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Blended-learning for courses in Pharmaceutical Analysis. Part 2

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Based on previous experience with the blended-learning for courses in Pharmaceutical Analysis we designed and implemented a new course institutionally organized in two semesters with the dual purpose of using blended learning as a tool to achieve the full integration of the two modules and to enable an efficient learning of the practical aspects of the course.

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1 The growing interest in e-learning shown by University of Torino

The news of the launch by the prestigious Massachusetts Institute of Technology (MIT) of an open source e-learning platform to reach out to people who cannot follow the traditional methods of education (<http://ocw.mit.edu/index.htm>, verified 09/10/12) and the subsequent similar initiative promoted by the University of Berkeley and Stanford have certainly raised a stir in European and Italian academies.

The effort that the University of Torino (UniTO) intends to do, to keep up with these great challenges has reflected in the performance plan 2011-2013 (a three-year planning document) that includes an increase in the use of e learning technologies as a UniTO's strategic objective. The commitment of UniTO to e-learning started in 2008-2009 when UniTO enabled the access to Moodle as a Learning Management System (LMS) and was reinforced in 2010-2011 with the provision of the software Live to Learning (L2L) for the production of multimedia material (Caramagna *et al.*, 2012).

2 Criticality analysis of previous experiences

Blended-learning is a term that characterizes a process of training and education enhanced through the use of technology. In general, the term blend (combine, mix) is used to describe a solution that combines face to face classroom methods with computer-mediated activities to form an integrated instructional approach. (Singh, 2003; Hoehn & Rietsch, 2007).

In a recent study we demonstrated that the application of blended learning is of fundamental importance for the courses of Pharmaceutical Analysis where it is essential to combine theory and practice in a single container (Caron *et al.*, 2011). The critical analysis of past experience highlighted two main limitations of our approach to blended learning. The first is a limited use of tools such as questionnaires and surveys which are self-assessment instrument. Moreover they can also be used to keep the teacher in contact with the students and maintain the interest alive by focusing where deemed suitable. The second main limitation is related to the preparation and use of multimedia material not specifically adapted to the students' needs (e.g. movies without voice annotation) and of poor quality. (Maran *et al.*, 2011).

3 Aims of the project

Based on the above discussion, in 2011-2012 we designed and completed a new project of blended-learning for the integrated course of Medicinal Analysis 2 (AM2) of the third year of the one cycle Master Degree in Pharmacy. This course is organized in two modules placed in two different semesters. Each

module includes 30 hours of lectures and 40 hours of practical sessions in the laboratory, these latter condensed into 4 days.

A clear definition of the integrated course is stated by the University of Siena (<http://www.farm.unisi.it/ctf/str-cor-ctf.php>, verified on 9/10/12): an integrated course consists of several modules, suitably combined to enhance the coordination of the content. In practice, the coordination of the content is rarely achieved and the individual modules of an integrated course are often independent one from the other. The obvious consequence of this situation is that the student is prepared to overcome the exam of a single module as if it were a course of its own and does not include the concepts in the broader context of the entire course. In the case of AM2, the division of the subjects in the two semesters is entirely artificial, since the matter (i.e. Pharmaceutical Analysis) is unique. In fact, Pharmaceutical Analysis as a whole includes the chemical and instrumental methods of identification of compounds of pharmaceutical interest, the main separation techniques (e.g. chromatography) and the different methods of sample preparation. Traditionally, the first module is mainly centered on methods of chemical identification of the drug while the second discusses the use of various instrumental techniques for separation and identification of the various chemical entities present within the medicinal sample. The first aim of this project was therefore to use blended-learning to accomplish a course which provides students with an actual knowledge, improved with respect to the sum of individual knowledge of the two modules.

Pharmaceutical Analysis includes theoretical and practical aspects. The practical experiences allow students to apply in the laboratory the chemical reactions that they studied. The laboratory practice is a fertile ground for developing experimental and reasoning skills. Moreover it allows them to develop critical thinking and to distinguish between evidence and interpretations. Based on these considerations, another important objective of the project was to optimize the learning of the practical aspects of the course making the most of multimedia resources and questionnaires. To do this, it has been necessary to prepare high quality multimedia material. Furthermore it was crucial to insert self-assessment questionnaires to allow students to check the level of their knowledge of theoretical concepts that were applied in practical experiences. The awareness of the level of their skill makes it possible for the student to execute more profitably the various experiences of different difficulty. In addition, the conscious and responsible practice is essential to minimize downtime between one exercise and the next. Last but not least, the act responsibly enables to conduct experiences in such a manner as to ensure the safety of students and to minimize the damage to the equipment and the structure.

