Proceedings of the Re(s)sources 2018 International Conference

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RE(S)SOURCES 2018

International Conference
ENS de Lyon - May 2018

+ Young Researchers Workshop /
Atelier Jeunes Chercheurs

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MOOC as a resource for teachers' collaboration in educational program

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MOOCs can be understood as digital resources for teachers, because they are a repository of many other digital powerful resources for teaching mathematics, with which teachers can interact by themselves or each other inside the MOOC environment. The aim of our paper is to answer the following specific research question: how to analyze the interactive nature of a MOOC and its influence on teachers' learning? The answer is linked to the elaboration of a suitable theoretical framework. It was born thanks to our involvement in different teaching experiments with some Italian MOOCs, designed and delivered for mathematics teachers' professional development.

Keywords: MOOCs, teacher professional development, MOOC-MDT, meta-didactical transposition, teacher collaboration.

Introduction

A Massive Open Online Course (MOOC) is an online course aimed at unlimited participation and open access via the web. MOOCs are a recent and widely researched development in distance education which were first introduced in 2008 and emerged as a popular mode of learning in 2012. Early MOOCs often emphasized open-access features, such as open licensing of content, structure and learning goals, to promote the reuse and remixing of resources. Some later MOOCs use closed licenses for their course materials while maintaining free access for students. In addition to traditional course materials such as filmed lectures, readings, and problem sets, many MOOCs provide interactive user forums to support community interactions among students, professors, and teaching assistants. Therefore, a MOOC can be considered as a digital resource with many other digital resources inside. Despite their big success, the emergence and use of MOOCs for professional teacher development is still uncommon, especially in mathematics, but on the verge of gaining a foothold. Moreover, the specific intersection of MOOCs and professional teacher development is poorly researched.

Mathematics MOOCs for teachers' professional development

In our Department at University of Turin, we are involved in a project called Math MOOC UniTO. The project aims to design and deliver MOOCs for mathematics teachers, mainly from secondary schools, with the aim of increasing their professional competencies and improving their classroom practices. The project started in the spring of 2015 and four MOOCs were designed, one for each of the main topics in the official Italian programs for secondary school: Arithmetic and Algebra, Geometry, Change and Relations, Uncertainty and Data. So far, the first two have been delivered and the third one will be delivered in January 2018. These MOOCs are open, free, and available online for teachers on a Moodle platform (http://difima.i-learn.unito.it/). It is important to underline that each MOOC is weekly based and from 6 to 8 weeks long in total. Every week the trainees become

familiar and interact with resources focused on specific mathematical topic (i.e. height, angle, sense of the number, …) related to the specific mathematical area considered in that MOOC. Therefore, in each week trainees watch videos where an expert introduces the topic of the week; read the mathematics activities based on a laboratory methodology (and, optionally, experiment these in their classroom). Trainees are invited to share thoughts and comments about the activities and their contextualization within their personal experience, using specific communication message boards (Forum, Padlet: https://it.padlet.com/, and Tricider: https://www.tricider.com/). From our experiences, there is a need for designing and implementing MOOCs for teachers' PD in mathematics education with a focus on the development of communities of practice (Wenger, 1998) and the collaborative work among teachers as a basis for their PD. Indeed, when people co-work (work together collaboratively) they can also co-learn (learn together collaboratively): teachers can learn through discussion, conversation and reflection on their own teaching, on student learning and on the teaching of others (Robutti et al., 2016). The methodology of our MOOCs aims to create collaborative contexts for teachers' work, where they can learn from these kinds of practices. Taking into account the necessity for teachers to be supported in exploiting technology affordances, the objectives are: accompanying teachers in the design of teaching resources, by examples of activities and reflection on their work in progress; fostering a reasoned use of technology, with the use of appropriate digital tools for classroom. A research question comes out: *How to analyze the interactive nature of a MOOC (understood as a digital resource with many other digital resources inside) and its influence on teachers' learning?*

The MOOC-MDT

Despite the fact that a rich literature exists about how teachers can develop their PD in traditional face-to-face courses, on MOOCs specifically there is not the same richness: hence our proposal is to present a theoretical framework aimed to interpret the interactive nature of a MOOC environment and its influence on teachers' learning. We revised the *Meta-Didactical Transposition*[1] model (MDT: Arzarello et al., 2014) and re-elaborated it from a framework apt to describe face-to-face teachers' PD to a new one, suitable for describing the PD dynamics within a MOOC environment. To do that, we integrated MDT through an *hybridization process* (Arzarello, 2016) with *Connectivism* (Siemens, 2004) and the *Instrumental Approach* (IA: Verillon & Rabardel, 1995), obtaining what we call MOOC-MDT. With the hybridization, you consider a particular component of a theory. This is "implanted" in another theory that, for this reason, will be hybridized: the old theoretical framework is so enriched and the language as well. In Connectivism, the notions of *personal knowledge* and *learning* are closely connected to the network theory. *Personal knowledge* is a particular kind of network, whose nodes are any entity that can be connected to another node (information, data, images, ideas...), while an arc is a connection, a relationship, a link between two nodes (Siemens, 2004). *Learning* is a continuous process of building, developing, self-organizing knowledge – understood as

