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The use of e-learning in pre-service teachers' training

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Abstract. In this paper we present the analysis of surveys concerning the use of a digital platform to support a blended pre-service primary teacher's course. The analysis is based on the *Focus/Role Model* for the use of an e-learning platform according to the *role* of the users (student and teacher) and the *focus* of the activities (mathematics and education).

1. Introduction and theoretical background

This paper is framed in the context of the use of e-learning in pre-service teacher courses in mathematics education. During the last years, research studies addressed e-learning as an appropriate domain for integrating technology and educational research in mathematics, able to be used within different theoretical frameworks (such as the constructivist and the socio-cultural ones) and at different levels (cognitive, meta-cognitive, non-cognitive) (Descamps *et al*.; 2006, Albano&Ferrari, 2008).
In the case of a course concerning pre-service mathematics teachers' training, the use of an e-learning platform can affect four different aspects, in accordance with the *role* of the users and the *focus* of the activities.

Focus\Role	Student	Teacher
Mathematics	to improve mathematics learning by means of e-learning resources/activities	to investigate exploitation of e-learning tools for improving mathematics teaching/learning
Education	to get practice with e-learning platforms and their tools	to use e-learning platform for investigating educational paths and methods

Figure 1. The Focus/Role Model for the use of an e-learning platform

Let us give a more detailed look into each of the aspects shown in Figure 1.

Mathematics/Student (M/S): the finding of PME research has stated teachers' understanding of mathematics as a crucial aspect for the effectiveness of their teaching practices (Llinares & Krainer, 2006). Thus among the goals of the pre- and in-service teachers' training there should be the improvement of their mathematical background. For teachers to become competent in mathematics is a prerequisite to their capability to propose meaningful learning tasks. In this frame, the e-learning platform is used as a mean to improve mathematics learning since it provides plenty of opportunities to design and implement learning activities, individual or cooperative/collaborative, meaningful for mathematics' features (multisemioticity, multivariety), impacting at cognitive, meta-cognitive and non-cognitive level (Albano & Ferrari, 2008).

Education/Student (E/S): in the frame of the *instrumental approach* (Rabardel, 1995), the student's activity cannot be investigated without taking into account the complexity of the context, which in our case includes an e-learning platform. This requires to consider the *instrumental genesis*' process, which can be split into two phases: *instrumentalisation* – the platform's potentialities and constraints are progressively recognized; *instrumentation* – the utilization schemes are progressively developed in using the platform in relation to the execution of a particular task. For instance, Trentin (2005) describes how undergraduate students, during a course on the use of ICT in support of human resources, comprehend some technical features of the platform. In particular, students, by using the platform, acquire knowledge and skills on "*methodological, technological and management aspects of the use of the new technologies to support professional growth processes*".

Mathematics/Teacher (M/T): even if e-learning platforms were born addressing general educational issues, it is undoubted that effective e-learning methods need to take into account disciplinary distinctive features. For instance, assuming the discursive approach to mathematics learning, Albano & Ferrari (2013) analyze the tools available in an e-learning platform and how to use them in activities devoted to foster students' progress from the point of view of multisemioticity and multivariety of mathematics' language. In this frame, e-learning platform is used for investigating and making practices on how its tools can be exploited in order to design and implement activities focused on mathematics' features.

Education/Teacher (E/T): from the professional development viewpoint, reflection is considered a key means "*by which teachers continue learning about teaching and about themselves as teachers"* (Llinares & Krainer, 2006). E-learning platforms allow distance participation, sharing, discussion, collaboration, which foster action research, that is teachers systematically reflect and investigate on their own practice, supporting the development of knowledge, skills and perspectives for teaching (Gueudet *et al*., 2012). In this frame, users utilize the platform in order to create and to reflect on possible teaching/learning paths, methods and resources (see, for instance, the *documentational approach of didactics*, Gueudet *et al*., 2012), that they can implement as teachers in their training sessions or in their future work, and on math teaching experiences.

