A CASE STUDY ABOUT MATHEMATICS AND E-LEARNING: FIRST INVESTIGATIONS

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Abstract. This paper presents a research in progress concerning e-learning practices in mathematics education. The described experiment can be linked to peer learning and assessment, implemented by a role-play among the students of the first Engineering year. The impact of the e-learning activities on both the meta-cognitive and affective sides have been analysed.

1. INTRODUCTION

In the proposal of the *elearning Programme[1]* of the European Commission we can read:

> Full development of the Internet's potential to improve access to education and training, and enhance the quality of learning, is key to the building of the European knowledge society.

and

> The eLearning initiative further develops these objectives from an educational point of view, stressing the need for innovative pedagogical approaches and for ambitious objectives regarding learning quality and easy access to e-learning resources and services.

On the other hand, any model for mathematics education has to consider that students' performances are affected by factors belonging to at least three different levels:

o   the cognitive level, which involves the learning of the specific concepts and methods of the discipline, also related to the obstacles recognized by research and practice;

o   the meta-cognitive level, which involves learners' control of their own learning processes;

o   the non-cognitive level, which involves beliefs, emotions and attitudes, and all affective aspects, which are most often critical in shaping learners' decisions and performances.

eLearning can play a part in each of these levels (Albano & Ferrari, 2008), including the non-cognitive one, as it from the one hand can deeply influence learners' beliefs, emotions and attitudes related to mathematics, from the other hand is itself the object of deep-rooted beliefs and can produce effects at the non-cognitive level.

In this paper we present the first result of a research in progress about a blended learning course for the teaching/learning of the mathematics at university level, that is the integration of face-to-face learning with online learning activities using a distance e-learning platform, named IWT (Albano et al., 2007).

We are going to present an experiment done in a course of Matematica II, attended by the Electronic Engineering freshman students at the University of Salerno.

The research questions concern both emotional factors (if and how the use of an e-learning platform can affect the attitudes, the relationship with mathematics and the teacher, the motivation to learn) and meta-cognitive factors (critical thinking, reasoning, learning strategies).

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[1] eLearning Programme (2003). Multiannual programme (2004 to 2006) for the effective integration of information and communication technologies (ICT) in education and training systems in Europe. http://europa.eu.int/comm/education/programmes/elearning/doc/dec_en.pdf

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2. THEORETICAL BACKGROUNG

According to Nichols (2003)

> eLearning is a means of implementing education that can be applied within varying educational models (for example, face to face or distance education) and educational philosophies (for example behaviourism and constructivism).

E-learning platforms generally provide a number of activities involving peer interactions or interactions between learners and tutors. Modules such as Moodle's 'workshop', 'wiki' or 'task' or IWT classroom virtual space are generally suitable for designing activities of this kind. In this section we describe some experiences with a 'workshop' module at undergraduate level. From the viewpoint of the theory of mathematics education, all of these activities can be framed within the so-called socio-cultural (or 'discoursive') approach. For more information see Kieran *et al.* (2001).

Our idea is to support the students by on-line, time restricted activities based on role-play, which actively engage them and induce them to face learning topics in a more critical way.

It is well known that the cognitive processes induced by talking, discussing and explaining to others the concepts to be learnt promote deeper level or higher-order thinking (Johnson & Johnson, 1987). In this framework we want to put emphasis on peer learning (Boud *et al.*, 1999), which is intended as the use of teaching and learning strategies in which students learn with and from each other without the immediate intervention of a teacher. It includes peer tutoring and peer mentoring. When the students in a group act as both teachers and learners we talk about reciprocal peer learning. This may incorporate self and peer assessment whereby students actively develop criteria for assessment. Falchikov (2001) analysed the various peer tutoring techniques and the benefits linked to each of them. She found evidence of some improvement in comprehension, memory for lecture content, performance and facilitation in encoding and retrieval of material given by Guided Reciprocal Peer Questioning.

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Many reasons can be found to foster peer learning (Boud et al., 1999) that match the benefits indicated by the students in (Godinho et al., 2002). Among them we cite the following: strengthening communication skills, critical enquiry and reflection; clarifying subject content through discussion; viewing situations from different perspectives; learning how to work as a team member; becoming actively involved in the learning process, learning to learn.

3. DESCRIPTION OF THE EXPERIMENT

All of the students of the Matematica II course were used to the e-learning platform IWT as passive tool, that is as repository of useful didactical material or as communication tool among students and teacher. The experiment has been performed with voluntary students of the course, inviting those who were liked to be involved in a massive and more interactive use of the platform. On one side the invitation letter explained the interest of the teacher in the impact of the platform's use on the learning process and on the other side it made clear that their choice of involvement or not had no implication on their evaluation at the exam.

