Peer Reviewed Papers

Monitoring academic progress in a Faculty of Pharmacy

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This paper describes the implementation of a system for continuous monitoring of university students' academic progression, integrated within the Kiro online platform employed in the Faculty of Pharmacy of the University of Pavia. This system includes a nonselective entry test at the beginning of the student's academic career and an analysis of the student's test results and platform activities during his career.

The present study, limited to a pilot course, preludes to the construction of a database containing the results of all tests taken by the student (and his/her online activity patterns), with the aim of building: 1) a measuring system for early individuation of student learning obstacles; 2) a tool allowing teachers of advanced courses to evaluate student knowledge of core subjects; and therefore 3) a feedback tool facilitating improvements of the program of study, by measuring its effectiveness.

We discuss the actuation of the system and its possible evolutions, the

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analysis of outcomes, and critical issues.

1 Introduction

Not surprisingly, most innovative approaches to university teaching are found in Education or IT schools, particularly in the Italian landscape. At difference from these fields, a Faculty such as Pharmacy displays at least three challenges, consisting in the high heterogeneity of: subjects taught, students' motivation and teachers' educational skills.

Previous experiences in other countries show that a noticeable improvement of pharmacist education is obtained when interactions among teachers (e.g. peer-review) are favored (Andurkar *et al.*, 2010), and when core courses build coherent conceptual systems, into which advanced knowledge can be integrated (Leslie *et al.*, 2004). A third, very effective, tool is mentoring, by the teacher or by a tutor (Boyce *et al.*, 2008); however, in our reality, the high number of students (458 freshmen enrolled in A.Y.2009-2010) in relation to the number of teachers (83 units) and tutors (one-two per course), limits the usability of this tool, since interactions would depend upon student motivation and personality. In fact, the teacher or tutor of a course with 180 students will hardly consider individual needs, unless they are openly stated by the student; therefore, the first moment when the "silent student" gets feedback to the teacher, to the tutor and to him/herself is the final exam, with noticeable waste of time and resources when the feedback turns out to be negative.

For these reasons we considered it useful to build tools aimed at the integrated and continuous evaluation of student curriculum, by the student him/herself and by the teachers. These tools, in facts, allow the teacher to evaluate the knowledge that the student has acquired in his/her course and in the previous ones, as well as to compare teaching methods employed in various courses; and provide the student a constant feedback on his/her academic progress.

The Faculty of Pharmacy of the University of Pavia has been employing for the past four years a Moodle-based LMS (Kiro project, Caldirola & Marini, 2009) as an integration of traditional face-to-face teaching. As of today (2010), a platform instance containing learning materials given by the teacher, plus a forum in which tutor and teacher can interact with the students (*ibidem*) is associated to every course of the ex-DM270 curricula of the Faculty.

The progress monitoring system described here exploits the potential of the Kiro platform. The current, preliminary version, includes:

- Student history analysis (attended high school type, high school graduation score, age, birthplace) – data from the Student Office;
- A nonselective entry test at the beginning of the academic career, implemented on Kiro;

- Remedial courses for students who did not meet the pass requirements in the entry test, implemented on Kiro;
- Final and midterm tests for a pilot course (Human Anatomy for the Pharmacy curriculum, Galeno[1] group);
- Student activity analysis in the Kiro instance of the pilot course.

2 Methods

2.1 Educational foundations

One of the main problems of today's University is what is a graduate supposed to know and to be able to do. Regarding the Faculty of Pharmacy, a degree should give (Leslie, *op.cit.*) «an understanding of the chemistry of drug entities, the delivery characteristics of dosage formulations, the disposition of drugs within the body, and the physiologic and pharmacologic outcomes of drugs' interactions within the biologic organism».

In order to obtain this outcome, core courses supply a subject-centered knowledge base that is to be used in advanced courses, where students are called to apply their knowledge with the creation of original material (papers, presentations), the execution of practicals and the discussion of scientific papers.

To optimize the educational value of this approach, a coordination among courses is essential, in order to minimize redundancies and/or gaps, and to favor interdisciplinary crosstalk. If this is not done effectively, the risk is that knowledge gained in advanced courses would not have solid logical-scientific foundations, but would be taken "as is", demeaning competence and credibility of the professional figure (*ibidem*).

