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MARÍA DEL MAR LÓPEZ GUERRERO
Faculty of Science, University of Malaga, Spain

GEMA LÓPEZ GUERRERO
Faculty of Science, University of Malaga, Spain

MIGUEL HERNÁNDEZ LÓPEZ
Faculty of Science, University of Malaga, Spain

MARÍA TERESA SILES CORDERO
Faculty of Science, University of Malaga, Spain

JOSÉ GONZALEZ-RODRIGUEZ
University of Lincoln, United Kingdom

PBL BASED ON CHEMISTRY LABORATORIES AT ENGINEERING DEGREE

Abstract:

Until now, the didactics used in the teaching of experimental chemistry contradicts its objective by continuing with a traditional approach and with passive didactic methods for students. Even, in virtual environments, working in the laboratory practices is basically "following a recipe" where the student does not have the opportunity to ask, make decisions or apply to their daily life. In addition to this, it happens that the "recipes" of the laboratories, in general, are repeated frequently, sometimes semester after semester. The recipes have been tested, being known to give good results, and offer no major difficulties, but the recipes do not present uncertainty for the student.

On the other hand, we find the problem of the use of ICT in laboratories, which needs a change of focus. It also requires a change of environment, it is convenient to incorporate measurement processes, analyze data in real time and treat what is observed.

It should be remembered that Chemistry is an experimental science, therefore, laboratory works are essential and provide an enrichment for procedures and research that cannot be replaced by virtual laboratories.

For all these reasons, this work focuses on the usefulness of the laboratory as a space with a problem-solving approach, which is, contextualizing problems and fulfilling a series of purposes. According to Zambrano (2007), these purposes are: ability to internalize general and specific knowledge (to know), to acquire technical and procedural skills (to know how), to develop attitudes (to know how to be) and social skills (to know how to live together).

The intention of this article is to show that, including chemistry laboratories self-managed by the students themselves, generates one of the fundamental competences in our changing society, such as self-learning (learning to learn).

To conclude the change of focus in the laboratories allows the student to be empowered since students are responsible for his own learning, so that it contributes to their self-learning; teamwork involving assertive communication. Both oral and written communication, students learned to argue and support his ideas. Therefore, it was revealed that is a training for students and are achieving better student performance.

Keywords:

PBL, Chemistry, Laboratory practices, Engineering Degree

JEL Classification: I23, I21, I29

1 The work context

The course is based on a hybrid active methodology, based mainly on Problem-Based Learning (PBL). On the first day of classes work groups are formed, with three members or with two. These work teams remain together throughout the semester (classroom activities, laboratories and PBL-type problems).

The teaching programming of the subject is done to cover the course content, but also, the objective is to help students acquire skills. It seeks to provide tools so that they can interact and make decisions in possible real situations in their professional lives, being assertive, oral and written communication, the development of teamwork, the ability to learn on their own, as well as positive attitudes towards work, study and life.

Global projects (PBL-type problems) are worked outside the classroom. In general, the problem / project covers the entire semester and refers to a conflict to be solved in an industrial plant. It closes with the integration of all aspects through some final activity, be it a debate, public presentation, etc.

The laboratories followed the following scheme: maintain the same classroom groups (of three or two members), take great care that the experiences offered to the student maintain a green focus, efforts were made not to use toxic substances and, whenever possible, that those employed, were not found within the audited ones, as well as avoiding generating waste. The students carried out a previous investigation, with guiding questions, about some of the concepts and applications of what they would see in the laboratory, in order to prepare them. Once in the laboratory, they were given a guide, which they had to fill out, with the data obtained during the experience. In the guide, they found the procedure to follow, it was tried to place the objective sought in the respective practice. In general, the students presented, a few days later, the report with the results and analysis of the experience.

When planning experimental sessions, factors such as the students' previous experience, their interests and learning objectives should be taken into account, therefore, my support in a constructivist theory of learning, with contributions from Brunner's theory of discovery learning , Ausubel's cognitive structures and the interpersonal relationship of learning of Vygotsky (Lucci, 2011), where learning is a social and adaptive phenomenon and it is important to relate to others that co-aid our learning. It is worth mentioning that the career that these students follow is Engineering and therefore it cannot be forgotten that, specifically, it is applied knowledge.

In this context, based on own experience and on reported experiences, methodological innovations are constantly promoted in the classroom, projects and laboratories.

