Blended-learning for courses in Pharmaceutical Analysis

Giulia Caron, Sonja Visentin, Giuseppe Ermondi

CASSMedChem Research Group, DSTF at the Centre for Innovation, University of Torino - giulia.caron@unito.it

Keywords: blended-learning, moodle, pharmaceutical analysis, university

The complex organization of courses in Pharmaceutical Analysis which also include practical lessons held in chemistry laboratories and the need to reduce the number of hours for each course due to the organization of degree courses in semesters, makes blended-learning techniques optimal tools to significantly improve the quality of teaching. This work describes the teaching experiences used to supplement the first modules of Medicinal Analysis I and Drug Analysis in the Master's degree courses in Pharmacy and Chemistry and Pharmaceutical Technology at the Faculty of Pharmacy, the University of Torino.

for citations:
Caron G., Visentin S., Ermondi G. (2011), *Blended-learning for courses in Pharmaceutical Analysis,* Journal of e-Learning and Knowledge Society, English Edition, v.7, n.2, 93-102. ISSN: 1826-6223, e-ISSN:1971-8829

1 Introduction

In compliance with current regulation (DM 509/99 & DM 270/04), in the past 5 years the Faculty of Pharmacy in Torino has opened two one-cycle Masters degrees: Pharmacy and Chemistry and Pharmaceutical Technology (CTF). In both 5-year degrees, courses are organized in semesters and offer hands-on experience in laboratories, which is an important part of the curriculum in the courses in Pharmaceutical Analysis (field of discipline CHIM08).

During the second year theory and practice are combined for the first time in the courses of Medicinal Analysis I (I module, Pharmacy) and Drug Analysis I (I module, CTF), so that in addition to attending lectures (4 CFU), students are expected to complete chemistry laboratories (2 CFU). In the following semesters this combination continues to be offered in order to guarantee graduates in Pharmacy and CTF a high quality professional profile.

2 Methodologies of blended-learning in courses in Medicinal Analysis I (I module, Pharmacy) and Drug Analisis I (I module, CTF)

The Kiro project from the University of Pavia represents the debut of integrated teaching in the Faculty of Pharmacy (Caldirola & Marini, 2008). Kiro was activated in the three-year degree course in Herbal Techniques and Scientific Information on Drugs with the objective of setting up an integrated system (thus blended-learning Singh, 2003; Gerber et al., 2008), in which classroom learning is combined with in-depth study, exercises, self-evaluation and online assessment. The pioneering work by colleagues in Pavia and the understanding of integrated teaching methods as an ideal model for all those subjects where learning is dependent upon and conditioned by experimentation (Boniolo & Spadaro, 2010), led us to weigh the pros and cons of introducing methods of blended-learning into courses which combine both theoretical and practical learning in Master's degree programmes offering highly professional qualifications like Pharmacy and Chemistry and Pharmaceutical Technologies.

Outside of computer sciences and engineering, the use of blended learning at the university in the fields of science is still considered extremely innovative and stimulating, but also problematic. In general, in fact, academic areas in science are scarcely inclined to experiment with new integrated teaching methods. Additionally, there exists a certain cultural distrust and basic confusion regarding social networks, material distributed online and integrated teaching methods.

Furthermore, the distinct nature of the subject involved (Pharmaceutical Analysis) makes it practically impossible to assess similar experiences in Italy and abroad; even in the English-speaking world, where innovative methodo-

logies are traditionally more advanced, the application of blended-learning in Pharmaceutical Analysis is still extremely limited. (Albon & Hubball, 2004).

Since the academic year 2008-2009 the teaching faculty at the University of Torino (UniTO) has had access to Moodle as a Learning Management System (LMS) to develop the teaching quality with online tools and resources. While noteworthy efforts have been undertaken by UniTO to offer personnel technical training (= like how to use Moodle), the creation of textual and multimedia material as well as its updating and backup of data are still today completely up to the teacher. Moreover, especially for teachers in the fields of science, training on ways to adapt language to a system of integrated teaching could be extremely useful. Writing for e-learning, in fact, means working with ways of writing generationally outside of traditional methods of communication and are somewhere between verbal and written communication, which does not use only linguistic codes but also various other codes (images, videos etc.) (Ancillotti & Baldassarri, 2003).

Access to a platform like Moodle and the need to improve the criticality which have emerged over time from our modules (listed in Table 1 and discussed in detail below) have led us to undertake an innovative experience of blended-learning in the programme of Pharmaceutical Analysis. Therefore, since the 2008/2009 academic year integrated teaching has been introduced on an experimental basis for the courses of Medicinal Analysis 1 (I module, Pharmacy) and Drug Analysis I (I module CTF) and has become a fundamental instrument for our teaching methodology.

