

Active Methodologies in Chemistry [†]

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Abstract: Cooperative learning is not easy to develop when we encounter large classes of approximately 70 students. This handicap is increased when the subject is taught in the first year and the first semester. This is the case of the subject of Chemistry 1 of the Degree in Agricultural Engineering, the student comes to the University without having worked in a group, with little knowledge of the subject and attending classes at random. To diminish these negative effects, the informal cooperative learning methodology has been used both in the classroom and through the Blackboard Learn platform. At the same time the student has self-evaluations on the Blackboard Learn platform, which must be done before going to class and before going to the laboratory. Summarizing, in order to increase student participation and daily work, a series of methodologies that have been implemented throughout the academic courses are proposed: (1) in the classroom, participatory master class and informal cooperative learning, (2) in the laboratory, laboratory experiences, cooperative learning and (3) On the Blackboard platform, informal cooperative learning, self-evaluations and portfolios of laboratory experiences and self-evaluations of theoretical topics. The final purpose is flipped classroom, to work before, during and after the class.

Keywords: cooperative learning; self-evaluation; flipped classroom

1. Introduction

The proposed experience is part of the first course and first semester of the subject of Chemistry I of the Degree in Agricultural Engineering from Almería University. This subject consists of forty-five hours, twenty-six in the classroom and nineteen in the laboratory. Class hours are divided into thirteen two-hour sessions and laboratory hours in nine two-hour practices and an oral presentation. During seven academic years the subject has been evolving focusing on doing activities before, during and after class.

A major problem in the first year is the high percentage of students who have not taken the Chemistry course in Baccaulaureate and therefore it is the first time they enter a laboratory or enter a chemistry class. The student feels lost both in classroom and in the laboratory. The two hours of practice seem insufficient for students who have never developed the competence of manipulation in the laboratory because they do not know the material and its use.

Developing active methodologies is a great challenge when we meet with a large class of approximately 70 students, in their first year and in their first semester. Tables 1 and 2 show the methodologies carried out before, during and after classes and laboratory practices to encourage participation and daily work.

Table 1. Methodologies in class.

Before the Classroom: e-Learning Platform	In the Classroom	After the Classroom: e-Learning Platform
PowerPoint presentations, YouTube videos, audiovisual material and self-evaluations	Lectures of 20 min, resolution of exercises through informal cooperative learning	Resolution of exercises through informal cooperative learning

Table 2. Methodologies of laboratory experiences.

Before the Laboratory: e-Learning Platform	In the Laboratory	After the Laboratory: e-Learning Platform
Guide of the practices and self-evaluations	Laboratory practices and formal cooperative learning. At the end of the course, oral presentation	Portfolios of practice reports

The aim of this work is to approach the flipped classroom [1], where classes are used to practice the concepts learned before in the e-learning platform. The same applies to the laboratory practices that should be used to put into practice the theoretical concepts learned in class. Before going to classroom or to the laboratory, visual, audio-visual and self-evaluation material has been used.

Self-evaluation is the evaluation of one's own learning and the factors that influence it. The self-assessment presents a series of advantages:

- Provides students with a personal and professional development strategy,
- helps to develop critical capacity,
- favours autonomy,
- engages the student in the educational process,
- motivation for learning,
- increases responsibility towards learning,
- promotes honesty over judgements,
- provides information to the teacher about their learning.

Noguera-Murray et al. [2], carried out self-evaluations (using the e-learning platform Poliformal) before conducting the practice sessions, encouraging the preparation and interest of the student in its implementation. Carrying out the questions on a platform presents a series of advantages a priori:

- The students control their learning process,
- learning can be completed at the time and place you want,
- the correction and feedback task is facilitated and,
- the student is not passive when interacting with the computer.

At the same time, the use of audiovisual media encourages student learning in skills that can hardly be learned by a traditional method [3].

In the face-to-face classes, cooperative learning has been chosen and objectives pursued have been:

- Start the student in the cooperative learning.
- Motivate group work.
- Motivate class attendance.
- Encourage participation in the laboratory.

2. Class Methodologies

The subject of Chemistry I is made up of the following topics:

1. Atomic structure and periodic table.
2. Chemical bond and states of aggregation of substances.
3. Stoichiometry, Solutions and Colligative properties.
4. Energy of chemical reactions. Spontaneity.
5. Introduction to chemical equilibrium.
6. Principles of chemical kinetics.

2.1. Before the Classroom

Before going to classroom through the e-learning platform students have a PowerPoint of each topic and their corresponding self-evaluation. They also have more detailed information in the textbook. As support materials, there are also YouTube and audiovisual videos produced by the teachers. The Active Presenter and a Wacom Intuos Pen with a touch small table program were initially used to create the audio-visual material. Finally, the Camtasia Studio 8, has been used to give voice to the PowerPoint presentations. Students must see the material and do the self-evaluation before going to class. The self-evaluation consists of more than ten questions. Once the students master the self-evaluation they do the evaluation. The evaluation consists of answering five questions at random. The evaluation is done in non-contact hours. It lasts three minutes and the questions are handed out one at a time and they are not allowed to return to avoid plagiarism. The score of the self-evaluation corresponds to five percent of the overall score.