In this paper we present a first experience of using e-learning in a course for primary future teachers of the University of Salerno. The contents concerned 'proof' and 'proving' in mathematics and mathematics education. The activities on the platform were planned in order to analyze how the participants use an e-learning platform, both as support for improving students' learning concerning the course topics and as support for promoting reflexive thinking about teacher practices or about tools to be used in teachers practice. By the analysis of the final surveys submitted to the students, according to the above described four aspects, we have found that maybe the students would appreciate e-learning more as reflexive tool for their future job (aspect E/T), otherwise they ask for 'something' directly linked to be successful in mathematics competencies (aspects M/S).

2. Course setting

The online laboratory is integrated in the course of 'Basic Mathematics and Mathematics Education' taking place during the second year of the University degree for primary school teachers. It consists of 80 hours of face-to-face lectures plus 30 hours of laboratory, 10 of which to be delivered online. The latter were organized making available both materials and activities focused on the 'proof' as a key aspect of mathematics learning and mathematics education. In particular, the difference between the verification of a statement in a finite number of cases and an actual proof was faced. The aim was to make the students able to analyze simple proofs and to construct simple deductive chains in order to prove own or others' conjectures and theorems. The materials addressed the theoretical aspects of proof. The activities aimed on the one hand to investigate the students' beliefs and conceptions about 'proof' in mathematics and in their future job as teachers, and on the other hand to train students in making proofs, using various tools of the e-learning platform according to various approaches. In this way the participants were involved in using an e-learning platform affecting the four aspects of the Focus/Role Model.

The used tools were:

- the 'task', allowing to arrange some open-ended questions and to activate a dialogue with each student;
- the 'quiz', allowing to arrange some close-ended questions, with automatic assessment.

In our case the 'task' was used for two purposes:

- the first one concerns the non-cognitive level of learning: at the beginning of the course, five open-ended questions were proposed to the students concerning the meaning of proving and the importance of the proof in mathematics education and in teaching practices; at the end of the course, the students were required to read their submitted answers to those questions and to submit new answers if their thinking was different at the current;
- the second one concerns the meta-cognitive level of learning: during the course, a task concerning how to study a given proof was set; a well-known arithmetic theorem with its proof was written and some open-ended questions focused on the key elements of the proof (hypothesis, thesis, justification of passages, link to other mathematics results, etc) were posed (Zan, 2000).

The 'quiz' included multiple-choice and fill-in-blank questions: the former concerned the formalization of some conjectures and the latter concerned the finishing of some steps in a theorem's proof starting from a given axiomatic system.

The limits of the quiz are well known, especially because they cannot allow to stake important competencies such as to construct a strategy or a text, which are particular pertinent when we deal with 'proving'. This is why the use of 'task' seems more proper. Unfortunately, its main drawback consists in some sense exactly in its potentiality, that is the huge effort needed for an effective use, consisting in one-to-one correspondence between the student and the tutors. For this reason, our use of 'task' was limited to one submission and one teacher's feedback and it has been mainly dedicated to investigate beliefs and feelings. The 'quiz' activities was used as complementary to the meta-cognitive task, exploiting its self-assessment feature.

The students involved in the online laboratory were 180. At the end of the course, five surveys were posted on the platform, in order to investigate the opinions of the students on the use of e-learning in the attended course. About 50% of the students answered to the close-ended questions and almost 70% of them answered to the open-ended part of the survey too.

3. Opinion survey on the use of e-learning

We give an overview of the answers of the students to the five surveys, looking at them according to the four aspects of the Focus/Role Model.

The first question is: *Tell us which were your expectations and which are the differences you have found with respect to what you imagined.*

Looking at the answers, we can draw some main ideas. First of all it seems that the aspects M/S and E/T emerge by the most of the responses: the participants thought the platform as a tool useful to them as students and not as future teachers. So they expected everything which could facilitate the success in passing the exam, that is, mainly, exercises and practices like those they were going to face at the exams. In this view, most of them considered the online laboratory as a 'support' to the course, and not as a part of the course itself. So they did not expect further topics, not discussed in face-to-face lectures, as it occurred: "*I expected that the platform should have been mainly exploited for practicing on topics discussed during the lectures and that we should have faced in the final test*". For the same reason, many students were worried about the time counting, so they highlighted the correct counting or complain some cases of bad functioning. We cite an extreme comment: "*we were interested in certify 10 spent hours and not to waste time in answering tests!!!*", which shows, in our opinion, the importance of well defining the scope of online activities, especially when the online course is mandatory and thus it is perceived just as 'something to do' in order to access the exam. Moreover, answers of this kind show the need to share, as scope, also the importance of the aspect E/S in using the platform during the course. Getting practice with tools' potentialities and constraints and with their utilization schemes allows the students to become aware of their usefulness for their professional development.

