THE VIRTUAL CLASSROOM IN BLENDED LEARNING MATHEMATICS UNDERGRADUATE COURSES

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In March 2001 a group of mathematicians working at Università Bocconi (Milan) started a project focused on integrating the use of e-Learning technologies into the traditional structure of Mathematics courses for undergraduates. A preliminary description of our experience was presented at the Second International Conference on the Teaching of Mathematics at undergraduate level (Crete 2002).
After a brief up-to-date description of the whole project, we examine the possible roles of Internet course forums; we believe that a lively and effective virtual classroom is the key factor to differentiate between weak and strong uses of blended learning technologies. However, the analysis of quantitative data coming from the tracking of messages exchanged in course forums seems to show that online participation accounts for only a slight improvement (if any) in the students' performance in mathematics. Finally, we draw some conclusions and suggest future developments.

1. The project

The use of e-Learning technologies is becoming more popular in Italian undergraduate courses. One of the first projects, and now one of the most advanced ones, is that of Università Bocconi in Milan.

Università Bocconi, a well-known business University, started in the academic year 1999/2000 a project based on IBM/Lotus e-Learning platform *Learning Space*, in which web courses are used as an integration to traditional face to face classroom teaching. The project foresees that for each undergraduate course a parallel web course will be developed, and tries to guarantee a strong coordination of the courses by proposing common standards.

After five years, at the undergraduate level this project involves more than one half of the courses and practically all students in the University (around eight thousands).

In year 2000/2001 our Institute of Quantitative Methods started a subproject focused on integrating an extensive use of e-Learning technologies into the traditional structure of Mathematics courses for undergraduates.

We gradually built up an *ad hoc* group of mathematicians and computer experts. This year (2003-2004) we set up twenty web courses on Mathematics and Mathematics of Finance, involving around three thousand students; in the present paper we only deal with these courses.

2. Different teaching models

The majority of courses use the e-Learning platform merely as a Bulletin Board System (*BBS*), attaching a variety of course materials such as previous exam papers, proposed exercises, homework and general information on the course. Although the *BBS* model is now sufficiently well-established and has proven effective to disseminate learning materials, we do feel that the bulletin board is only a part of the complex and powerful tool represented by an e-Learning platform; other parts are to be experienced and their learning efficacy investigated.

In five courses out of twenty, more sophisticated features are used:

a) *An electronic interactive forum, open to course lecturers, online tutors and students*. Depending on the teaching model in the background, the forum may show a strong usage of mathematical software and tools and/or a particular attention towards the establishment of various forms of collaboration among students; in one case, the forum is mainly devoted to sustain students with particularly poor performances.

b) *The electronic management of online tests, self-assessments and exams*. This gives the opportunity to automatically correct and evaluate students' assignments. However, we encountered many problems in setting up a satisfactory environment: if one takes into account security issues, logistic constraints (*i.e.* the shortage of computer labs), defects and weird design in software and the limitations in graph representation and formula handling in web pages, it is evident that the effectiveness of an online assessment procedure can be seriously compromised. Therefore, this procedure has not become a real standard, although we still think it represents a chance to simplify the traditional assessment procedure and we are working to find solutions to issues raised.

The previous remarks lead us to consider the virtual classroom, with its enormous versatility and potentiality, as the most challenging feature in an e-Learning platform. However, an important critical point has shown up:

The implementation of an effective virtual classroom requires a lot of time and energy on the part of lecturers, tutors and students. Is it worthwhile?

In other words, the fundamental issue is whether the students' online participation is positively correlated with their overall performance in Mathematics. This point is particularly important for University administrators, as it is crucial when deciding the allocation of resources. Our investigation shows that this remains a rather controversial issue.

Let's just mention some interesting aspects we noticed in some courses:

- The course *5015 Clemit*, which accompanies the use of e-learning technologies with an extensive use of mathematical software and tools, seems to have succeeded in motivating students' participation more than the other courses. However, this course is utterly oriented to new technologies; other experiences of proposing the same technological approach to less technology-oriented students have been less successful.

- The course *271*, dedicated to students with poor performances, has shown a rather lively virtual classroom, but a closer look shows mainly "service messages" (questions about exam rules and results, office hours and so on), while messages with a strong mathematical content have been almost exclusively one-way, from lecturer to students. Students even rarely asked for deeper online explanations.
- In course *5131*, the virtual classroom was used to launch non-standard problems, or problems on topics which otherwise would be cut out of the course due to lack of time. This proved appealing to a significant part of the classroom, usually (but not always) the ones who got the best marks at the end. In order to correctly assess this experience, the reward of a few extra points for this online activity has to be considered.
- In some courses, the push on collaboration activities led to controversial results. The best-working groups were usually the very small ones (preferably 2 people, rarely 3); and some important features of a really collaborative learning leave to be desired till now.

