álvarez, González Fernández, Gracenea Zugarramurdi, Marzo Ruiz, L. et al., 2012).

In this learning context, as a result of the collaborative process between one of the young lecturers and his mentor, a project was developed to incorporate some general skills development into the University of Barcelona's *Basic Analytical Chemistry Laboratory* course. The project was advised by the University of Barcelona's Institute of Education Sciences (ICE) and was launched in 2011-2012.

The present work describes this innovation experience and analyses the impact of its various components on student motivation and learning results.

1.1 Developing general skills: an innovation project of the Basic Analytical Chemistry Laboratory

Experimental courses offer an ideal framework to teach skills because they acclimate students to the professional practices that they will need to develop in the future (Baird, 1990; Bybee, 2000; Graham Gibbs & Simpson, 2004; Hofstein & Lunetta, 1982, 2004; Okebukola & Ogunniyi, 1984; Zeidler, 1997). In such courses, students must independently apply their previous knowledge to planning and developing different activities proposed by the teacher. These activities allow students to achieve significant, profound, and constructive learning. Moreover, the reduced number of students in these courses' groups makes these courses optimal curricular areas for the integrated development of the skills needed to become a good professional.

The *Basic Analytical Chemistry Laboratory* is a first cycle compulsory subject performed in the second year of the chemistry degree. To take this course, it is necessary to pass the *Applied Chemistry II* course (to learn how to work in a laboratory) and the theoretical course *Analytical Chemistry*. The subject have 4.5 ECTS that corresponds to 112.5 h (60 h attendance, 20 h tutored and 32.5 h of autonomous work) it was performed during 3 weeks, 4 hours per day, in groups of approximately 30 students (25 students during the term in which the innovation project was conducted), distributed among three sub-groups corresponding to three teachers. The three teachers have enough experience in teaching this course even when they have different level of experience. In the laboratory, students must apply their knowledge of the quantitative analysis of majority and

minority components using classical determinations, titrations and gravimetries explained in the theoretical course *Analytical Chemistry*, which the students take prior to the laboratory course.

The development of this course required students' continuous interaction with their classmates and the teacher. The process began when the teacher proposed the determination of the concentration of a compound in a sample. The proposed determination was selected depending on each student's characteristics and his position in the learning process. Some of the proposed analyses were determining water hardness, determining the presence of active chlorine in a domestic bleach bottle, determining the presence of phosphoric acid in a cola drink, and determining the concentration of copper in a 10-centime euro coin (89% Cu, 5% Al, 5% Zn and 1% Sn).

To perform these tasks, students searched the literature for different procedures to develop their assigned determinations and selected the most appropriate procedure in terms of safety, reagent availability, and quality of results. The selected procedure was then discussed with the teacher, and agreement was reached about what procedure to follow. Next, each student performed the assigned task and obtained results. The student was required to evaluate the results and to compare them with the results obtained by classmates. Finally, each student showed his results and conclusions to the teacher, who then discussed the results, evaluated the student's work, and assigned the student a new determination. All this procedure was registered in a notebook which was to be performed in the attendance time in the laboratory. Additionally, during the autonomous work time, the students have to answer questions about this determination in the notebook.

The course has an initial presentation session and two seminars performed in the first day (2 hours). Some determinations were performed in specific days due to material availability and its corresponding seminaries were performed the day before with the students that will perform these determinations (30 minutes). In general, the determinations have not specific timings and are the students' responsibility to distribute the time for the realization of the different determinations. Finally, the last day is fully dedicated to perform the oral presentations.

The assessment of the course was continuous during all the laboratory work. Mainly, the assessment takes into account the understanding of the determinations, the evaluation of the results and the solution of the problems appeared during the development of these determinations. This was observed by the discussions with the teacher, the answers to the questions and the revision of laboratory notebooks. Also, the oral presentation, attitude and time distribution was tacked into account for the assessment. During the discussion with the teacher feedback was provided to students. This feedback consists on a formative assessment about how this determination was performed and the aspects that needs to be improved for the next determinations that were selected to maximize these aspects.