This coordination requires training of teachers (Duncan-Hewitt *et al.*, 2007; Boyce, *op.cit*), which is a critical issue for the Faculty of Pharmacy, because of the low teacher/student numerical ratio, and the presence of strong priority conflicts between teaching and other activities (such as scientific research). The path chosen here represents therefore a compromise, where the teachers which are more sensitive to educational problems will be motivated through example and peer pressure, establishing a corpus of best practices to be subsequently adopted by the whole Faculty.

2.2 Technological infrastructure

The project employed the LMS Moodle 1.9, installed on a Linux server and configured by the IT staff. The Faculty of Pharmacy, as part of the University

[1] Given the high number of enrolled students, the Master curriculum in Pharmacy has been split in two groups (Galeno and Ippocrate) of about 180 students each.

campus in Pavia, is covered by the university wireless network, granting access to Kiro from desktop PCs and laptops. All tests described in this paper have been delivered through Kiro, in a computer room equipped with 25 PCs.

3 Contents

3.1 Entry Test

The Faculty Office of Pharmacy has supplied a database of about 3000 multiple choice questions[2] covering 6 fields (biology, chemistry, physics, math, IT, English). The test, given in two independent sessions (september and november 2009), consisted of 30 questions (7 for each biology, chemistry, physics, math; and one each for English and IT) randomly extracted from the database.

Before test sessions, students had at their disposal face-to-face training courses held by faculty members, and an online simulator that randomly extracted 30 questions from the same database used for official tests (which was used by about 500 students, for about 3200 simulations total).

3.2 Tests and materials in the pilot course

The course of Human Anatomy was taught face-to-face; in class, in addition to classical slide-based lectures, the teacher largely employed animations (of various origin) and manipulated 3D virtual models (Visible Body) broadcasted to the room.

On the Kiro instance, students found the slides projected in class, and screenshots of the 3D program (which unfortunately was not freely available). For each covered topic, a multiple-choice test was available. On loading of the Anatomy instance, two panels ("Now playing" and "Do you recognize it?") displayed, randomly, one of the animations shown in class and an anatomical structure to be recognized.

Finally, the instance contained a forum, a chat session and the link to a game site (Anatomy Arcade). Every activity available online (including times when the teacher and tutor would be available in chat) was given publicity in class.

Human Anatomy course exams (both midterms and finals) consisted of three parts:

A. Multiple choice test (10 questions extracted from a database of 253);
B. Identification test[3] (1 image extracted from a database of 87);
C. Open question (extracted from a database of 82 items).

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[2] Available here: http://lotarionline.unipv.it/moodle/mod/resource/view.php?id=3907

[3] consisting in the identification of 5 elements of an image, indicated with the letters A-E. The student has to associate the correct term to each letter.

Results for A and B tests were immediately available to the student upon test completion, whereas the answer to test C was corrected later by the teacher, who also gave to each student, online, detailed feedback regarding answer evaluation.

Several days before exam dates, a test simulation was available online, with automated feedback for A and B tests.

3.3 Entry test failure and remedial courses

Students getting grades below a certain threshold in the entry test would be put on probation. In particular, we decided to indicate as a threshold, for each test subject, the grade corresponding to one standard deviation below the average grade, instead of a fixed value.

As a help for probationers, remedial courses were then prepared, designed by teachers of a course related to the failed subjects and set up with the support of project staff, containing activities and teaching materials aimed at filling the educational gaps related to probation.

Remedial courses were held entirely online, and asynchronously, to allow the students to attend regular courses in the same period; for each remedial course, a teacher and a tutor were available for student support in the related forum.

3.4 Statistics

Entry and pilot course data were analyzed using Microsoft Excel and MATLAB, and standard methods were used for correlating among them the various test scores (if necessary after normalization) or comparing scores among groups (i.e. types of high school attended).

Numerical parameters were normalized and correlated using linear regression. Given the presence of data which were non numeric, or with distributions significantly deviating from normal, we employed nonparametric tests (Wilcoxon rank test) to evaluate significant differences among populations.

