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eLearning challenges and new horizons

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Online Asynchronous Collaboration for Enhancing Teacher Professional Knowledges and Competencies

Marina MARCHISIO, Alice BARANA, Michele FIORAVERA, Cecilia FISSORE
Dipartimento di Matematica, Università di Torino, Via Carlo Alberto 10, Torino, Italy
alice.barana@unito.it, michele.fioravera@unito.it, cecilia.fissore@unito.it, marina.marchisio@unito.it

Anna BRANCACCIO, Massimo ESPOSITO
Direzione generale per gli ordinamenti scolastici e la valutazione del sistema nazionale di istruzione, MIUR, Viale Trastevere 76/A, Roma, Italy
anna.brancaccio@istruzione.it, massimo.esposito24@istruzione.it

Claudio PARDINI
ISS Carlo Anti, Via Magenta 7, Villafranca di Verona (VR), Italy
dirigente@carloanti.it

Sergio RABELLINO
Dipartimento di Informatica, Università di Torino, Corso Svizzera 185, Torino, Italy
sergio.rabellino@unito.it

Abstract*: Teachers need, in a lifelong learning dimension, occasions that provide them with opportunities to reflect on the activities done by themselves, to learn how to use the newest and most advanced technologies in their teaching, to exchange ideas, to confront themselves on the updated didactic methodologies. Only in this way can they enhance their professional competences and keep the motivation for their job high. Online contexts seem to be the most appropriate option for in-service teacher training because teachers work fulltime in school and, having personal and family responsibilities, it is difficult to find time for scheduled meetings. In this paper we will discuss online asynchronous collaboration within the virtual community of the Italian teachers of Mathematics of secondary schools who participate to the national Problem Posing and Solving (PP&S) Project of the Italian Ministry of Education. One of the main goals of PP&S, which started in 2012, is to enhance teaching and learning Mathematics and Informatics using new methodologies and technologies. The community lives on an e-learning Moodle platform integrated with several tools. Using a multi-method approach, we analyse the online forum discussions among teachers and tutors collected in the last three years; in particular, we explore which kind of activities they suggest to adopt in their real-world classes and the nature of the interactive processes activated in the community. This collaboration among teachers is a peer support and facilitates the process of transformation of practices and of construction of new professional knowledge and competences. Some implications for the training of teachers in pre-service are discussed.*

Keywords*: E-learning; In-service online teacher collaboration; Lifelong learning; Moodle; Teacher professional competencies; Virtual communities.*

I. INTRODUCTION

In the past it was considered important to discover what teachers thought about education, today more attention is paid to the beliefs that people have about themselves, to how they see their role as teachers (professional identity). Korthagen in [1] and [2] considers the professional identity as a

core dimension in the search of the essence of the "good teacher". In his "onion model", he illustrates six levels to define the essential qualities of a good teacher: the external levels (environment and behavior) are easily changeable, the intermediate levels (competences and beliefs) are shaped by their own education, and the internal levels (identity and mission of the teacher) are more related to the self and are extremely resistant to change. The author emphasizes the need for educational projects to aim at the inner levels of the model. In a Vygotskian perspective, Joanne Deppeler [3] views collaboration as a key factor for professional development: teachers, like all learners, learn through collaborating with others, articulating and sharing ideas, finding solutions to the challenges posed within their context; professional learning is thus a process of collaborative inquiry that implicates the transformation of practices and the construction of new professional knowledge [4]. Working on cases involves the same principles that characterize the conditions for effective, substantive and enduring learning in the communities of learners [5]: learners are active agents in the process of learning, they can reflectively turn around on their own thought and action and analyse how and why their thinking achieved certain goals while failed to achieve others; they are engaged in collaboration and supported by the community and by the community's culture. What is more, case-based discussion would represent the favorable setting to develop mutual teaching and peer support, and to build depth of thought. In other words, case-based discussion would promote experiences that generate cognitive dissonance and would stimulate shifts in personal perspectives [4]. Web-based forums are very suitable for structuring activities based on the socio-constructivist perspective, such as the production of group knowledge, work involving learning communities, and represent useful artifacts to support cognitive and metacognitive processes, such as individual and group reflection on the activities carried out. This paper focuses on the benefits of using the online asynchronous collaboration (OAC) in a community of practice and learning, developed within the Italian *PP&S* Problem Posing and Solving Project of the Ministry of Education, and it shows how it fosters collaboration and exchange of materials and experiences among teachers.