TABLE 1
Proposed solutions with methods of blended-learning for course needs in Pharmaceutical Analysis

Criticality	Proposed solution by blended learning methodologies
Organizational needs	Overview of course and daily communications with students
Initial self-evaluation of acquired knowledge in preparatory courses	Quiz for self-evaluation
Identifying fundamental contents of the course	Audio material for basic knowledge
Optimizing training for safety in chemistry laboratories	Multimedia tools for correct working methods
Testing knowledge of safety norms before beginning work in the laboratory	Test with assessment
Assessment of results obtained in the laboratory	Results published online in real time and report submitted.

2.1 Organizational needs

The organization in semesters of the Master's degree courses combined with the numerous locations of classrooms for lessons and laboratories requires an extraordinary economy of time for the two courses discussed here.

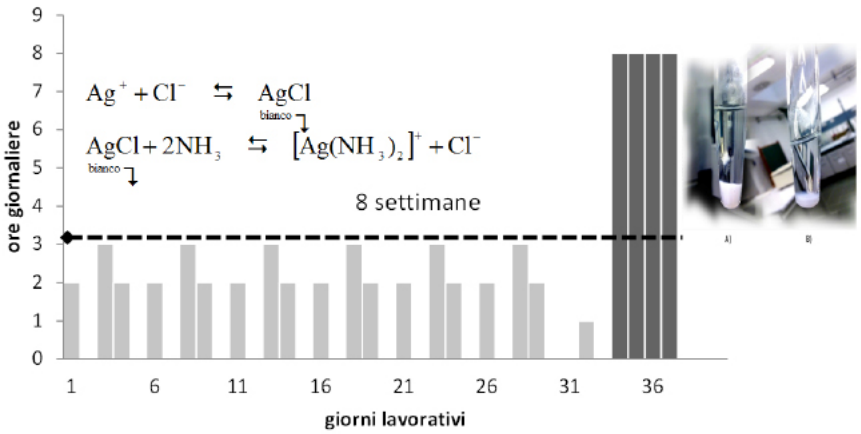

Fig. 1 - Representation of lesson schedule for courses discussed in the text.

In reality, for the academic year 2010-2011, courses started 4 October 2010 and the exam was scheduled for 3 December 2010, leaving two months to teach 6 credits of subject matter (Figure 1). This tight time frame makes it absolutely necessary to make students understand the need to work daily and to learn by doing. For this reason it becomes fundamental to furnish at the beginning of the semester an overview of all the work that will need to be completed during the course and all the materials needed (including questionnaires for self-testing, see below). Finally, the objective of stimulating the active collaboration of students enrolled in different years of studies can be reached with forums (not anonymous), generally very well accepted by users who perceive the net as their natural habitat.

2.2 Self-Assessment of acquired knowledge in preparatory courses

To enrol in the courses of Medicinal Analysis I (I module, Pharmacy) and Drug Analysis I (I module, CTF) it is necessary to pass the exams related to first year courses in General and Inorganic Chemistry and Analytical Chemistry. The topics of these courses play a fundamental role in courses in Pharmaceutical Analysis and must be completely clear to students before beginning to take classes. A self-assessment of this knowledge becomes essential to students

in order to understand personal gaps so they can be filled within the first two weeks of the course. To perform the self-assessment three quizzes (30 multiple choice questions in each) are used on the main topics of the compulsory preparatory courses.

2.3 Identifying fundamental course contents

The Faculty schedules lessons in our courses in 2 or 3 hour periods, generally during the early afternoon, and therefore, students' attention can be expected to fluctuate. In order to highlight fundamental topics presented during single lessons, audio-recordings of these topics (lasting no longer than 15 minutes each) are made and placed on Moodle almost immediately following the lesson.

Since attendance is compulsory, the intensity of the course makes the continuous participation in the classroom very demanding. From the information on Figure 1 it becomes clear that missing just one week because of flu means missing about 15% of all lessons. To help meet students' needs 10% of classroom teaching is supplied with audio files associated with relative slides.

Finally the Forum has been used to prepare the subsequent lessons, addressing any questions/doubts raised by students and correcting any errors on the slides.

2.4 Optimizing training for safety in chemistry laboratories

Laboratories allow students to perform the chemical reactions they have studied during lessons, mainly taken from the current edition of the European Pharmacopeia, a reference text for medicines.