Given the possibilities offered by this course, different activities were incorporated into the teaching programme that would permit the development and evaluation of some general skills included in the degree curriculum (Sayós, Amador & Pagès, 2012); these skills are considered important to students' future development. To reach this goal, a teaching innovation project was designed with the following specific objectives:

- To increase student motivation and consequently to involve students in their own learning processes through activities that are as meaningful and functional as possible.
- To assist students in self-regulation and learning autonomy, encouraging them to conduct metacognitive reflections that ensure their personal control over knowledge acquisition and the learning process.
- To promote group work, for two reasons: first, the interaction that occurs in collaborative activities among students is a good strategy for improving learning results; second, to respond to the demands of a labour market that is increasingly interested in organising work groups that generate synergies to achieve better results than those obtained by the sum of separate individual capacities.
- To contribute to the development of students' communicative skills. Given the importance of information properly flow between professionals and between the workplace and society, this course aimed to improve both oral and interpersonal communication. Good oral communication must allow students to be effective in transmitting ideas, thoughts, and feelings in various communicative contexts, such as conversational situations, group activities, and public presentations in front of large audiences. Interpersonal communication facilitates the establishment of positive relationships among people through active listening and discussion ability.

2 DESIGN/METHODOLOGY/APPROACH

2.1 Changes introduced in the course

The actions implemented to reach the expected learning outcomes as a function of the objectives described in the innovation project were the following:

- To increase student motivation, samples of potential interest to the students were chosen. Explanation of the real-life utility of these samples analyses was emphasised, and students were encouraged to bring and use their own samples to easily relate the analysis to their own life experiences.
- To promote the reflections of students on their own learning and that students conduct their self-regulatory processes, as an essential step towards autonomy, the use of portfolios or learning folders was analyzed. The function of this activity was twofold. First, students were required to present evidence of their learning processes, explaining their decisions and strategies that led to the obtained results. This process was used to prompt students to reflect, self-evaluate, and propose future improvements. Second, in addition to this formative assessment, learning portfolios allowed students to perform accreditation assessments because they contained evidence of the level that each student achieved. Therefore, by using the portfolio, it was possible to evaluate both student and teacher perspectives.
- To strengthen group work, some learning situations were proposed in which students had to collaborate with classmates, organise themselves, and make decisions to reach common goals that would improve the quality of their results. First, complex experiments to be performed in pairs were proposed. Second, small-group discussions were organised.
- Finally, work on communicative skills was performed through student participation in small-group discussions and oral presentations. The first learning activity mainly focused on interpersonal communication. Students were required to assert themselves in discussions with classmates, to consider the contributions of others, and to reach agreements. The second activity involved the instrumental components of oral expression: forming a clear and structured discourse that is adapted to the communicative context, paying attention to the reactions of the audience, properly using nonverbal language, and ensuring that the message reached the audience without interference and in a fluent and understandable way.

The general methodology followed in this course was the same than previously but introducing the modifications above mentioned. These modifications lead to change the general development of the subject in a more participative course, with more discussions and interactions between the students and teachers and also promoting the reflexion of the students about his own learning. This makes that some of the time that students normally spend in the realization of the determinations was used in the different discussions and explanations as well as in the preparation of the different activities.

2.2 Instruments for the collection and evaluation of the results

The instruments, techniques, and methods of evaluation used to assess the achievement of the objectives and students' learning results were as follows.

2.2.1 Forms

Two forms (Tables 1 and 2) were used to evaluate objectives 1 (motivation) and 4 (communicative skills). In Form 1, through open questions, comments, and closed questions with rating scales, students were asked which practices they liked more or less and the reasons for their ratings of those practices. Form 2 implemented the peer assessment, in which students were asked to evaluate different formal and content aspects of their classmates' oral communications.