3. Tracking and quantitative data

Our quantitative analysis of data dealt with two aspects:

a) the collection of data which help us to estimate students' participation;

b) the correlation between this participation and the students' final marks.

The collected data come from the forums activated in three Math courses, a very technological two semesters Math course (*5015 Clemit*) in year 2001/2002 and 2002/2003, and an intensive one semester Math course (*5131*) in year 2002/2003. In the following, they are respectively indicated by A1, A2 and B. As with other tools of this kind, we had discussion threads began by lecturers and students, with questions posed and answers given by both groups.

A1) We had a total of 1056 messages, with 407 (38%) sent by the lecturers. There were 500 discussions started so the average discussion thread length was of 2.11 messages, with 83 students out of 122 participating in online discussions. Each student sent 7.8 messages on the average. The participation data (*i.e.* the number of messages sent) were compared to the actual marks given to students at the end of the course. The resulting scatter plot is reported in Figure 1.

A2) We had a total of 1329 messages, with 417 (31%) sent by the lecturers. There were 532 discussions started with an average discussion length of 2.49 messages, with 101 students out of 141 participating in online discussions. On the average, each student sent 9.0 messages. A scatter plot comparing marks given to students and their online participation is reported in Figure 2.

B) We had a total of 308 messages, with 173 (56%) sent by the lecturer. There were 99 discussions started with an average discussion length of 3.11 messages, with 37 students out of 98 participating in online discussions. Each student sent 3.6 messages on the average. A scatter plot comparing marks given to students and their online participation is reported in Figure 3. The smaller number of messages in this course is linked to two facts: course B was only a one semester course, and a number of "service messages" were unfortunately deleted from the forum before our investigation.

The three plots show a similar pattern. As we can see at first glance, there is no strong relation between online participation and students' performances. There were "online invisible" students (*i.e.* those who did not send a single message) who could obtain good marks. Moreover, figures 2 and 3 show a limited number of students who were frequently seen online but did not complete the course. Given these data, it seems clear that the main role of the virtual classroom is not that of a tool to improve students' performance. The linear correlation coefficient between the total score and the number of messages confirms this feeling, as it varies from 0.21 (with a 95% confidence interval of 0.02-0.40) in course B to 0.33 (with a 95% confidence interval of 0.17-0.47) in course A2.

To further investigate these data, we performed a more detailed statistical analysis on courses A1 and A2. In these two courses students do not take an entry test and take four partial tests at regular intervals. We assumed their score in the first test gives an approximate measure of their initial mathematical knowledge. We investigated the dependency of the sum of scores in the second, third and fourth test (y_{234}) from the score in the first test (y_1) and the number of messages in the forum (x): the corresponding linear regression model is $y_{234} = \alpha + \gamma \cdot y_1 + \beta \cdot x + \varepsilon$. Statistical analysis showed that in both cases there is a strong relationship between the first score and the subsequent scores, but there is only a small influence of online participation. However, in both cases the 95% confidence interval on β does not include 0, which means that we can reject the hypothesis that online discussions have a negative effect. We did not perform a similar investigation on course B because in this case students took only two partial tests.

4. Conclusions

To set up a virtual learning environment and to maintain it (i.e. produce electronic materials, monitor and participate in online discussions, etc.) is a time consuming activity for which, at the moment, there is no adequate reward. Universities can sustain these activities if there is evidence of their value but, given the previous data, such value can hardly be found in an increase of the students' performance.

This raises two fundamental questions: are all these tools really useful for the average learner? And, consequently, do they deserve so great an investment from the institution and its lecturers?

The answer depends on the meaning of "useful". It is conceivable that its real meaning is that of enhancing some capabilities and attitudes which are not usually measured in traditional educational environments. In progress research in our Institute shows that participation in virtual classrooms is effective in enhancing some "meta-responses" such as cognitive empowerment (the individuals' sense of mastery of the world in which they live), capacity for life-long learning, attitudes towards Information Technology and attitudes towards collaborative work.

Anyway, future research should take into account all aspects of the learning process and plan the design of more accurate teaching experiments on the effectiveness of e-Learning technologies – whatever we may mean by effectiveness.

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References

1. M. Impedovo, *The NT (New Technology) Hypothesis*, ICTM2 Proceedings (Crete, 2002), http://www.math.uoc.gr/~ictm2/Proceedings/pap352.pdf .