At first the students answered to a questionnaire about their beliefs and expectations w.r.t. a blended learning course (Albano, 2005) and w.r.t. the mathematics (inspired by Zan, 2000). It was just the answer of a student to give rise to the experiment we are going to describe. In fact, asking if the student is satisfied of his/her profit to the Matematica I exam and, if not, explain why, a student ascribed his poor performance to *strange* and *unexpected* questions. This answer suggested the idea of a role-play where stu-

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dents can play the role of a teacher, to force them to ask questions and so to stimulate them to study in a more critical way.

Such initial idea has been further developed as described in the following. The course programme has been split into different parts and each part into as many topics as the involved students. For each part a cycle of activities based on role-play has been created. Three topics have been assigned to each student. For the first topic, the student acts as a teacher who wants to evaluate the topic's learning so he/she has to prepare some suitable questions. For the second topic, the student has to answer to the questions prepared by a colleague. Finally for the third topic, the students again acts as a teacher, checking the correctness of the work made by the previous two colleagues. Each activity takes two days. At the end of each cycle, the files produces by the students were revised by the teacher-tutor of the course and the revised files were made available to the students. All the produced worksheets were stored in a shared area of the platform in order to be available to all the students.

After these activities regarding prevalently the study of the theoretical part of the Matematica programme, similar activities have been performed about the exercises. The latter have begun later and, due to time restrictions, the work flow has been reduced skipping the first role of teacher for the students. The questions have been posed by the teacher-tutor and have regarded the theoretical references justifying the application of some resolution procedures or the control procedures for checking the correctness of the obtained results.

4. FIRST RESULTS OF THE ROLE-PLAY

At the end of the course, after the exams, feedbacks have been collected by interviews, mainly aimed to understand if and how the students' waits about a blended course have been satisfied and the activities done have influenced their learning process. Particular attention has been given to investigate to the side-effects of the activities done on students' attitude toward the mathematics, on their way of studying and on their relation with the teacher. In this section we want to expose the first results collected by the interviews.

4.1 META-COGNITIVE IMPLICATIONS

Let us examine the reasons why each of the roles played have been considered useful for learning.

The most appreciated role has been the first one. *To ask questions* have helped to study in a more critical and deeper way, with greater care, because it is not simple to ask a question:

> I had to better repeat the topics because to ask a question is a much complicated thing, more that to explain, because a question has to be well formulated, there is no method to formulate a question, then it is something more difficult.

Moreover the request of a certain number of questions on a topic requires to range over all the programme:

> I had to range over the links of that topic with other topics, which theorems are reminded, what notions are needed, so I go into the deep.

There has been an attention to ask non trivial questions, also for pride reasons, and this has required the mastery of the topics. It is also interesting to note that some students has used this role to clarify some own doubts:

> Personally when I asked questions, most of them were questions I did not know the answers, so I have used them to understand things that I had not understood.

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The role of the student who *answers* to questions of colleagues have been considered useful because it has allowed to revalue neglected parts and it has fostered the reasoning.

It is interesting to have a look to two answers that can be linked to the cited answer generating such activities:

> When one meets someone else with a twisted mind which has asked tortuous questions and I have to answer, then I have to study the subject much more in the depth.

> If the question was "smart", then to give an answer required great care.

In my opinion, here we can see the quite general assumption of the students who consider *tortuous* the questions asked at the exam and this is why they fails. Actually, if we have a look at the files produced by the students, there are no really tortuous questions, as there are not at the exams. Anyway the feeling of the students simply shows their habit to a flat and rote-learning style that is the lack of asking themselves questions. In the same direction, we note that most of them have found questions that they did not think of before. At first they were astonished, asking where such questions came from, but they definitely consider positive:

> Anyway it is positive, because to think about something which is never considered previously is good, it enriches his/her own knowledge.

The role of the teacher who *checks the correctness* is not really very appreciated, essentially for two reasons: students do not feel themselves to be equal to this task or consider the task not useful because they surely do well. More spur has been given those answers that have created some doubt of correctness, creating some kind of discussion, at least of the student with him/herself.

All of the students waited for the final check of the teacher-tutor, which institutionalised the knowledge they constructed by themselves.

There also has been a positive weighing of the mistakes, because to answer for those increases the success of the exam:

> Without those corrections I would have made exam without knowing a lot of things.

> They are a chance to see where you make a mistake.

It is interesting that everyone has had a look at all the final files and has considered that as the most efficient way to have a final revision of all the programme before of the exam.