II.   STATE OF THE ART

Online asynchronous collaboration is useful to support learning processes in training contexts and their potentials are mainly the following:
  – the online asynchronous discussions well support the complexity of knowledge building processes, where the dynamics of interaction and participation in learning practices are also relevant, and it allows to expand the interaction space giving further possibilities for self-expression;
  – the use of technologies in training contexts can support their complex dynamics through the reference to specific psycho-educational models that guide the educational action both at a theoretical and practical level [6].

The online asynchronous discussions are characterized by linguistic parameters, that consist of discursive strategies adopted by participants to enhance interactivity, collaboration and consistency in their communication actions. These are interactive in so far as the interlocutors use writing not as an instrument of autonomous reflection, but with the aim of participating in communication interactions. Moreover, since different voices contribute polyphonically to weave a single text, cooperation between the interlocutors becomes fundamental. Finally, the term coherence refers to the result of a link syntax that allows the creation of cohesive and coherent texts by combining messages written by different authors. The interactional coherence is deeply linked to the interactivity of writing [7] but it is also connected to the collaboration strategies adopted by users [8].

2.1   Where and how peer to peer online asynchronous collaboration is used

Online asynchronous collaboration can be used in contexts and for multiple purposes, such as: activities between students (peer evaluation), collaboration between teachers, training courses, evaluation of students in university courses. For example, in some university courses, lessons are supplemented by activities carried out by students within a virtual platform, where students can not only share material, but also post notes in discussion forums. In this case, the main objective is not the definition of an answer, but the modeling of a way of reasoning and processing information. Discussing becomes a way to have time and space for reflection in support of the metacognitive

dimension, to allow teachers to monitor the discussion process (thanks to the automatic recording of each message) and to emphasize the explorative, expressive and constructive value of the writing [6].

The asynchronous collaboration can also be used in secondary schools for platform activities, such as solving mathematical problems collaborating among students [9]. Social interactions are relevant in the problem solving process: through discussions in a community of practice they favor the construction of knowledge and awareness of learning [10]. Students through the asynchronous discussion collaborate on the network to solve problems and this favors the maturing of mathematical skills, problem solving and collaborative working.

In all contexts, communicative interactions can play a very important role. They can considerably support the work of the teacher and the student in the realization of complex learning processes that also involve the structuring of the identities of apprentices. For this reason, they cannot be left to chance, but need careful planning [8]. In particular, it is good practice to plan the environment, structure and organization of the asynchronous collaboration in order to facilitate interactivity, collaboration and consistency and overcome the restrictions of the technological interface, encourage cooperative and interactive discursive strategies and stimulate the group's reflection on dynamic communication.

III. PROJECT *PP&S* PROBLEM POSING AND SOLVING

The Problem Posing and Solving, *PP&S*, promoted by Italian Ministry of Education, is a project started in 2012 to support a strong action aimed at innovating Mathematics teaching and learning in the secondary school [11]. The main goal of the project is to enhance teachers' professional knowledge and competencies; in particular the most important objectives of the project are:

- to develop integrated training that interconnects logic, mathematics and information technology;
- to build a culture of Problem Posing and Solving by investing, in the broad applicative domain of disciplinary teachings, in a systematic activity, based on the use of logical-mathematical-informatics tools;
- to support a growth in the information technology culture of teachers;
- to promote online activities with actions of teaching, tutoring and self-assessment.

The project partners are: University of Turin, Polytechnic of Turin, AICA, CNR and Confindustria; the lead school is Carlo Anti Institute of Villafranca di Verona.

To date, the Project involves 1,229 teachers (from all over Italy) of Mathematics, Computer Science, Physics, other scientific disciplines, and 16,400 students.