2. F. Iozzi, *Collaboration and assessment in a technological framework*, ICTM2 Proceedings (Crete, 2002), http://www.math.uoc.gr/~ictm2/Proceedings/pap412.pdf .

3. J. Klobas, S. Renzi, *Integrating Online Educational Activities in Traditional Courses: University-wide Lessons after Three Years*, in Aggarwal A.K. (ed.), *Web-Based Education: Learning from Experience*, pp. 415-439, Hershey, PA: Idea Group Publishing, 2003.

4. J. Klobas, S. Renzi, D. Francescato, P. Renzi, *Meta-response to Online Learning*, Ricerche di Psicologia 2 (1), pp. 239-259, 2002.

5. G. Osimo, *E-learning in Mathematics undergraduate courses (an Italian experience)*, ICTM2 Proceedings (Crete, 2002), http://www.math.uoc.gr/~ictm2/Proceedings/pap312.pdf .

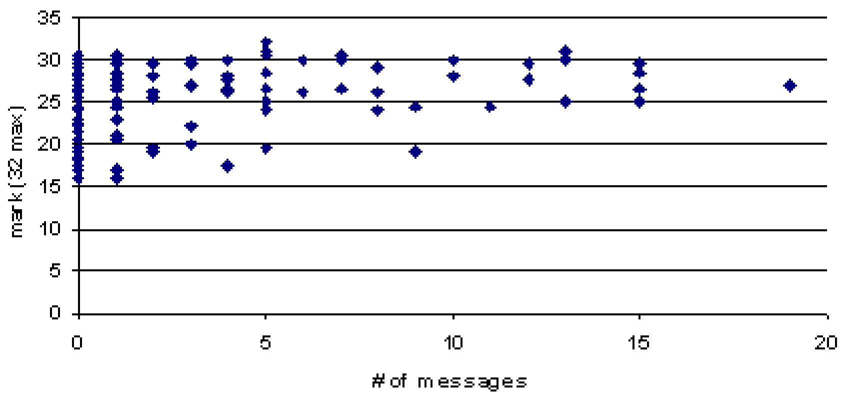

Figure 1: marks vs. # of messages (A1)

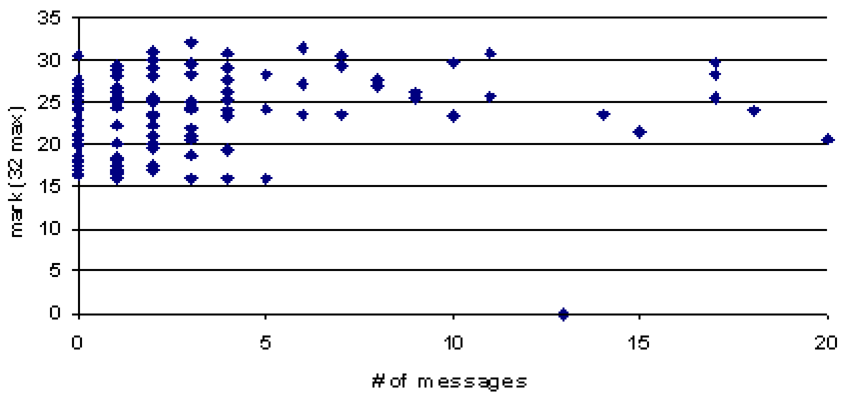

Figure 2: marks vs. # of messages (A2)

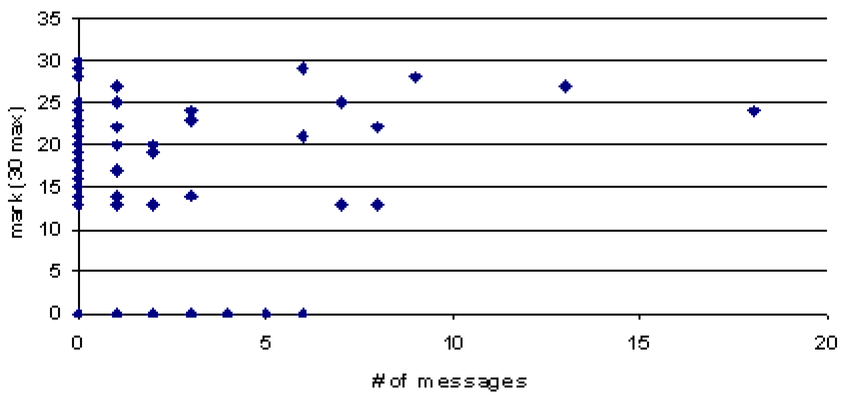

Figure 3: marks vs. # of messages (B)