During the interviews we have also investigate if and how the performed activities have changed their habit of studying. It happened and the reasons can be grouped in two main areas:

- <u>Method to study</u>: the students have acquired the habit of going into depth, in order to understand the meaning of a theorem, and the habit of looking at something from more viewpoints (also through the comparison with other colleagues):

  > For sure now I usually go more in depth.

  > Now I try to reason about what I am studying, not to learn by heart.

- <u>Practical organisation of the study</u>: the involvement in the proposed activities has given the students a sort of guidance for the management of their study, having time constrictions, topics to revise, indications of the important activities, which have given continuity to the study of the matter and less waste about what to do. It is interesting to note that someone has considered such activities as a training for his/her future work:

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> These activities have given continuity, above all for the fact that I had to be complied with the deadlines. It is to enter a little bit in the work world where you have forced to be complied with some deadlines, even because the activities of others students depended on my activities.

4.2 AFFECTIVE IMPLICATIONS: THE RELATIONSHIP WITH THE MATHEMATICS AND WITH THE TEACHER

In (Albano, 2005) we have seen that most of the students do not expect that the an e-learning platform can produce changes in their relation with mathematics, because the assumption is that one likes mathematics independently on the computer. Moreover most of the participants already had a good relation with mathematics, anyway some changes have happened. Someone has overcome his/her previous vision:

> Mathematics does not scare me anymore. Maybe, it is because I have got through the exam, but I saw it as a mountain, mathematics was a very difficult thing.

Some others have got used to mathematics and to the teacher:

> To ask questions and questions and questions, after a while to ask becomes simpler, also because you find that some teachers are not as bad as they look like and they are open to communication more than we thought.

As we can see the relation with the teacher changes, improves a great, as it has been expected (Albano, 2005). In some cases the use of an e-learning platform can help to create a relation that is inexistent otherwise:

> In an face-to-face course there is more aloofness among students and teachers, I mean that there is almost no relation, whilst in this case the platform has been useful also to this aim, to give rise to a stronger relation because previously I dreaded to go to the teacher's office to ask questions whilst this year it has been simpler.

The support offered by an e-learning platform also helps to feel less lost from the viewpoint both of the entrance in a new and less attenuated reality such as the university is w.r.t. the high school and of the organisation of the study of the subject:

> It allows to recover the relation student-teacher not existent here, so even if the teacher does not know each single student but he know the group and this is useful above all for the students of the first year, a little bit lost guys in a new environment so to meet some friendly face is of some help.

> When I came back home, I was wondering what to study and I did not able to decide, also because there were some concepts I did not understand. So to go to the platform gave me a guide and I could also ask a question to you (teacher) or to the colleague if I had some doubts, so I had more chances to contact others.

We would like to underline that a teacher who use a blended course has been considered as a teacher who takes care of the learning of his/her students, who wants to communicate with and to them, and this positively impacts on the students' motivation:

> Each time I noted updating I feel encouraged thinking "the professor did not neglected us!". If all the course should be organised with the same willingness and care, I think that all of us would be more eager...! Thank you!!

> The platform is a further communication way, so it is like to have a teacher always available t o give an answer and a place where to go, where to always ask your questions.

To be in the habit of communicating with the teacher can help to reduce the anxiety of the exam:

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> I say the truth, I do not know why, maybe because there has been such interactions with the teacher, so if I had problems I had already asked and then at the Matematica II exam I was quiter than Matematica I exam.

Note that the mastery of the subject is not always sufficient to calm the anxiety of the exam:

> I was aware of well mastering the matter, that I liked, but I felt anxiety anyway because it has been generated by the not familiar people, which you have never talked with during the course, depending on you or on the way of acting at university level...

5. CONCLUSIONS

The initial idea, shown in this paper, based on problem posing, has been further developed in collaboration with P.L.Ferrari, introducing a control group, based on problem solving. A parallel experiment at the University of Salerno and at the University of Piemonte Orientale has just finished and we are collecting the results.

We would like to conclude this paper with a final remark underlying all the interviews: all the students involved in the experiment have been thrilled about the work done and everyone is firmly hoping to continue such experience in other courses. Anyway two points have to be stressed in order to have a successful e-learning course:

- the presence and the intensive interaction of the teacher on the platform (by various ways, such as continuous updating of the didactical material, messaging with the students, arrangement of homeworks with active involvement of the students) is a fundamental key to have some significant impact of the e-learning tools on the learning process;

- maybe a total "distance" course could not have the same positive effects we exposed:

  > To join face-to-face course and IWT has been an excellent idea. Only face-to-face course is lacking in points of reference. Only IWT makes us on-line students, but I do not like only on-line course.

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