The *PP&S* Project has adopted the following technologies as essential tools for professional growth and for the renewal of teaching and learning: a Virtual Learning Environment, VLE, a Moodle e-learning platform, which can be reached at www.progettopps.it integrated with Maple (an Advance Computing Environment, ACE), Maple T.A. (an Automatic Assessment System, AAS) and Adobe Connect (a web conference system). The asset developed and proposed has proved to be an essential tool both to allow collaborative learning among teachers and to promote problem posing and problem solving as learning methodologies, to the extent of revolutionizing the teaching of scientific subjects [12]. In the last years, the Department of Mathematics of the University of Turin has developed and experimented a model for teacher training aimed at providing teachers with support, instruments and methodologies for developing - autonomously and collaboratively - instructional practices intended to empower Mathematics learning [13].

In the *PP&S* project, teacher training takes place online, through a constant and extremely effective action of asynchronous and synchronous tutoring. Through exchanges of ideas, materials and educational strategies, the teacher training is carried out in a peer-to-peer manner and in a perspective of lifelong learning. Moreover, teachers can practice the cross-coursing, i.e. each teacher can visit a colleague's course to get ideas on how to set up their activities with their students. The Project also offers the possibility for teachers to open courses on the platform in order to work with their students and share the teaching materials and methodologies proposed on the platform.

IV. ONLINE ASYNCHRONOUS COLLABORATION ANALYSIS: TOPICS AND ACTIVITIES

In the PP & S Project platform, teachers collaborate and interact with each other through OAC. The Moodle platform offers different types of activities for asynchronous collaboration, such as the wiki (which allows you to enter and edit a collection of web pages keeping the history of changes and indicating for each the respective author), the database (for collection and sharing of material) and the forum (which supports many-to-many communication). The different collaboration tool is chosen on the base of the objective and of the composition of the working groups.

For example, for activities in small groups consisting of teachers from the same type of institution and with common learning objectives, wikis were used for collaborative writing of materials and databases for the collection of the same. In order to meet the different needs deriving from the heterogeneity of the community of professors who adhere to the Project and to allow discussions among all the community members (teachers and tutors), the Forum was chosen as an activity. Teachers are not limited to exploiting the activity for asynchronous discussions (asking questions, answering or exchanging ideas), but sharing material and creating educational material collaboratively (sharing a file, reworking it, developing it and sharing it again). In addition, teachers can use with their students the educational material created by themselves, by other teachers in the community or by tutors and then they can share the results of the activity with other teachers, adding personal considerations or advice on how to improve the material.

To facilitate collaboration and the exchange of ideas and material on specific topics, several forums have been created, each one concerning a main topic linked to the aims of the project. In the OAC the protagonists are the teachers, while the tutors intervene only if necessary.

Our analysis will focus on the OAC carried out via forum, since it revealed to be the most efficient method to pursue the aims of the projects and to build a teachers' community of practice. We will restrict the analysis to the discussions about three main topics, corresponding to three Moodle forums, which are particularly relevant for the community and, as a consequence, the most frequent. They are:

- sharing of experiences as teachers, of ideas for methodologies to be used with students, exchange of information and updates (Forum open to all for the exchange and sharing of ideas);
- the use of the ACE: request of information on the use of the software suggested for the preparation of interactive material, exchange of professional opinions on the creation of material, collaboration in the drafting of teaching materials (Maple tutoring forum);
- the use of the Automatic Assessment System: collaboration in the creation of questions and tests, comparison between the different types of formative and summative assessment (Maple T.A. tutoring forum).

Table 1 shows the number of discussions opened and the total number of posts about these three topics since 2012. In the forums the teachers can start a new discussion by creating a new post; moreover, they can respond to an existing post. Every time a post is published teachers receive a notification via email.