Evaluation form for the determinations ***Course: Basic Analytical Chemistry Laboratory***	
Nº: 00001	***Page 1/2***

List the 3 determinations that you liked the most:
1:
2:
3:

Why?

What factors influenced your answers:			
Type of sample:	*Greatly*	*Moderately*	*Little*
Objective of the analysis:	*Greatly*	*Moderately*	*Little*
Difficulty:	*Greatly*	*Moderately*	*Little*

The samples related to the determinations mentioned in the first question belonged to:			
Determination 1	*You*	*Laboratory*	*Others*
Determination 2	*You*	*Laboratory*	*Others*
Determination 3	*You*	*Laboratory*	*Others*

In average, the level of your learning in these three determinations was:		
High	*Medium*	*Low*
In average, your effort in performing these three determinations was:		
High	*Medium*	*Low*

Comments:

Evaluation form for the determinations ***Course: Basic Analytical Chemistry Laboratory***	
Nº: 00001	***Page 2/2***

List the 3 determinations that you liked the least:
1:
2:
3:

Why?

What factors influenced your answers:			
Type of sample:	*Greatly*	*Moderately*	*Little*
Objective of the analysis:	*Greatly*	*Moderately*	*Little*
Difficulty:	*Greatly*	*Moderately*	*Little*

The samples related to the determinations mentioned in the first question belonged to:			
Determination 1	*You*	*Laboratory*	*Others*
Determination 2	*You*	*Laboratory*	*Others*
Determination 3	*You*	*Laboratory*	*Others*

In average, the level of your learning in these three determinations was:		
High	*Medium*	*Low*

In average, your effort in performing these three determinations was:		
High	*Medium*	*Low*

Comments:

Table 1.Form 1 used to evaluate objective 1

ORAL PRESENTATION EVALUATION						
Name:						
Formal aspects:	***Yes***					***No***
The presentation was clear: *(voice tone, diction, speed, visual slides)*	*6*	*5*	*4*	*3*	*2*	*1*
The presentation was well organised: *(structure, contents, including all sections)*	*6*	*5*	*4*	*3*	*2*	*1*
The presentation was adjusted to the time allowed: *(total time, adequate time for the different sections)*	*6*	*5*	*4*	*3*	*2*	*1*
Contents:	***Yes***					***No***
Provided all of the necessary information:	*6*	*5*	*4*	*3*	*2*	*1*
Knew the content well:	*6*	*5*	*4*	*3*	*2*	*1*
Evaluated the obtained results:	*6*	*5*	*4*	*3*	*2*	*1*
Answered questions correctly:	*6*	*5*	*4*	*3*	*2*	*1*
Comments:						

Table 2. Form 2 used to implement the peer assessment

2.2.2 The teacher's direct observations

This procedure was applied to evaluate objectives 3 and 4. The teacher's direct observation of the group work (objective 3) took into account the commitment with the common objectives, the organisation and planning of the work, the distribution of roles, the method of decision making, and the general operation of the group. Oral presentations provided evidence with which the students' communicative skills could be evaluated (objective 4). Clear exposition, the precision of vocabulary, the use of proper registration, argumentative ability, the dynamics of the discussions, and willingness to value and accept the opinions of colleagues and the obtained consensus were all evaluated.

2.2.3 Portfolios or learning folders

Portfolios were conceived as learning tools to understand and monitor development as well as collection of evidences on effort, it can be defined as a collection of materials or evidences selected to show, reflect and evaluate a learning process during a period of time (Cano, 2005). One of the classifications of portfolios takes into account two different dimensions, if are assessment or formative and if are mandated by external requirements or self-directed for personal use, leading to four types of portfolios: the dossier(used to evaluate a subjects or competences degree by the university),the training (used to promote the reflection in the students about his own learning), the reflective (used as a personal initiative to show or demonstrate the skills acquired) and the personal development portfolio(used for personal evaluation and reflection of the professional growth in long-term process) (Smith & Tillema, 2003). For this study, the training portfolio was selected in a showcase modality. This selection was performed because the main purpose of this innovation is promote the self-regulation and learning autonomy. Also, using only one selected proof, it is necessary that students perform this selection in a reflective way, producing only one page portfolio that permits focus students' time in the selection, and reflection not in writing long materials.