4 Method

The team for the project consists of three professors, a laboratory technician and a trainee. Each team member plays a definite role but the final product is the result of a team approach. In particular, teachers provide the organization and management of Moodle, in addition to being responsible for the cultural aspect. The laboratory technician is able to show students the proper procedure for the experiences designed by the teachers and how to work safely. The trainee, a specialist in the use of L2L, guarantees the optimization of the production of multimedia materials.

As mentioned above, UniTO provides Moodle as Learning Management System (LMS). The ease of access and the undoubted evidence that Moodle represents a good compromise between performance and ease of use even for non-specialists, has made the choice of this platform for our applications of blended-learning almost obligatory. In addition, on the basis of previous experiences, a weekly format of Moodle is more effective than a topic format since it allows teachers and students to have a time-based overview of the whole course. A second tool of easy access for UniTO teachers is L2L platform that enables the production of multimedia material with a minimum of effort in terms of production, both time and cost (Caramagna, *op. cit.*).

5 Results

The results reported below relate to the experience that took place from 3 October 2011 to 31 May 2012.

5.1 Integration between modules

Pharmaceutical Analysis is built around the concept of the elucidation of drug structure that may occur through the use of chemical tests (discussed in the first semester of AM2) or through the application of instrumental methods (second semester of AM2). The integration between the two modules is considered achieved when the student understands that the two approaches (chemical and instrumental) are the two sides of the same coin. In other words, the two approaches give information about molecular properties (e.g. ionization, polarity, etc.) that in turn reflect molecular structure, unique and characteristic for each molecule.

Maintaining the same teaching methodology throughout the academic year has been identified as a prerequisite for ensuring the integration of the two modules and thus the usage of blended learning itself favors modules integration. From a technical point of view, it was decided to keep the same format for Moodle (colors, etc.) to induce the student to visually realize a link between

en the arguments developed in two semesters. From a management point of view, an identical questionnaire for the evaluation of each lesson (e.g. content clarity, topic difficulty, time required for learning), to be completed before the next lesson, has been developed in both semesters. In addition, the individual assessment was carried out in each module with weekly self-assessment questionnaires.

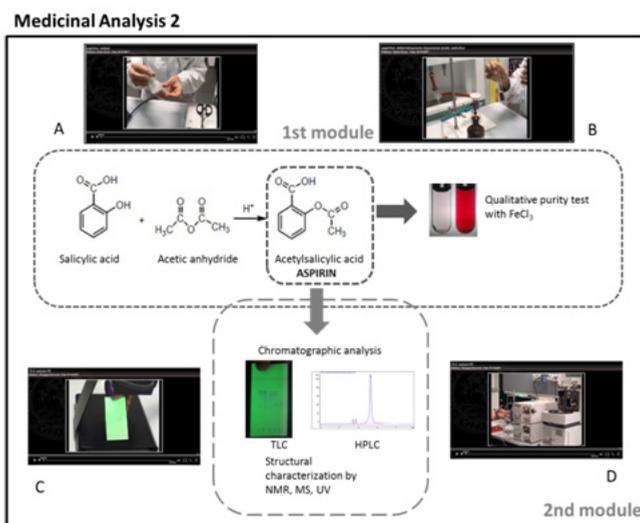


Fig. 1 - The aspirin experiment spread over the two modules of the course of Medicinal Analysis 2 (see text for explanation)

The laboratory experiments are designed to promote the integration of modules including the use of multimedia tools. In fact, instructions on how to use analytical tools common to both semesters were provided as a movie in the first module and reused in the second.

Furthermore, as far as possible the products prepared in the first module, were used for quantitative evaluations in the second. An example is described in Figure 1: in the first module, students synthesize (A) aspirin from its precursor (salicylic acid) and evaluated qualitatively by a colorimetric chemical test whether the reaction was successful or not (B). These two procedures are described with special clips and remain available to the students through Moodle. In such a way they can review them at any time to remember what they did. In the second module, the success or failure of the reaction carried out in the first semester is verified by two instrumental techniques (thin layer chromatography (TLC), liquid chromatography (HPLC), C and D respectively in Figure 1). At the end of the exercise, the students are requested to compare

and comment the results obtained in the two modules.