4 Results

4.1 Composition of Pharmacy students

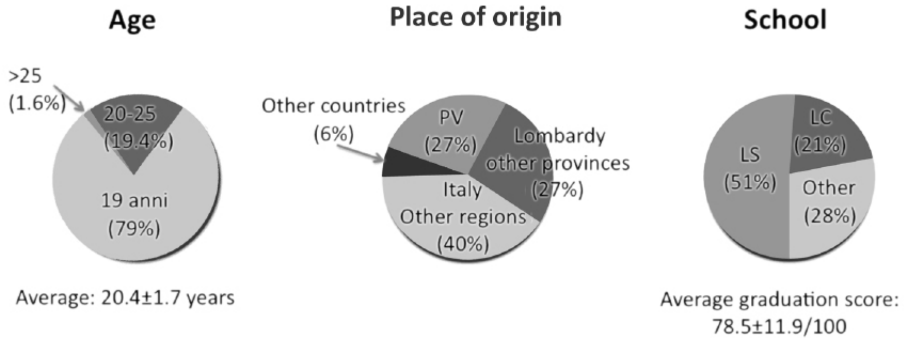

Fig. 1 - Age, place of origin and high school attended for freshmen enrolled at the Faculty of Pharmacy in A.Y. 2009-2010. LS: Liceo Scientifico; LC: Liceo Classico.

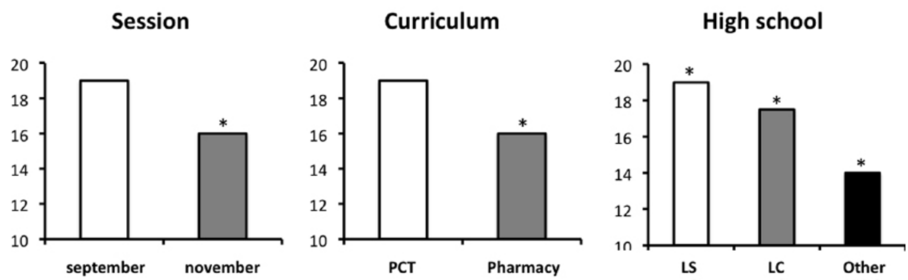

Fig. 2 - Entry test scores (median) as a function of session, university curriculum and type of high school attended. All differences are significant ($P<0.01$).

As shown in Figure 1, the typical freshman of the Faculty of Pharmacy is a young high-school graduate interested in a scientific education. Entry test score analysis (Figure 2) shows significant differences among groups characterized by different motivational levels (more motivated students enrol in september, before the start of the academic year, and the Pharmaceutical Chemistry and Technology curriculum is perceived as "more challenging" than the Pharmacy curriculum), and a better background given by *licei* high school, in particular by *liceo scientifico*. However, the correlation between high school graduation score and entry test score is quite low (R^2=0.281).

Given the present results, we started evaluating student motivation and implementing measures aimed at improving it (see 4.2.2).

4.2 Pilot course

4.2.1 Test scores

In the Human Anatomy course for Pharmacy - Galeno group (n=180), exams were performed on platform, and exam scores were correlated with entry test scores and student history.

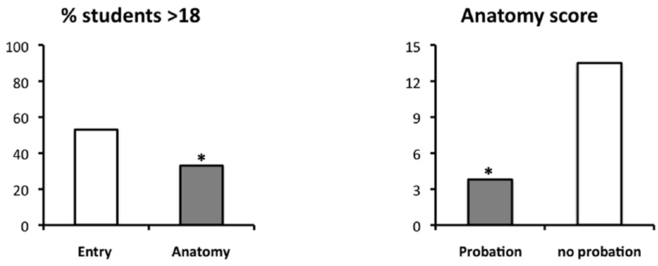

Fig. 3 - Performance at midterm exams in the pilot course. The percentage of students with scores >18[4] was lower ($p<0.01$) for the Anatomy course than for the entry test; score median in the Anatomy exam was much smaller ($p<0.01$) for probationers.

Result analysis shows a negligible correlation between Anatomy and high school graduation scores (R^2=0.1296) or entry test scores (R^2=0.2204), if probationers are excluded. On the other hand, although there was no overlap in the subjects tested in the two midterm exams, scores for the two exams were quite well correlated (R=0.605) in a highly significant way ($p<0.01$), suggesting a good continuity of student activity. Continuity is also suggested by the comparison of student partecipation to midterm (76%) and final exams (80% at 6 months from end of course). Of the students that never attended any test session (n=36), half did not attend any entry test as well, and were put on probation for all subjects, a third attended the entry test in November, and only the remaining 16.7% in september. High school graduation and entry scores were not significantly different from those of "active" students, other things (entry test date, attended high school, Master curriculum) being equal.