As the use of the ACE and of the AAS are object of the teacher training activities, held on the platform through weekly synchronous tutoring, among the discussions on these topics we can find some posts made by tutors to remind of the next online tutoring (about 300 posts in each of them) and to share the material created during the online lessons. To these posts the teachers often respond by asking for further explanations/deepening or proposing a re-elaboration of the shared material (attaching the revised and reinterpreted material to the post). Other less frequent topics deal with the use of the Moodle platform and other learning technologies adopted by some teachers.

Main OAC topics	Number of discussions	Number of posts
Forum for the use of ACE for the creation of educational material	899	3755
Use of AAS for the creation of tests and questions with automatic assessment	671	1908
Exchange and sharing of ideas	380	2495

Table 1. Number of discussions and posts about the main topics

We have analyzed online teachers' discussions to explore the main issues emerged from all the posts and to see how teachers use the forums and how this helps them improve as teachers (professional identity). To examine the OAC we have taken into account the following aspects:
- The main issues that emerged from the discussions, through keywords;
- the Moodle logs and data about the platform's usage to select the users who read and write posts;
- the effectiveness of the OAC (interactivity, collaboration and coherence) through the linguistic parameters.

We have limited the analysis to teachers who have been active on the platform from March 2015. From the platform's logs it emerges that approximately 450 teachers collaborated online in this period of time. To evaluate the effectiveness of the OAC we have divided teachers into 2 groups: those who only read the forums and those who read the forum and participate actively. This classification has been matched with a second one: teachers who effectively work with their students within the platform and teachers who have not dedicated to their courses on the platform yet.

4.1 Main issues emerged

The main issues emerged from all the posts made by the teachers in the various forums are:
- Sharing skills for the use of the proposed tools;
- Co-planning of the preparation of teaching material;
- Sharing of the created material and re-elaboration of the shared material;
- Exchanges of ideas on learning and teaching methodologies;
- Other information (project information, event notices or interesting communications).

As the graph in Figure 2 shows, the majority of the posts (51%) is dedicated to the exchange of ideas on teaching and learning methodologies. They may include specific topics such as: how to propose the methodology of problem posing and solving to the students, methodology of flipped classroom, proposals of didactic courses, remedial courses, the preparation of the students for the state exam or the national Italian INVALSI tests, etc. The high number of posts (20%) dedicated to share skills for the use of the proposed tools is related to the fact that a large number of activities proposed on the platform promotes the training of teachers. Teachers collaborate assiduously with each other and with the tutors to acquire and develop computer skills and to make the best use of the ACE and the AAS. Other very important aspects are: co-planning of the preparation of teaching materials (10%), sharing of the created material and re-elaboration of the shared material (8%). All the posts highlight how the learning community created on the platform collaborates online with the other members of the community. The collaborative research determines the transformation of teaching practices and the construction of new professional skills, enhancing personal and professional growth.
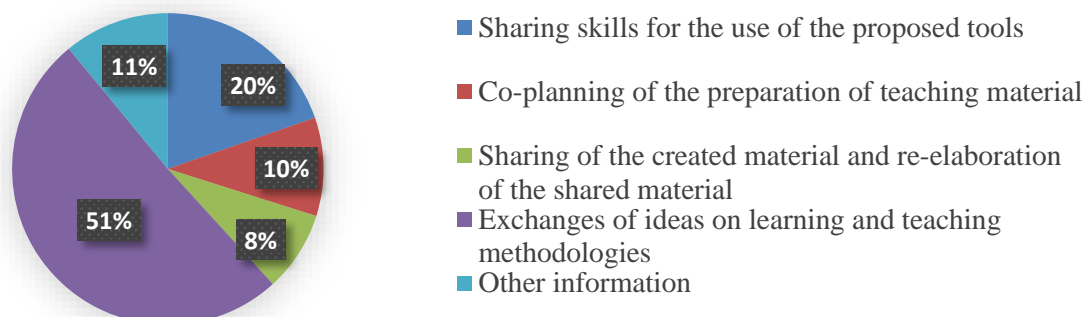
Figure 1. Subdivision of the main topics in the various OACs

Table 2 shows an example of a discussion, entitled "Graphical display error" in the Maple Tutoring Forum, during the Easter holidays, attended by four teachers.