Learning portfolios were used to evaluate objective 2 (self-regulation and learning autonomy). In their learning portfolios, the students were required to select a single determination as the most significant evidence of their learning. They were required to describe that evidence, explain the reasons it was relevant, and reflect on potential changes that they could make in that determination if they were required to repeat it.

3 RESULTS AND DISCUSSION

The results obtained in the different activities, grouped according to the specific objectives, are shown below.

3.1 Objective 1

To study the increase in student motivation, the results obtained through the questions on Form 1 were analysed.

Figure 1 shows the results of the analysis of the first question on Form 1 (Table 1). Specifically, Figure 1 shows the number of times that each determination was selected as one that was liked more or less. The determinations were classified into two categories depending on whether their real-life applications were explained during their introductions (left) or not (right).

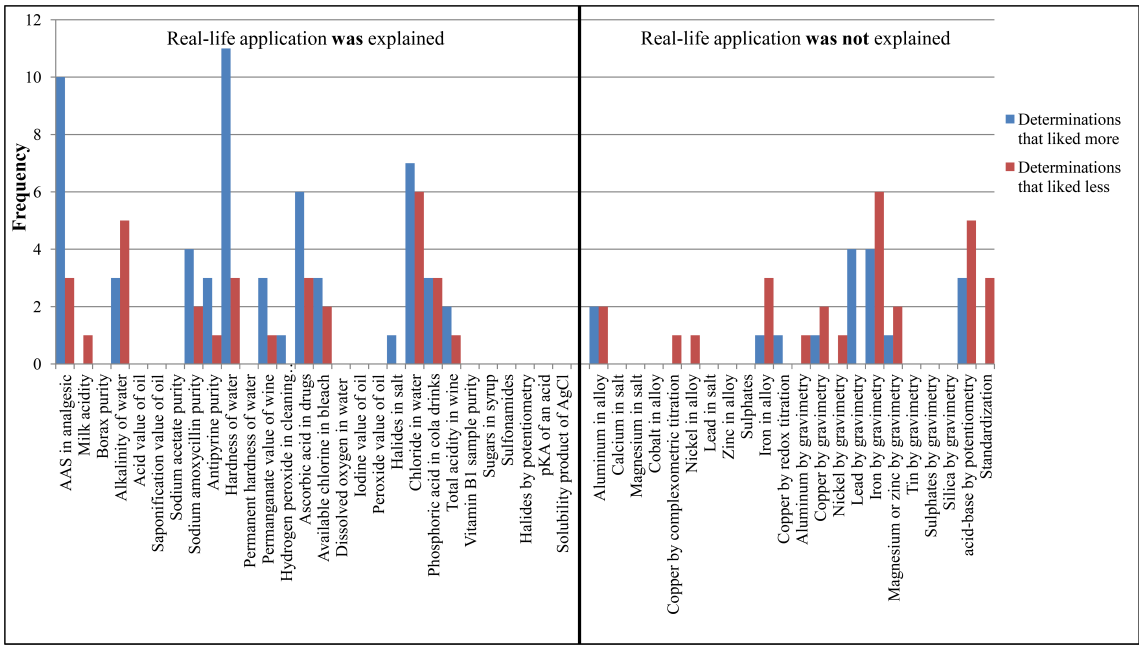

Figure 1. Answer frequency of the determinations that students liked more or less when their real-life applications were explained (left) or not explained (right)

The results have important variability, but the determinations for which real-life applications were explained had more positive answers (determinations that students liked more) 65%, whereas the determinations for which real-life applications were not explained showed a larger number of answers corresponding to less-liked determinations 61%.

Following the analysis of Form 1, the second question asked students, in an open-ended manner, to specify the reasons why they had stated that they liked certain practices more or less. All of the comments can be grouped according to the following factors.