In courses of Pharmaceutical Analysis, the allure of applied chemistry must be combined with the need to guarantee safety in an environment which can be dangerous. The regulations regarding the protection of health and safety in the workplace are extremely complex, placing students and workers on almost the same level (DLgs81/2008), and therefore they must be trained by the head of the laboratory (the teacher) and made accountable for the knowledge of at least three fundamental aspects: a) the current regulations, b) the workplace and the relative rules of conduct and c) the practical experiences to perform and the related dangers. (Figure 2).

Fig. 2 - The student must also be trained with multimedia instruments to guarantee safety in a dangerous environment like a chemistry laboratory.

In particular it is, therefore, necessary to focus students' attention on their workplace with multimedia tools such as photos and films which can show the entire structure, the technical furnishings, the instruments and substances that will be used for the experiments. Particular attention has been given to creating the films (produced in collaboration with technicians from the Quazza multimedia laboratory to create high quality multimedia materials, http://www.labquazza.unito.it/) in which the main operations to perform in the laboratory are carried out and discussed by the teachers themselves.

2.5 Testing knowledge of safety norms before beginning work in the laboratory

The objective of the lessons on safety is to provide students with the knowledge necessary to protect themselves, their colleagues and the workplace. Because of the importance of this topic, it is also the teacher's duty to make sure that students have acquired this knowledge before entering the laboratory. This test is carried out in the computer lab using an online test on Moodle and represents the first assessment teachers will use to decide whether students are qualified to enter the laboratory and the final mark of the course.

2.6 Assessment of results obtained in the laboratory

Time spent in the laboratory must be perceived by the student as a moment of professional training also because it represents an irreplaceable proving

ground for the three practical tests on the State Exam in Pharmacy. For this reason the results of the analyses they perform in the laboratory must be submitted on Moodle in the form of a quiz (ex. Which substance is contained in the test tube marked by the letters AAA?) and the assessment of these results will contribute to the final evaluation (II moment of assessment in the course). Knowing the outcome of the analyses performed in the laboratory immediately allows the teacher to assign students individual homework based on the description of one of the incorrect analyses to motivate students to look for the source of their own errors. The homework assignment (III moment of evaluation in the course) represents the first scientific report that students have to prepare for their Master's degree, making it a moment of great difficulty. The reciprocal support guaranteed by the Forum allows for a better approach to the topic dealt with and offers a technical solution to problems related to the use of software for writing chemical formulas and reactions.

3 Results obtained

The academic year 2010-2011 concludes the first three years of blended-learning in the first modules in the courses of Medicinal Analysis I and Drug Analysis I. In these three years we have continually increased the contents and their quality, and in fact, the average total activities for a single course (about 45 students) has gone from 28000 to 37000 in 2010-2011.

Analysis of the trend of successful exam results, in terms of how many students pass and the average mark, does not show considerable variations which can be associated with the change from traditional methodology to integrated teaching (the percentage of successful students rose from 68% to 70% in the first two exam sessions of the year, which have the largest number of students, while the average mark fell slightly from 25.0 to 24.7). It must be considered, however, that these data are not terribly revealing since they have been influenced by a number of substantial changes in the last two academic years, such as changes in the teaching organization, and therefore, credits (CFU) per course, preparatory courses and course programmes.

On the other hand, in the forum, face-to-face interviews and university questionnaires on the evaluation of teaching quality, students expressed significant satisfaction with this type of experience. For example in the last three years the quality of teaching material for the courses involved has been evaluated positively or very positively by almost 90% of the students.

Finally, it should be noted that in this analysis of the results obtained with the introduction of integrated teaching, an essential parameter is missing: the number of hours effectively used by the student to prepare the exam. This datum along with other indicators which make it possible to assess a student's

entire academic course of studies over the years will have to be monitored in the immediate future.

The analysis of activities in the courses of Pharmaceutical Analysis is illustrated in Figure 3.

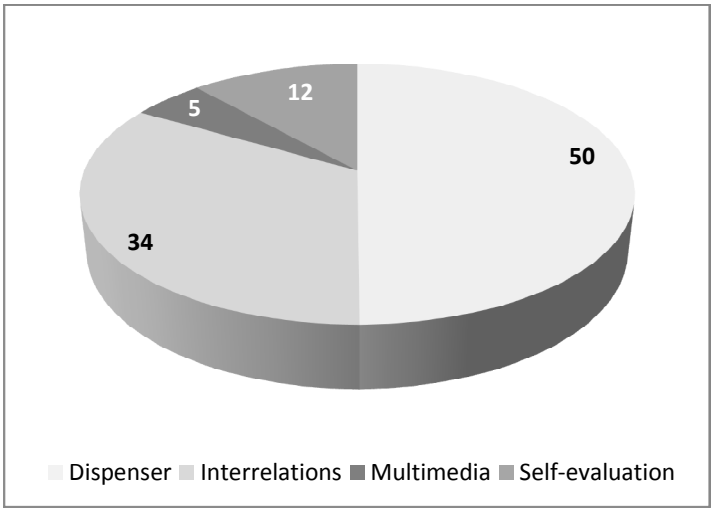

Fig. 3 - Distribution of an individual student's activities

The pie chart shows that students use Moodle mainly as a way to attain teaching materials (50% of the activity) and to interact with other students (34%). Multimedia material would seem to be underused (5%) but on the other hand, in the past academic year only 7% of the students have not passed the test on laboratory work. Finally, the self-assessment quizzes make up about 12% of the activity on the platform.