Teacher1 (Monday, 17 April 2017, 22:39):   Dear friends, I was working on a file in which I had to represent a straight line and next to the corresponding hourly law I tried to make the point move but I did not remember which command to use. two graphics has been divided into many squares and I can no longer bring it back to the original view. I cannot understand what I did. Someone can help me? I attach the file Thank you!!!
Re: Teacher2 (Tuesday, 18 April 2017, 04:15)   Nice! I simply changed the instruction to line 23 like this: Do (% Plot0 = d3). I did not understand the need for the display command, removing it works but I do not know how to leave the trace.
Re: Teacher1 (Tuesday, 18 April 2017, 08:57)   Thank you!!! The display was left because originally I had to visualize two graphs, then I deleted one, but I did not change the command. The file, however, worked the same, then it became a check ... mystery! Thanks again.
Re: Teacher3 (Tuesday, 18 April 2017, 09:13)   Just add the command trace = n (for example after the frames command), with n number of visible traces with maximum value the number of frames; it is not convenient to exaggerate because it weighs down the code, I would put trace = 35.
Re: Teacher2 (Tuesday, 18 April 2017, 09:37)   Thank you. I would like to observe that a trace makes the motion of the object less "legible", I would not put it ... Good day to all
Re: Teacher3 (Tuesday, 18 April 2017, 10:31)   Indeed, the visualization of the tracks does not improve the graphic appearance. I modified a code that I had inserted in a previous maplet with the data of our friend, I share it and I dedicate myself to the correction of the last package of tasks!
Re: Teacher4 (Tuesday, 18 April 2017, 12:23)   Dear friends, I thank you for these important contributions. Beautiful works ... Interesting and engaging debate in these messages ... Between the correction of the various test packages, it is nice to find this "intellectual vivacity" on the platform. A dear greeting and Happy return to school to all!

Table 2: Example of a discussion

In the discussion Teacher1 asks for help to represent the trajectory of a rectilinear motion. Teacher2 suggests a useful command of the software but does not really know how to respond to the colleague. Then Teacher3 explains a correct command but according to Teacher2 this is didactically not relevant. Teacher3 then proposes a file where he had previously obtained a similar result. At the end of the discussion, Teacher4 congratulates his colleagues and thanks them for the ideas that came out. In the above discussion we can see a first discursive signal ("Can someone help me?") that

indicates interactivity. In the following posts we can see discursive signs of agreement (in our example: "Nice!", "Indeed".) But also disagreement ("I would not put it"), which represent parameters of collaborative communication. Finally, it can be observed how teachers use the discursive mechanism of repetition of the topic (in our example the trace of motion in the graph) to reduce the fragmentary nature of the discussion and increase its consistency. From this discussion we can see that the teachers, in a colloquial language, respond promptly exchanging information and advice on the use of the software and on how to best use it to teach the uniform rectilinear motion. In these cases, the tutor is an observer ready to intervene in case of need. His task is summarized in terms of: tutoring, scaffolding, facilitator, participant, observer, and evaluator of the correctness of the process.

4.2 How teachers use the Online Asynchronous Collaboration and how this helps them improve as teachers (professional identity)

The analysis of the *PP&S* teachers' community platform logs showed that teachers uses the OAC activities in different ways: some teachers (64%) only visualize other teachers' posts, while others (36%) also intervene in first person by creating new discussions or by responding to other post (Figure 3).
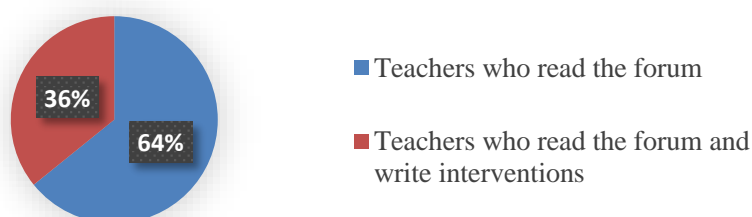

Figure 2. Actions of the teachers

To test the effectiveness of the OAC we checked if teachers effectively work with their students within the platform. Counting the teachers who read the forum section without actively intervening, data show that 33% of them work in their courses on the platform and create good educational material for their students, while the remaining teachers have not taken much care to their courses on the platform yet. On the other hand, considering the teachers who actively participate (responding to other teachers or creating new discussions), it can be seen that 69% of them work in their courses and create high-quality teaching materials.