- Determinations that students like more have the following qualities:
  - Permit students to apply and consolidate theoretical knowledge obtained in other courses
  - Use samples closer to students' contexts and experiences
  - Provide knowledge with real-life applications
  - Are interesting and complex in both their execution and calculations
- The determinations that students like less have the following qualities:
  - Confront students with unsolvable problems
  - Are long
  - Have specific practical issues related to difficulties in observing the endpoints of some volumetric determinations.

To summarise, the reasons that explain why a determination is liked more by students are related to the use of common samples and an understanding of the relationship between the determination and real life. The arguments provided to justify why a particular determination is liked less by students are related to difficulties with performance.

Figure 2 shows the results obtained for the remaining questions on Form 1. In these last questions, different factors were proposed: the type of sample, the objective of the determination (application to real life), and difficulties encountered in the determination's practical development. Students were asked to evaluate, on a three-level scale, the influence of these factors on whether they liked the determinations selected in the first question more or less. An additional question about the origin of the samples (to reveal which samples were provided by the students) was included. In the last two questions, students were asked about the learning and level of effort required to perform these determinations.

In the determinations that were liked more by students, the type of sample is the factor that has the greatest influence, the objective is secondary, and the difficulty has no influence. In the determinations that are less liked by students, the distribution is more centred, with a slight emphasis on difficulty (the differences between populations were established by Mann-Whitney U tests at 95% confidence level). These results are in accordance with the previous results observed in the free comments question.

In both cases, for the determinations that are more and less liked, the resulting learning is high and the effort is medium. This result is found even for those determinations that, according to the students, present higher difficulty.

Additionally, it was observed that in most of the cases involving student-provided samples, those samples are the high-influence factor.

From these results, it is possible to conclude that the proximity of the sample, especially if it is a student-provided sample, has the highest influence on motivation. The explanation of a determination's real-life application also has an influence, but at a lower level. Finally, difficulty hinders motivation, but it is less important.

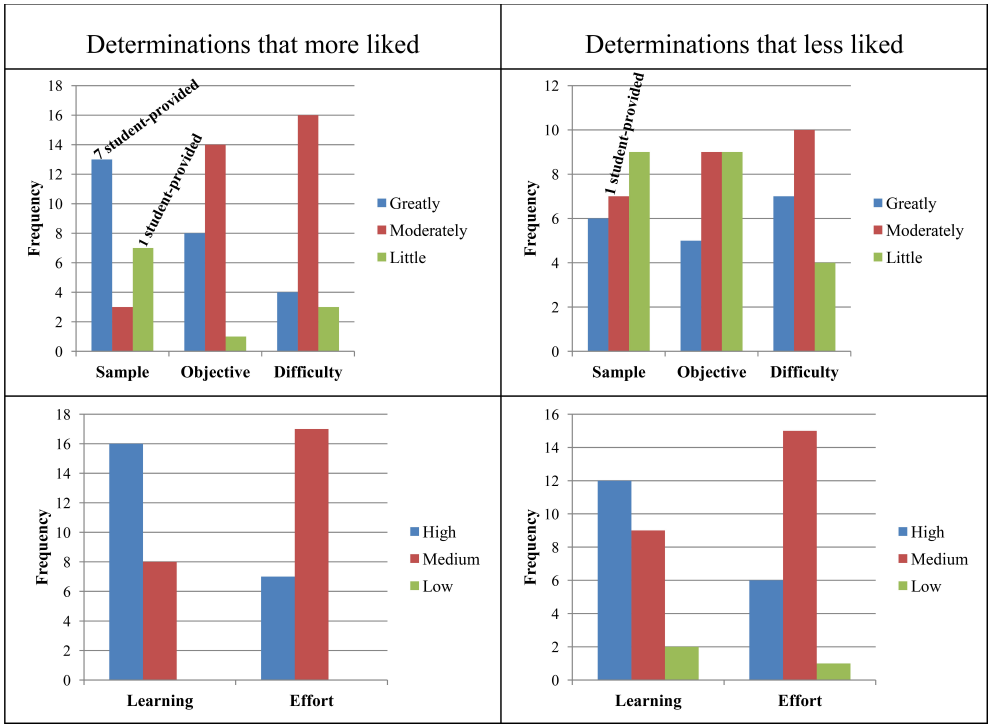

Figure 2. Answer frequency of the factors that influenced the assessment of determinations along with the degree of learning and effort invested