2.2. During the Classroom

In the classroom, the teacher again explained the PowerPoint for 20–30 min approximately to consolidate the knowledge and at the same time not let down the students who had not entered the e-learning platform before going to class. The following is the informal cooperative learning methodology based on the RIVeG method [4], which involves:

- Distribute an unfamiliar exercise to each student, a total of 6 different exercises are distributed.
- The students have 20 min to solve it individually, they can talk with the classmates they have by their side.
- For their answer they cannot ask the teacher, only clarify related to the statement of the problem.
- The teacher groups the students into four who have the same exercise. If possible, the groups must be formed by students who have not previously spoken. Two groups usually have the same exercise. There is a maximum number of twelve groups.
- For 30 min each group has to reach an agreement to resolve the same exercise
- In the last 45 min of class, the board is divided into three parts, to do three of the six exercises. Spokesperson from each group does the exercise on the board for the rest of the classmates. The spokesperson is chosen at random by the teacher. The spokesperson must solve the exercise and explain it. The score obtained by the spokesperson will be the score obtained by the group. At the same time, from the other group that has the same exercise, the teacher chooses at random another student who comes to the board and has the role of teacher. The student with the role of teacher must check if the exercise is well resolved and asks some questions to the spokesperson who has resolved the exercise before. The role of teacher is also evaluated and the score will also be the mark of the group. In summary on the blackboard we found three spokespersons solving exercises and three students with the role of teacher, it is a peer-to-peer presentation/teacher. As there are six exercises, the students chosen at random are 12, one student from each group. This activity is done in all master classes and lasts two hours. The note of this activity represents ten percent of the overall score.

2.3. After the Classroom

The subject consists of six topics, each topic has a list of problems. Informal cooperative learning is done through the e-learning platform which consists of the following:

- The teacher distributes the exercises of the first three problem relationships among all the students in the class. Each student has to do an exercise.
- The student has a week to do it and delivers it to the e-learning platform.
- The teacher creates three blogs, one for each topic, where the solved exercises will be presented. If the exercise is well resolved, the student is allowed to upload their exercise to the blog and see the solved exercises from the other blogs or topics. If the student does not do the exercise, they will not have access to the blogs or the solved problems of the first three topics. In addition, he no longer has the option to do an exercise of the last three topics. If the student does not do the exercise well, he always has the option to receive one or several feedbacks until the resolution is correct and he can upload it to the blog.
- The exercises of the last three problem relationships are shared among all the students who have access to the blogs. One per student.
- The student has a week to do it and delivers it on the platform.
- The teacher creates the blogs of the last three topics. If the student has solved the exercise well, he will have the option to upload it to the blog, which will allow him to see all the exercises solved. If you do not have it right, you will not have an option until you solve it satisfactorily. This activity corresponds to five percent of the global mark.

3. Methodologies Followed in the Laboratory

Laboratory practices allow us to remember theoretical concepts and apply them, learn skills, safety standards and know equipment and laboratory equipment. By performing the laboratory practices, the competence of preparing laboratory reports and oral communication is evaluated through the following activities, laboratory reports and an oral test. For both competences, the rubric is used as the evaluation instrument.

There are nine practices weekly, two hours each, plus the oral test at the end of the course. The practices, which are carried out, are totally related to the syllabus of the subject, being the following:

1. Law of multiple proportions. Law of conservation of mass.
2. Separation of the components of a mixture.
3. Preparation of solutions.
4. Limiting reactant and theoretical yield.
5. Chemical bond and properties of substances.
6. Reaction enthalpy. Hess's Law.
7. Rate of reaction.
8. Chemical equilibrium. Principle of Le Châtelier.
9. Strong and weak electrolytes. Conductivity.

3.1. Before the Laboratory

In the e-learning platform, students have, one week in advance, the guide of the practice that is formed by the following sections: introduction, materials, methodology, calculations, results and questions. In addition there is also the self-evaluations formed by photographs where the students have to order the steps of the practice and they have to recognize the material of the laboratory that is going to be used. The self-evaluation consists of more than 10 questions. The self-evaluation allows the student to think carefully about what he knows, what he does not know and what he needs to know in order to carry out the practice. Once the student has mastered the self-evaluation, he does the evaluation. The evaluation consists of answering five questions at random. The evaluation is done in non-contact hours. It lasts three minutes and the questions are handed out one at a time and they are not allowed to return to avoid plagiarism.

The photographic material used in the self-evaluation has been selected from the photos found in the students' practice reports [5].