5.2 Optimizing multimedia

Movies and photos are displayed twice during the module. Firstly they are shown during theoretical lessons to create a link between theory and practice. Then they are shown immediately before the starting of the practical session in the lab since the main objective of the use of multimedia in Pharmaceutical Analysis is to train students on how to behave in the laboratory. Moreover movies show students how to work safely. The use of new technologies replace the traditional way of teaching the practical experience that is generally held in the overcrowded lab where most students are far from the materials and equipment to be used. The use of multimedia, therefore, has a strong educational value because it allows the student to focus either on a particular instrument or on a particular procedure. In addition, the use of multimedia allows students to work in the laboratory with greater autonomy and faster, and therefore the teacher can concentrate on more advanced aspects of the experiences.

YouTube and other websites that allow you to share and view videos also contain material about practical experiences in a chemical lab. However this online material is not controlled by experts and is therefore difficult to use in the framework of teaching activity. Students in fact, can view the correct and incorrect procedures but do not have the sufficient experience to distinguish from each other. In other words, for the courses of Pharmaceutical Analysis multimedia material should be designed by the teachers and prepared under their supervision. Specifically, in the course of AM2 movies show a) the correct use of simple tools (e.g. automatic pipettes), b) how scientific instruments work (e.g. the polarimeter), with, if needed, the parallel recording of what happens in associated software (e.g. UV spectrophotometer) c) some procedures that require the experience of the laboratory technician to achieve the expected results (e.g. Identification Reactions taken from European Pharmacopeia), results that are not always easily obtainable operating "by the book" but without experience.

L2L is designed to record lessons with largely static shots and frontal with the teacher speaking in the presence or absence of the public. It was therefore crucial to understand how to adapt this instrument to something completely different. The first important variable, for our purposes, is time: it is in fact experienced as 5 minutes is the maximum duration over which those who use the video would lose the necessary concentration to a careful vision. This involves a series of tests prior to the execution of the recovery (e.g. a given reaction could require freezing/heating for some minutes) that are necessary since L2L allowing immediate use of the resource does not allow to modify

movies in post production.

The second variable, which is essential when shooting in a totally different context from that of a classroom with a teacher, is what to shoot and especially in which mode. When a wide frame it is not needed, it was decided to resume positioning the camera inside the fume hood, focusing materials and procedures performed by the laboratory technician. The presence of this actor is extremely important since only hands are shown in the clips and thus it is necessary that those who are working make the steps with confidence and skill, without breaks or uncertainties (Fig. 1A-B).

Overall, for the course of AM2 we produced 50 movies for the total duration of about 3 hours. Eight of them were produced by the students themselves who, guided by the technician, become the protagonists of the experiences. Students are therefore self-correcting and their presence in the multimedia products induces a greater involvement of the learner community in practical tests. This result is of great importance and demonstrates with facts how in a university course you can put the student and not knowledge at the center of the educational system.

5.3 Analysis of the questionnaires

Multiple-choice questions were submitted to students. The teachers produced some automated items in order to create a database of questions ordered by topic and randomly distributed. The questionnaires were made in the diachronic method that allows students to answer questions in contexts (home, study centers) and time congenial to them. After collecting the responses teachers statistically analyzed data.

The questionnaires for the evaluation of the quality of the individual lessons have been formulated to understand if and how the different theoretical concepts to be applied during the exercises were understood by students and the main learning difficulties associated with them. Analysis of the responses showed a good level of understanding of the contents and allowed the real-time rescheduling of the next lesson. This commitment by the teachers was perceived by 85% of students (Fig. 2A). Curiously, as regards the number of hours deemed necessary for the domestic study very variable results were detected (e.g. for the same two hours ex-cathedra lesson, the range of hours of study ranged from 2 to 20). Beyond the explanations behind these emotional responses, there is certainly the feeling that the definition of college credit (CFU) is not absolutely acquired by the majority of the students in Pharmacy.

The self-assessment tests were proposed weekly. Their average duration was about 90 minutes and students rarely had connection problems (data not shown).

The questions proposed are divided into three categories: basic notions, simple applications (e.g. which is the solvent that should be used to completely solubilize aspirin?) and complex applications (i.e. with the use of interactive web sites, e.g. www.chemspider.com, verified 10/09/12).