A further consideration, which is beyond e-learning, comes from a lot of comments in which students state that they should have liked to spent more time, even on the platform, on topics concerning mathematics education, instead of proof… as if they did not consider 'proof' concerning mathematics education!

For completeness, we have to say that by the analysis of some answers it seems to emerge also the aspect E/T: the participants, even if few, expected to use platform as a constructivist support to their future work of teachers. One of them gives us a specific hint: "*Maybe I imagined that we could create something by means of the virtual laboratory. For instance: 'let us show how you should explain the multiplication to the children'*".

The second question is: *Write what you consider an "added value" of each activity done.*

Some of the answers concern e-learning general aspects/advantages, such as the possibility of attending a course without space and time constraints: "*I think that the most useful activity was the home-work because it has given the possibility to attend the course through the home-work on the platform to whom that could not*

attend unable to face-to-face attendance". In this extract it seems to emerge the aspect E/S. Some others underline the possibility of having 'much more time to think', highlighting the aspect E/T in using e-learning platform: "*Besides of the delivery of the materials, I consider an 'added value' the multi-choice and the fill-in-blank tests, and above all the possibility of reflecting for much more time about these exercises to do at home*". Concerning the specific issues of the laboratory, although some students state that they should have preferred repeating the topics of the course, many others, on the contrary, use the platform in accordance with the aspect M/S and E/T, asserting to have found very useful the online materials in order to increase and deepen what acquired during the face-to-face lectures: "*The addition of new activities is good because in this way we deepened and extended our cultural baggage and now I consider Mathematics not only for 'numbers', but also for education*". Some positive considerations are done about the usefulness of the online materials and of the open home-works. Moreover the close-ended questions have been appreciated in the view of self-assessment.

The third question is: *Would you have preferred more interactive activities with your colleagues? Justify your answer and tell which kind of activities you would like to be involved.*

Looking at the answers to this question, we can say that they are affected by the student's beliefs about collaboration ratio and online platform, strictly linked with the aspect E/T and the aspect M/T, contemporarily. Many students think that the platform is a tool proper for individual learning ("*online the work can be better managed autonomously and individually*") and that collaborative activities are proper of face-to-face context. In the best case, someone wish to mix the two modalities: "*I would have preferred to interact face-to-face with my colleagues, even concerning tasks previously done online. I think that it is better to work individually on the platform*". Moreover someone misunderstands the word 'collaborative' with 'synchronous', so consider the collaborative activities more demanding in terms of spent time and organization as they do not allow to work autonomously.

Anyway the pointed out added value of collaborative activities is in its power to construct knowledge by means of the comparison among peers. Sometimes this idea is affected by the students' view of mathematics: "*being a mathematical exercise I think that the group work could be of help, both for comparing and for asking a colleague to clarify something not well understood*". Moreover collaborative activities would have made the tasks more stimulating.

Finally, the most interesting data, in our opinion, concern the fact that the collaborative activities are seen as useful for the whole learning community, especially for what deals with their future job. It seems that collaborative setting would support the growth of the students as future teachers, and some hints can be found in the comments: *"Even if not simple, it should be interesting to make a collaborative activity; for instance each group could have proposed how to explain to the children some mathematical or geometrical topics*", "*It would be interesting to create a blog aimed to discuss of the experience of the teacher training in schools. Attending the school lectures, a discussion about a comparison between what we are studying at the University and what we actually found in the classroom practices should be promote. Above all, it should concern a comparison among the teachers of a small town or of a city, whether they make the same activities or not, which programs and methods are used by the teachers in various cultural situations in Campania*". From the first excerpt it emerges the aspect M/T but in the latter it seems evident the aspect E/T.