[1] MDT is a model that describes the process of teachers' PD, aimed at describing teachers' and researchers' activities over time, in terms of meta-didactical *praxeologies* (Arzarello et al., 2014, pp. 353-355): tasks in which they are engaged in the educational program, along with the techniques used to accomplish them and their theoretical justification.

a network (Siemens, 2004). Therefore, learning not only adds new nodes, but also connects existing nodes and makes sense to these connections. The personal knowledge can be understood as an evolving network: the knowledge at a given moment corresponds to a timely conformation of the network, while the act of learning, of increasing knowledge, corresponds to the process by which the structure and complexity of the network expands. Taranto considered these two key concepts of Connectivism and made a hybridization with the IA (Verillon and Rabardel, 1995) taking into account also successive refinements (Trouche, 2004; Drijvers & Trouche, 2008).

In this frame, a MOOC can be considered as an *artifact*, that is a static set of materials. Connectivism considers the *MOOC-artifact* with its own network-based knowledge: its nodes are the used content, ideas, images and videos; the connections are the links between their node pairs. When a MOOC module is activated, it dynamically generates a complex structure that we call ***ecosystem***: "all the relations (exchange of materials, experiences and personal ideas/points of view) put in place by participants of an online community thanks to the technological tools through which they interact with each other, establishing connections within the given context" (Taranto et al., 2017). The network-knowledge of the *MOOC-ecosystem* is dynamic: it evolves as the MOOC-artifact's network, thanks to the participants' contribution. Also, the network-knowledge of individuals evolves as a personal self-organization (Siemens, *ibid*, p. 4) of the ecosystem. The process of transformation from artifact to instrument (Verillon & Rabardel, *ibid*) is here replaced by the evolution artifact-ecosystem/instrument. In particular, what the IA indicated as instrumental genesis, here is replaced by an hybridization between IA and Connectivism, triggering what we call "***double learning process***": from the one side, the MOOC-ecosystem is a specific learning tool for the individual; from the other side, the use of the MOOC-instrument by the individual generates learning for the whole ecosystem. The dynamic process has the following components, intertwined and self-feeding each other: (i) **Instrumentation/Self-organization** (from the ecosystem to the individual): process by which the network of MOOC-ecosystem expands the individual's network-knowledge. In particular, the **instrumentation** is the process by which the chaos (Siemens, *ibid*) of the ecosystem network reaches the individual. The many novelties of views and experiences make sure that the individual compares himself with new usage schemes. A phase of **self-organization** of the MOOC's information follows this process: namely, when the individual selects which usage schemes proposed by the MOOC are valuable and which are not. (ii) **Instrumentalization/Sharing** (from the individual to the ecosystem): process by which the individual's network-knowledge expands the network of MOOC-ecosystem. The **instrumentalization** is the process by which the individual, with her/his renewed network-knowledge independently builds new connections. The individual is stimulated by a task requested by MOOC and (s)he caters to the ecosystem to turn it according to her own (new) usage schemes. (S)He wants to integrate it with her/his own cognitive structures. **Sharing** is the process by which the MOOC welcomes the contribution of the individual and makes it available to all: information goes towards all members.

Discussion and Conclusion

The hybridization takes place considering two components of the Connectivism: personal knowledge and learning. These are implanted in the IA, which is so adapted to MOOC's own dynamics, where the community of participants becomes subject and object of a new, more complex kind of

instrumental genesis: the double learning process. In fact, it maintains the structure of the instrumental genesis, with directions from the subject to the object and vice versa, but it is also enriched with the Connectivism standpoint. If in the MDT, the trainers shape their proposals according to the practices they think appropriate, and so they can estimate how much the trainees learn such proposals, in the MOOC-MDT the process of training appears to be more difficult to control. The trainers do not know "what" the user has really looked at among the presented materials, nor they can know how (s)he interpreted them. Equally, the trainees benefit from material provided by trainers and other trainees sharing their materials and ideas using the communication boards. The process evolves stochastically: a determining role is played by each trainee feeling part of an interacting community. MOOC-MDT facilitates the study of the specific dynamics of the interactions among trainees and between trainees and trainers, which occur online in virtual environments. We will show the MOOC-MDT efficacy through examples of collected data emerging from the experiences of our MOOCs.

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