The days in which the greatest number of logins were recorded, as expected, were those a week before the exam (excluding the final days) but in the end, the login trend was quite constant while courses were in session.

Conclusions and future prospects

Integrated teaching in the courses of Medicinal Analysis I and Drug Analysis I has undoubtedly been of great practical-organizational use for teachers and highly appreciated by most of the students that, after an initial phase of disorientation related to the newness of the situation, recognised many of the opportunities offered by this tool and the consequences it had in terms of flexibility in the organization of their studies and in the management of their laboratory experiences.

Despite its proven success, large margins for improvement remain in the system described here.

Technically speaking, L2L (Live to learning) has just recently been presented by the University's Division of Web Services. L2L is an integrated service offered by CINECA (InterUniversity Computer Center) as one of its e-learning services, which makes an almost complete transformation possible of traditional classroom lessons into materials which can be distributed via e-leaning. (Fiumana *et al.*, 2010). This service should greatly facilitate the creation of films in chemistry laboratories and guarantee a complete integration with the rest of the material.

In the courses of Pharmaceutical Analysis, the next objective set involves the integration of materials provided by the teacher with those provided by students (notes for targeted topics and insertion of multimedia materials produced by students in the laboratory). In order to reach this goal students must assume more responsibility and take on more active roles in their own courses.

As for student participation, greater emphasis will have to be to placed on the evaluation of experimental data obtained in the laboratory. This evaluation will have to take place in small work groups and lead to a personal elaboration of the concept of experimental error and to the application of statistical knowledge acquired in other modules.

As concerns the development of this approach in the Master's degree courses in Pharmacy and Chemistry and Pharmaceutical Technology, the use of blended-learning in these courses is the first, relatively manageable objective. A second, more ambitious objective might consist in applying the power of mix-and-match to integrate courses in Pharmaceutical Analysis with theoretical courses in Medicinal Chemistry. To clarify this aspect let us consider the example of aspirin, a well known anti-inflammatory drug. The chemical and physical characteristics of aspirin such as solubility and the acidity measured experimentally during the courses of Pharmaceutical Analysis will be uploaded on Moodle and they can then be used again in Medicinal Chemistry where these characteristics will be used to explain the mechanism of action of the drug. A third important objective has been identified as the creation of an e-leaning platform for the construction of a system which can record, in progress, the student's course of studies based on the Kiro model (Perin *et al.*, 2011).

Finally, it needs to be underscored that increasingly more often the Continuing Medical Education courses offered to Italian pharmacists to bring them up-to-date on innovations in their field are taught using e-learning, and therefore, it becomes fundamental to train future professionals at the university with tools already being widely used in the working world.

REFERENCES

Albon S., Hubball H. (2004), *A Learning-Centered Course in Pharmaceutical Analysis*, Am J Pharm Educ. 68 (5), article 114.

Ancillotti A., Baldassarri F. (2003), *Materiali per un corso di scrittura professionale*, Perugia, Morlacchi Editore.

Boniolo B., Spadaro C. (2010), *NEMO+3D, un ambiente integrato per la didattica universitaria avanzata*, Je-LKS, 6 (1), 101-110.

Caldirola E., Marini A. (2008), *Progetto Kiro: didattica interattiva ed integrata presso la Facoltà di Farmacia*, Je-LKS, 4 (3), 109-118.

Fiumana F., De Florio A., La Placa M., Bertazzo M. (2010), *L2L Live to Learning*, URL http://www.cineca.it/sites/default/files/L2Lnotiziario65.pdf (veryfied il 05th March 2011)

Gerber M., Grund S., Grote G. (2008), *Distributed collaboration activities in a blended learning scenario and the effects on learning performance*, Journal of Computer Assisted Learning, 24 (3), 232-44.

Perin P., Caldirola E., Cofrancesco P., Marini A. (2011), *Monitoring academic progress in a Faculty of Pharmacy*, Je-LKS, 7 (1), 31-40.

Singh H. (2003), *Building Effective Blended Learning Programs*, Educational Technology, 43 (6), 51-54.