4.2.2 Platform activity

In the Kiro Anatomy instance, students could write in a forum, participate to synchronous tutoring sessions (chat with the teacher and tutor), and perform self-evaluation random tests, quizzes associated with teaching materials, and exam simulations. In addition, the student had access to all slides shown in

[4] minimum pass score in the Italian University exams

class, to an "in-depth" section containing advanced papers focusing on selected topics covered in class, and to a website containing anatomy games.

The analysis of activity logs shows that students participated in a very active way to the course. All students logged in the Kiro platform, and 51% of them actively interacted with the teacher and tutor in the forum (3988 actions from February to June 2010, including 67 subject questions) or in chat sessions (391 actions in 3 chat tutoring sessions).

The possibility to attend online synchronous tutoring sessions, well accepted by the pilot course students, may turn out to be very useful, since it allows personal "real time" interaction with the tutor and teacher (more motivating than asynchronous interaction or than the simple display of materials), does not require classroom availability, and allows recording of discussions, thus making logs available to all interested students. Last but not least, it stimulates students to the use of writing, an expression mode that requires an highly instructive thought formalization process.

Midterm exam simulations were used by 87% of students that attended the first exam, and by 64% of students that attended the second. 94% of the students that attended midterm exams tried at least one self-evaluation test or simulation. Interestingly, the scores of simulations and related midterm exam were not correlated (R^2=0.0475), while there is a significant difference ($p<0.01$) in midterm exam scores between students that performed the simulation (n=164, median: 16) and those that did not (n=63, median: 13).

Students that did not attend any exam showed minimal platform activity. Only 16.7% of them performed actions, which were limited to downloads of educational material just before exam sessions (with the exception of 3 self-evaluation tests). On the other hand, 3% of students (as checked in December 2010) still accessed educational material and games even after passing the exam, showing an appreciation for the offered material.

5 Discussion

The current experience (notwithstanding its limits deriving from the short analyzed period, and from the fact that the analysis is restricted to a single course) shows that monitoring platform activity with feedback to students may represent an useful tool to estimate reached competence levels with a sufficient temporal detail to allow both student and teacher to get promptly back on track. Students introduced to the Kiro platform with the entry test show ability to use it a) initially as a tool for communication; b) subsequently as a tool for self evaluation and deep learning of the subject as well. Moreover, students that are most active online are also able to pass exams more easily. A natural evolution of the work so far performed would be, therefore, to extend monitoring and availability of self-evaluation tools to more courses (possibly all).

The main critical issues correlated to this extension are the time and competences required to implement the described self-evaluation tools, which require a strong commitment by the teacher, only in part replaceable by the work of tutors (which, in addition, would need to be trained every year, since they are assigned on a yearly basis).

A possible motivation for teachers would be the simplification of exams upon their implementation on platform: in this way, exams are in facts automated (the teacher only needs to prepare the tests), personalized (thanks to Moodle randomization tools) and easy to re-engineer (with the possibility of performing item analysis to optimize test difficulty). Naturally, a full realization of this potential requires a close collaboration between teachers and IT project staff.

As a prerequisite, curriculum monitoring requires that the platform becomes the "examination place" for an adequate number of courses. Once this aim is obtained, it will be possible to follow student performance with good continuity, in order to calibrate and personalize support interventions with appropriate time and mode.

The issue of probation deserves a separate discussion. The performance of probationers turned out to be significantly lower than average, whereas for nonprobationers the correlation between performance and previous knowledge was minor. This can be interpreted in two ways: as an index of the necessity of a minimum knowledge core in order to usefully employ the tools given by the teacher towards the acquisition of new competence; or as a self-fulfilling prophecy of inadequacy, where the students feels stigmatized and does not enter the right cognitive mode for learning (Biggs, 1999).

In both cases, however, the building of an educational course which is shared rather than suffered by the student, and less focused on the test, would produce a gradual elevation of student competence and responsibility (Jonassen *et al.*, 2008). As for the teacher, he/she would change from judge of a single (although reiterable) instance (the exam) to evaluator of the growth of subject experience and final competence reached by the student (*ibidem*).

Conclusions

The current project represents the initial implementation of an in progress evaluation system for academic performance in the Faculty of Pharmacy of the University of Pavia. The outcomes of this initial study, notwithstanding its limitations in aims and time, suggest that, in order to evaluate student performance, an analysis of platform activity is more useful than an analysis of previous test scores.

Given these premises, what seems advisable is an increase of the time students spend learning autonomously (although in a structured system) and a decrease of test centrality. The evolution of the project will extend the analysis to more courses, both basic and advanced.

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