3.2 Objective 2

Observations of students' self-regulation and autonomy were performed using their portfolios or learning folders.

It is important to note that the students experienced considerable difficulty in preparing this material because it was the first time that they had performed exercises related to the selection of evidence and self-reflection. Furthermore, the fact that the course was developed in a very short period of time hampered the assimilation of the portfolio concept, thus increasing the difficulty of implementing this concept.

The portfolios were written free-style, and students selected the structure and format. Consequently, the analysis shows that different students' personalities are clearly manifested in their portfolios, corroborating some of the laboratory observations. For example, some portfolios were written formally, whereas others were written informally. Portfolios were written in either the first or third person.

The selection of determinations as evidence of learning was very diverse. Some students chose to demonstrate that they could perform valid analyses, selecting determinations in which they did not make any mistakes and their results were correct. Other students selected determinations that included mistakes to allow the opportunity to reflect on the sources of their errors and to propose potential solutions to implement if they were to repeat the determination in the future.

In all of the cases, it was possible to observe the satisfactory accomplishment of the objective of self-reflection in students' learning using the portfolio as a learning tool.

Finally, it is interesting to note the character of the portfolio as a reliable method for summative evaluation. Table 3 presents the students' grades, divided according to the three sub-groups of the course. It can be observed that the marks assigned to the portfolio (which were evaluated by the same teacher for all groups) and the global marks assigned for the laboratory (evaluated by the different teachers of the sub-groups without knowledge of the portfolio marks) statistically have no differences at a 95% confidence level (Wilcoxon signed rank test). Therefore, it can be concluded that is possible to conduct a reliable and adjusted evaluation of the skills developed in a laboratory course through the use of portfolios.

Group 1		***Group 2***		***Group 3***	
Portfolio	***Global Mark***	***Portfolio***	***Global Mark***	***Portfolio***	***Global Mark***
6	*8.5*	*7-8*	*7.5*	*6*	*6.5*
7-8	*7*	*5*	*6*	*6-7*	*5.5*
7	*7.5*	*8-9*	*8.5*	*7-8*	*8.5*
9.5	*9*	*6-7*	*7.5*	*6-7*	*8.5*
9	*9*	*6*	*7.5*	*7-8*	*9.5*
9	*9*	*7-8*	*8*	*8*	*7.5*
9-10	*8*	*6-7*	*7.5*	*7*	*6.5*
9-10	*9.5*	*7-8*	*8*	*7-8*	*7.5*
8-9	*7*				

Table 3. Portfolio and global marks of the course divided in the three sub-groups

3.3 Objective 3

The group work was evaluated by directly observing the teacher during the development of complex determinations that were performed in pairs.

In general, the development of these collaborative learning situations was very easy because each group contained only two persons and the composition of each group was chosen by the students themselves. In some cases, minor problems appeared due to a lack of knowledge about group dynamics. These problems were solved using solutions or guides that were provided by the teacher who conducted the direct observation.

The teacher's direct and continuous observation of the group throughout the working process allowed him to assess both the end product of the work (through the results obtained and the corresponding discussions) and the process of collaboration established between the group members. With regard to the collaboration process,

the following aspects were taken into account: task planning and management, the contributions of each group member to the final product, and the dynamics established between the students in developing the work.

The small-group discussions offered additional opportunities to develop competence in group work and facilitated the development of both linguistic and interpersonal communicative skills, as discussed in objective 4.