The fourth question is: *Which changes would you propose to the laboratory with respect the current setting?*

According to what already seen in question 1, most of the changes goes in the direction of using online laboratory as training for being successful in exams, highlighting the predominance of the aspect M/S and E/T. This aim suggests to equip the online laboratory with more and more exercises, tests and activities similar to the exam's ones and concerning the topics of the 'course'. Once more, the use of the word 'course' for referring to the face-to-face lectures highlights the students' view of the online lectures simply as 'support' and not as integral part of the course. Anyway, it is worthwhile to note some students' links to their future job. For instance "*e-learning for training us in the use of ICT and for making exercises and proofs to be used with the children during the lectures* is an excerpt in which the aspect M/T seems to emerge as it emerges when some students extend the concept of e-learning, suggesting the use of further tools, such as LIM and exploration of mathematical web site, that the teachers are currently required to make use of, or such as mathematical software cited during the lectures (Cinderella, Geogebra, Matematicamente, Quaderni a quadretti). Finally we want to cite a student's comment, related to the aspects M/T and E/T, which concerns the different learning styles and thus the possibility of tailoring the learning process, which is considered one of the 'added value' of e-learning: "*Concerning the exercises, it would be of help in my opinion to have a more extensive range of activities in order to foster the capability of explain topics in alternative modalities*".

In the fifth question the teacher's role is explicitly present, considering both the M/T aspect and the E/T aspect: *As future teacher, do you think e-learning should have a role in teaching your practice? Explain your answer and, in the case of positive answer, write how you could use it.*

Most of the answers was positive (only 10% says to think that it is not "necessary" using e-learning in primary school teaching). About 40% of the students thinks that it is not possible to ignore technologies' advance and the evidence that the rising generations grow up in a strong relation with them: "*Yes, because we, but above all new generations are digital-born*"; "*All the teachers working in the education field 'must' keep themselves up to date in order to be able to use educational technologies. […]all the future teachers 'must' engage themselves at their best in order to be able to interact, by these means, with digital-born children. […] A teacher is a good teacher also if he/she is able to spur his/her pupils by using both traditional and innovative mediators*". This kind of motivation is associated with the possibility offered by e-learning to reach pupils temporarily absent because of illness.

Another 40% of the students considers platforms as an innovative methodological tool, allowing to support and complete face-to-face activities with online ones. It is interesting to note that some students suggest activities which consider the platform's support from two viewpoints: keeping track of the improvements (Descamps *et al*., 2006) "*I would use e-learning for home-work or, more in general, as a tool to record the learning process in itinere. Maybe using a shared diary to trace the learning experiences at school and at home*"; thinking over experiences carried out face-to-face and writing own considerations in a shared document (Reggiani, 2011): "*As an example, think that at school the abacus is discussed. The teacher, to clarify the argument, shows the artifact to the pupils. Then, in a second moment, the teacher asks the children to carry out the activities on the class' blog (activities regarding the exploration and the use of the abacus). After the correction by the teacher, a discussion in the class among teacher and pupils follows*".

The remaining answers concern the use of e-learning as an "emotional" support or as a support for children with specific difficulties.

4. Conclusions

All the modalities of use described by the Focus/Role Model highlight the opportunities offered by an online course for improving the professional development of a mathematics teacher. The e-learning inclusion in all the educational proposals from various institutions makes urgent to take care of teachers' training with this respect starting from educational research context.

The first analysis of the experience, taking into account the surveys, gives us some recommendations for further work:

- e-learning needs to be well planned: tools and activities should be designed in full details and the scope and the focus of their use has to be well stated to the students, in order to avoid just 'formal' participation and thus just attention to 'formal' parameters (e.g. time counting);
- balance all the aspects of the model in pre-service (and maybe in in-service) teachers' training blended learning should be fully exploited, by means of communication tools and collaborative activities, in order to link actual practices in classroom to reflexive thinking, sharing and discussing various experiences.

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