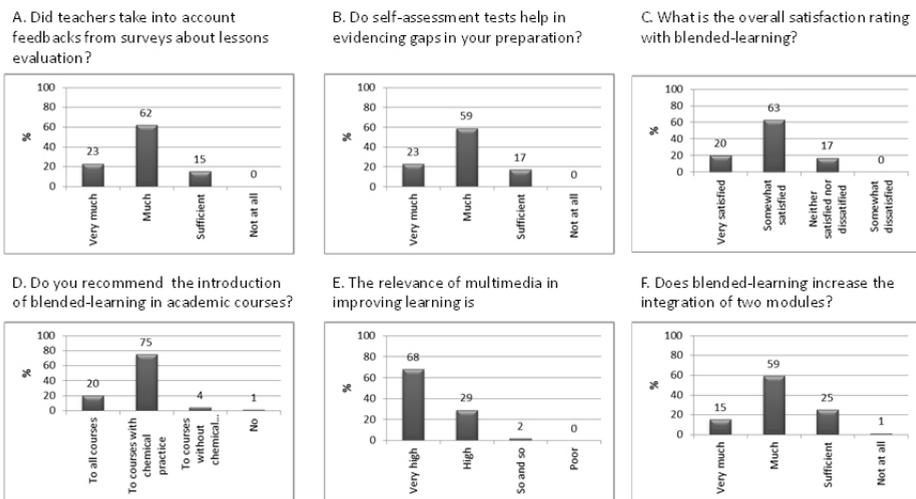


Fig. 2 - Main results of the final questionnaire

In the first module 171 questions were proposed and spread over seven tests (the first to assess the level achieved in preparatory courses, the other 6 to check comprehension of topics developed in the course). In the second module 96 questions have been proposed distributed over 8 tests. The results showed that about 70% of the students passed all the tests. Figure 2B shows that these questionnaires were very useful to highlight the gaps in their preparation for over 80% of students.

To get an overall feedback at the end of lectures and laboratory practice, students (90) responded to a final questionnaire on the course itself whose analysis allowed us to highlight the results achieved in relation to the two main objectives that we placed (integration between modules and optimization of the learning of the practical aspects of the course) and the direction to be taken to further improve our *modus operandi*.

Some results of the questionnaire are summarized in Figure 2C-2F. The blended-learning was generally appreciated (Fig. 2C) by the vast majority of students and its application to all courses with laboratory practice has been widely recommended (Fig. 2D). Multimedia products received a high approval rating and were considered essential for the performance of the various

experiences to almost 100% of the students (Fig. 2E). From the data obtained it is also obvious that the integration of the modules is facilitated by the use of blended-learning methods (Fig. 2F), although 25% of students is not particularly convinced of this.

Finally, the ease with which students have participated to this experience should also be assessed by knowing that most of them had already had a similar experience in the blended-learning approach with the same teachers during the course of Medicinal Analysis 1 (Caron *et al.*, *op. cit.*). Actually students were already educated in the use of multimedia and encouraged to the use of PCs, tablets and mobile phones to watch clips and slides. (Five & Martini, 2012).

Conclusion

This experience highlighted two critical points. The first is certainly represented by the production of self-assessment tests. These tests are essential since, besides representing a stimulus to discussion and dialogue among colleagues, also promote integration between the various modules of the same course. Based on experience we are moving towards formulating questionnaires more professional, a step which, considering our scientific background, requires the collaboration with professionals (Coimbra Group Office, 2012).

The second critical point is the production of multimedia material and its adaptation to special needs such as those required by chemical experiments. Results were satisfactory but improvements are also possible especially for increasing the independence of students in producing their own movies. It should also be noted that the multimedia material is a database of resources for modules other than those in which it was developed, but also for dissemination purposes (e.g. the counseling days addressed to future university students).

Compulsory attendance is required by law in all courses of Pharmacy and in principle it does not encourage students to actively participate to the lessons. On the other hand the application of blended-learning to Pharmaceutical Analysis has found very positive feedback from the participants. These considerations confirm the potential of this tool to increase student involvement in the development of the course. The first session of exams, although not very representative due to the predominant presence of the most diligent students, show a significant improvement in performance in line with the greater involvement of participants in lessons.

The authors' hope is that this work represents a stimulus for the diffusion of the blended-learning in the field of Pharmaceutical Analysis traditionally reluctant to embrace the changes resulting from the application of new technologies for teaching (this trend is surprisingly verified not only in Italy but also in English speaking countries). To proceed in this direction, the authors are

trying to find courses at different levels of education (e.g. third level courses, master, etc.) that are well suited to the blended-learning methodology in the effort of exporting to them the experience here described.

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