These groups, which contained a maximum of five students, provided a relaxed context for pooling problems, discussing these problems, and reaching consensual solutions. The teacher moderated the discussions in an informal way and provided criteria or ideas that students could use. Discussion groups provided an ideal framework to promote reflection and facilitate students' comprehension of the fact that it is easier to solve problems in a collegial way and that problems can be solved in different ways, all of which may be correct.

It is especially interesting to note that the idea that a problem can have different, correct solutions was difficult for the students to accept. This idea was easier to understand after peer discussions comparing the different individual solutions adopted by different students.

As a result, it is possible to affirm that these two learning activities—experiments performed with peers and small-group discussions—facilitate the acquisition of specific knowledge of the course and familiarise students with the dynamics of group work. The advantages derived from collaboration allowed the students to be more effective and to achieve higher-quality results. Moreover, direct observation by the teacher was very helpful to guide and regulate the manner in which students learned these dynamics. It is noteworthy that continuous and close contact over many days in the laboratory facilitated the integration of the teacher as an element of the course's routine dynamic.

3.4 Objective 4

The course's contribution to the students' communicative skills was primarily accomplished through two actions: small-group discussions and oral presentations.

In the small-group discussions, which were briefly explained in the previous section, the students felt free to discuss their ideas, results, and solutions. Intervention in these discussions required students to structure their speech and speak with clarity and precision. This exercise also helped students learn how to interact positively with their classmates and with the teacher through dialogue and to express their opinions assertively, defending their views and listening to others while considering and valuing all contributions.

The oral presentation performance required students to employ their communicative skills and to adapt them to a more formal context. These presentations, which were previously prepared using the teacher guide and students' own group work, allowed to consider different learning styles that had previously emerged in the oral discussions.

During the presentations, all students had a peer review Form 2 (Table 2), which had a formative but not a summative evaluation character. This form was used to evaluate different formal and content-related aspects of the presentations of the students' classmates. This exercise required the student to reflect on his own presentation and therefore on his own learning. These objectives were transmitted to the students. It was also explained that the purpose of the form was to improve the students' own communicative skills but that it would have no impact on the final marks. This allowed the students to have more freedom and to be more honest when completing the forms. The performance of these peer evaluations required students to focus during their classmates' presentations, which encouraged their reflections on their own presentations.

The analysis of the comments contained in the evaluation forms showed that the students offered genuine and constructive criticism of their classmates' skills, with useful ideas for improvement in clear and respectful language. These results demonstrate the high utility of this tool as a method for improving students' communicative skills and for prompting students' reflection on their own learning process.

4 CONCLUSIONS

From the analysis of the results obtained, the following conclusions can be made:

- The choice of the type of sample proposed to the students for determination has a direct influence on increasing students' motivation. Therefore, it is important to provide students with interesting samples that are related to their personal experiences and linked to their environments.
- The explanation of the meaning and utility of the proposed analysis in real life makes learning more meaningful and functional, which is also a source of motivation.
- A portfolio or learning folder is an excellent tool to promote reflection, which favours students' self-regulation and learning autonomy. This tool is also very useful to evaluate a degree's general skills and an experimental course's specific skills.
- The dynamics of a laboratory course, which involves a close and deep trust relationship between students and teachers, permits students to easily develop their group-work skills. In the same way, a laboratory course is a good context in which to work on communicative skills.
- Peer evaluations, as forms used during oral presentations, are a good tool to improve students' communication skills and to promote metacognitive reflection that will help students to become autonomous learners.

Finally, the project demonstrates that it is possible to train students in general skills through the substantive content of a course and that the incorporation of participatory methodologies in educational planning encourages students to become actively involved in the teaching-learning process and trains them in a way of thinking and acting that allows them to make knowledge their own.

The innovations implemented in this study were applied in other courses with satisfactory results. It is important to highlight that some students that participates in this study ask in advances course to repeat some of the experiences (as the peer review classmates' oral presentation) because they considered helpful tools to improve their skills.

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