2 Methodology

The members of the group were selected from the first day of class. In our university, those who repeat the subject for the second or third time do not study in the laboratory again, this causes that, in a part of groups, there are two members for the laboratory work.

Each laboratory theme corresponded to the unit that had been working in the classroom, so the group's proposal was within the theme. Students could present their experimental research as a problem to solve, some phenomenon to study, the utility of some principle, etc.

• The dates, materials, reagents, available equipment, presentation dates, feedback opportunities, shifts and schedules were published on the course intranet, with due anticipation (at least two weeks before). Regarding the topics and the way they would approach the experimental sessions, the students were informed from the first day of classes, when it was explained to them that they would be responsible and executors of their experimental proposal.

Once in the laboratory, as they were several groups of students (maximum 4 groups per shift) who worked on different experiences and objectives, there were two teachers and the support of students from the last cycles. Once the proposals of the students were known, the assistants were trained to prepare them to guide the initiatives expressed by the students. That was the reason why it was so important to know the proposals in advance. In that context:

- The students requested the equipment and materials that they felt they needed, choosing within an offered relationship, although they also had the possibility to ask for something special that was not on the list, so that they had the time to acquire or replace it, if possible.
- Before carrying out the laboratory, they asked their research question, the objectives, the data they will require to achieve it and how they planned to treat that data. They developed their own protocol, with the steps for their practice and decided how they would carry it out. They received feedback regarding the question asked, clarity in the objectives raised in relation to your question, ways and forms in which they would proceed and about the proposed reagents, mainly due to the possibility of being able to select a reaction with toxic products or the use of controlled substances (controlled by the government), in order to guide them properly.
- In the same laboratory, they received their reagents, materials and permanent feedback for the duration of the experience.

A week later they presented a report that was evaluated by a rubric. The complete qualification of the laboratory included the task done previously, the work in the own laboratory and the report after the experience.

A couple of surveys were conducted at the end of the semester. In this survey at the end of the course, some questions were asked in order to inquire about the contribution of laboratory practices and mini-experiences.

The content of the survey / measurement instrument used from 2019/20 was validated by four specialists. The clarity of the questions, the coherence or logical relationship with what you want to measure and the relevance for the desired measurement were evaluated. As a result of this validation, two questions were reconsidered and one was eliminated, leaving a total of eleven questions closed.

The students gave their opinion, using a Likert scale, where 1 corresponds to completely disagree and 5 to completely agree. The information includes quantitative including closed.

These were students over 18 years old, since they belonged to the first year of the degree, the survey was anonymous and voluntary.

Table 1 shows the average of some of the factors, collected through the survey, before the implementation of self-directed laboratories.

In Table 2 can see the opinion regarding the contribution to self-learning of self-directed laboratories has varied.

Table 1. Relevant aspects according to student perception.

Ítem	%
Developing teamwork skills	62
Developing self-confidence	91
Develop professional ethics	41
Facing real problems	67
Develop ability to plan and organize	71
Develop ability to identify and process information	64
Develop oral and written communication skills	60
Developing self-regulatory skills	50

In Table 2, that prior to the experience, 29% totally agreed that it contributed to their self-learning, while 27% agreed that they did not affect their learning, 23% that it helped them understand better and 21% in that there is no coherence between theory and practice. This result left 52% of students, who judged that the laboratories favored their learning (aspects such as comprehension and self-learning) against 48% who thought that they did not help in this regard.

Table 2. Student perception after the implementation of self-directed laboratories

Item	Agreed	Disagreed	NS/NC
Contributed to their learning	59 %	41%	0%
Helped you understand better	88%	10%	2%
There is no coherence between theory and practice	14%	55%	31%

• The first proposals were laboratories that the students found online and tried to adapt. They had a hard time identifying what question to ask, what aspects of what was reported on the web could be relevant to their specific topic and make changes or propose, based on what was found, how to answer their question.

3 Conclusion

• The change of focus in the laboratories, allows the student to be empowered since they are responsible for his own learning, so that it contributes to his self-learning.
• Teamwork involves assertive communication. Both oral and written communication improved as they learned to argue and support their ideas. That is

The personalized advice and guidance served to monitor teamwork, since the majority of the group approached in their search. It was possible to identify who were those who became more involved and those who only "hung" on their peers.

• Some aspects, collected in the survey, after the implementation of self-directed laboratories and not shown in Table 1 were: that contributed to their ability to search and process information, their interest in research and their level of understanding of science. None of these aspects resulted with significant percentages. Apparently, the students think that they have enough skills in this regard.

4 References

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