Teaching-learning methodologies: use of blended learning in chemistry laboratory

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1. INTRODUCTION

With the aim to ensure comparability in the standards and quality of higher education qualifications in Europe, the European Higher Education Area (EHEA) was created (Romanian Bologna Secretariat, 2010). With its implementation, a new concept of teaching has to be considered: the interactive learning, in which the student must take an active part.

From this point of view, it seems more than appropriate the use of a learning system that combines Internet and digital media with established classroom forms that require the physical co-presence of teacher and students, i.e. the blended learning. A proposal of implementation of virtual technological tools in non-presentential activities (video-tutorials and virtual laboratories) with the aim of building a blended learning pedagogical framework for the subject “Chemistry” (which belong to the first year of Mathematics Degree) is showed below.

2. DEVELOPMENT OF THE PROPOSAL

Table 1 summarizes the learning times dedicated to every teaching activity and the methodology used for the subject Chemistry.

Table 1. Learning times devoted to every teaching activity and methodology used.

<table>
<thead>
<tr>
<th>Teaching activity</th>
<th>Methodology</th>
<th>FPI</th>
<th>SLT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interactive lectures</td>
<td>Learners supported by the use of blackboard, power point presentations, videos and connections to suitable web links</td>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td>Problems resolution</td>
<td>Resolution of chemistry problems, using the suitable informatics supports</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Virtual laboratory</td>
<td>Experimental approach to chemistry, showing the reactivity of the chemical elements and compounds, as well as the basis of a chemistry laboratory</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Seminars</td>
<td>Preparation and exposition of a monographic work and its power point presentation</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Total time (hours)</td>
<td></td>
<td>60</td>
<td>90</td>
</tr>
</tbody>
</table>

According to this methodology, and with the aim to improve the student comprehension of the subject, blended learning has been introduced. Overall, the advantages of this methodology are (Garrison & Takuwa, 2004; Alexander, 2010):

- Contribute to student satisfaction and success in courses.
- Improve access to as well as student attitudes towards learning.
- Improve communication between lecturers and students.

2.1. Laboratory video-tutorials

Until the past school year, laboratory training was undertaken with a combination of laboratory experiences videos, connections to suitable web links, and use of blackboard (face to face instruction). This methodology was chosen based on the following criteria:

- Time optimisation: considering the limited time dedicated to laboratory training (6 hours for each face-to-face instruction and self-learning time), the methodology followed allows the student facilitate a simultaneous independent and collaborative learning experiences to view and discuss many more experiments than they would if they had to carry them out in a laboratory.
- Prevention of potential danger in the laboratory: as first year students are not trained enough in laboratory skills, the use of videos and web links allow them to experience important but dangerous chemical reactions, as ammonium dichromate volcano (Fig. 1a) or obtaining of chromium through aluminothermic reactions (Fig. 1b).

The use of laboratory video tutorials that we propose in this paper would change the teaching methodology used until now:

- Instead of showing videos and web links to the students during the face-to-face time, they would be embedded in the web media used to interact virtually with the student (“campus virtual”, web environment created by the University of Alicante Data Processing Centre).
- Instead of explaining face-to-face the steps of the reaction showed, the student should watch the videos and, using all the information obtained through the interactive lectures and the bibliography, try to explain the reactions observed.
- Instead of having the right answer directly, during the face-to-face time their conclusions would be contrasted among them and with the teacher results.

The benefits of this change in the teaching methodology would be:

- Increase in the reinforcement of the concepts developed in class, through the increase in the student self-learning effort.
- Improve the ability of the student to correlate different concepts with the aim to find the solution to a practical question.
- Enhance the critical ability of the student, through his results contrast with those of his classmates.
- Allow the student to connect the different learning methodologies.

Fig. 1. (a) ammonium dichromate volcano reaction; (b) obtaining of chromium through aluminothermic reactions

2.2. Virtual laboratories

Among the large amount of tools for Virtual Laboratories available in the market (or freely on the web) we have selected the tool ‘Virtual General Chemistry Laboratory’ (VCL), corresponding to a Prentice Hall’s publication, edited by the Pearson Publishing company on its 3rd edition from 2009 with ISBN: 978-067-442-310-8 (Woodfield, Asplund & Haderlie, 2009) (Fig. 2a). This tool is highly versatile as far as its scope of application in a classroom is concerned. This publication provides a VCL installation CD and a paper guide for the execution of each practical session proposed. Fig. 2b and Fig. 2c are snapshots of general views of the inside of the laboratory to which VCL tool gives access.

We propose to explore the VCL tool in two aspects:

- It can be a complementary tool for the explanation of new chemistry concepts in the classroom (FPI). To that end, the VCL tool can be used for the execution of several experiences in class, which might be afterwards followed by a proper debate on the treated issue.
- The program can be distributed among a limited number of students, so they can assess from home its utility as reinforcement to the practical sessions of the different subjects and to the concepts seen in class.

In the following there is a compilation of expected outcome in the implementation of the VCL tool:

**Use in the classroom by the teacher**

- For the teacher
  - Advantages: i) possibility of adding laboratory experiences in the classroom; ii) perfect time control of the experiences, since there is no risk of experimental error
  - Disadvantages: i) the activities require extensive planning and a significant investment in time to prepare; ii) it creates a situation of dependence on computer tools

- For the students
  - Advantages: i) better understanding of the topics covered by relating them to experiences; ii) greater ease in relating phenomena and theories
  - Disadvantages: i) lack of interaction with the experience

**Use at home by the students**

- For the teacher
  - Advantages: i) it helps to avoid overlapping with the practical sessions of other subjects; ii) it reduces costs and assemblies, being a cheap and efficient alternative to an actual laboratory
  - Disadvantages: i) heavy dependence on computer tools

- For the students
  - Advantages: i) there is no risk involved in experimenting; ii) absolute time flexibility to perform the exercises; iii) it is a self-learning tool
  - Disadvantages: i) misjudgment of the laboratory circumstances

3. CONCLUSIONS

The implementation of virtual technological tools in non-presentential activities for the subject “Chemistry” will lead to a blended learning pedagogical framework with many benefits for the students.

On one hand, the use of laboratory video tutorials would:

- Reinforce the concepts developed in class, through the increase in the student self-learning effort.
- Improve the ability of the student to correlate different concepts with the aim to find the solution to a practical question.
- Enhance the critical ability of the student, through his results contrast with those of his classmates.
- Allow the student to connect the different learning methodologies.

On the other, virtual laboratories advantages in the classroom are also multiple:

- Provide a lot of visual information (hence, direct reception)
- Interactivity (it holds both the teacher’s and the students’ attention for the achievement of the different steps required for the accomplishment of an experience)
- Obtaining immediate results, exempts from the circumstantial problems which often arise in an actual laboratory.