V. RESULTS AND DISCUSSION

The proposed analysis on the OAC shows that the teachers community on the *PP&S* Project platform is a learning and practice community. The OAC is fundamental for working together for the development of learning materials, helping each other, discussing teaching methodologies, sharing practices. Teachers learn by discussing online, not just by talking about concepts and ideas, but by questioning themselves as apprentices, authors and partners of collaborative processes. So, learning through OAC also implies co-building one's teacher identity. The learning processes are also favored by participation in a community of practice, because the participants feel that they belong in a context and define themselves with respect to this belonging and to the dynamics of participation that they establish.

Teachers collaborate online in different ways: some ones actively intervene while others only read the posts written by others. The analysis carried out shows that the teachers who actively intervene and collaborate with the other teachers develop greater skills in the tools proposed by the Project and are more likely to work on the platform with their students. On the other hand, even those who only read the forum can acquire skills and learn new methods. We have seen in the discussion example (Table 2) how the OAC is important to create a family work environment in which it is possible to build knowledge through a continuous sharing of proposals, theories and questions: ideas are born, enunciated, discussed, reviewed and organized; the progress achieved generates further progress and the problems are continually being reformulated to a more complex level which pushes us to consider a wide range of knowledge. The colloquial language used by the tutors and all the

teachers helps to overcome the restrictions of the technological interface, encourages cooperative and interactive discursive strategies and stimulates reflection on the issues developed. This example let us understand also how interactivity, collaboration and coherence emerge in online asynchronous discussions, which indicate the effectiveness of OAC.

The OAC also responds to the need to identify teachers and, at the same time, to satisfy the needs to belong and to share which make learning a cultural practice and not just a process of acquiring knowledge.

VI. CONCLUSIONS

Learning is the result of a complex dynamic of interaction and comparison between the individual activity of elaboration-construction of information and the socio-organizational context in which teachers are put to the test in the first person. In this sense the OAC responds to the necessity of satisfying the need to belong to and share with a learning community that makes learning a cultural practice and not just a process of acquiring knowledge. The most frequent social interactions are based on the exchange and construction of new knowledge and lead to collaborative learning. The latter can occur by exchange, when some knowledge or a competence is spread by a subject to others who do not have it, or by construction, when it is the result of the union of knowledge and reflection of several subjects interacting in a context.

The OAC in the *PP&S* project platform has proved to be a fundamental tool for creating the teachers' learning community. The community uses the tools for OAC both as a means of professional growth (development and sharing of skills and learning new tools and teaching methods) and as a tool for sharing experiences related to teaching. Through the OAC it was possible to build and spread the culture of problem posing and solving, which all community members share and try to adopt as a teaching methodology. If on one hand the results of the OAC are very positive, a further step must be made to try to involve all the teachers who are currently less active in the community, who have more difficulties either in getting involved in first person by intervening actively or in adopting the methodology proposed by the Project.

It would be very interesting in the future to use these methodologies for the training of future teachers, led by active teachers in the Project platform and by the tutors. In this way they would be accompanied on their journey by experts in the field who can introduce them to well-tested training courses. When new or veteran teachers work on one case, they are actively involved in their own learning, they are stimulated to reflect on their own lived experience and to examine it. Through the OAC the thought process is dialogic and the cases become educational for teachers within the teaching communities. By reading analytically, commenting on the others' cases, writing on their own, relating stories to each other, principles or theories emerge. This aspect is of particular importance in light of the current Italian school policy which pays particular attention to teachers in service throughout their life. It would certainly be interesting to study the different constructions of the professional profiles of future teachers and in service teachers and to analyze the nature of the interactions that would be created, in particular the social cognitive processes within a shared online discussion.

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