3.2. During the Laboratory

During the realization of the practice cooperative learning is carried out. The students receive a rubric in which they indicate what each component of the group has to do both in the laboratory and in the writing of the report. The practice groups usually consist of three people. The roles are generally:

- Responsible for the preparation of the practice guide.
- Responsible for the preparation of the practice material and solutions.
- Responsible for executing the practice.

3.3. After the Laboratory

The students make the practice report following the rubric. They have a week to do it. Generally the report is delivered on the same day as the second practice. The teacher creates a blog-portfolio for each group. The report of the practice is uploaded to the blog and to Sphorus an anti plagiarism platform by the student. The practice report is corrected before the third practice is performed and so on. The students receive feedback of the practice which allows them to improve the practice report during the course. The blog created for the laboratory reports turns into a portfolio in which all the practice guides and all the comments and annotations made by the teacher plus the score received are found.

The rubric evaluates both the practice report and the work performed in the laboratory. The value of the rubric is ten percent of the overall score.

At the end of the course each group makes an oral presentation of one of the nine practices of the laboratory. The oral presentation lasts between 5–10 min. The three members of the group must prepare it but only one presents it. The student chosen to present the practice is decided by the teacher at the time of the presentation to encourage positive interdependence. The value of the oral presentation is five percent of the global mark.

4. Results and Discussion

On a voluntary basis, fifty percent of the students have completed a satisfaction survey on the self-evaluations and evaluations carried out. 57% had no problems working with the e-learning platform, the rest had problems to connect. This is the biggest handicap we have encountered. 71% find it useful to do the self-evaluations. Regarding the time set for the evaluation 3 min, only 36% considered it appropriate, the rest would increase it. It should be emphasized that the evaluation is done with five random questions from the self-assessment which is always available. The evaluation is done to ensure that the student has worked before going to class or to the laboratory. Increasing this time would be ineffective, since it would encourage plagiarism, because students perform this evaluation in non-contact hours and could have the answers of the self-assessment without having to make a preliminary study of approach to class or the laboratory.

Surveys have been carried out in the quicks format, which consists in responding quickly and briefly to a question where they should indicate the most positive and most negative aspects of their experience. The quicks have been used to ask them about cooperative learning in class. Table 3 shows the results obtained. The students consider classroom classes useful, although they believe that the teacher should explain more but at the same time they also want to have more time to do the exercises. This implies that we must continue working with the material that is given to the student before going to class to optimize the work done at home, the best we can.

Tabla 3. Quick about cooperative learning in the classroom.

Positive
1. Promote the relationship between colleagues
2. Take the subject to day
3. Put in common the knowledge that each one has, helping to better understand the topic

Negative

1. Little time
 2. Failure to explain more in class
 3. Go to the blackboard
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During the seven academic years that this experience has been carried out, a graphic of enrolled students's percentage pass rate is shown (Figure 1). First of all what has been pursued is to encourage participation and avoid as far as possible the student's abandonment. Around eighty percent of the students have attended class and have carried out the activities programmed by the teacher. Only the activity carried out after class has been carried out by 40% of students. Overall, between 30 and 40 percent of students passed the subject. This value is high if it is considered that many students do not have knowledge of chemistry. Overall, of the 80% of students who attended the final examination, a 52% pass rate was achieved. In order to increase this percentage it would be necessary to put more emphasis on basic concepts or that the students can attend a leveling course.

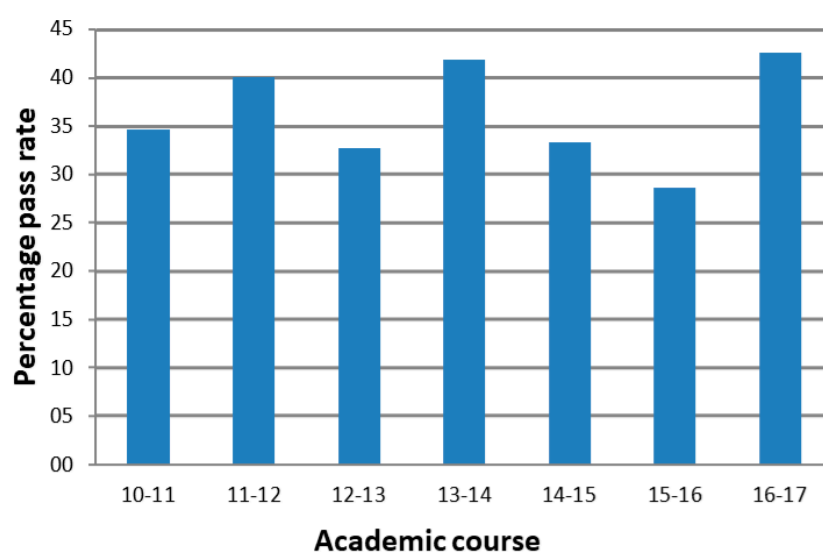


Figure 1. Percentage pass rate of students attending the exam.

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