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Methodological Approach and Technological Framework to Break the Current Limitations of MOOC Model

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Abstract: A methodological approach and technological framework are proposed to improve learning outcomes in Massive Open Online Courses (MOOCs), taking into account the distinguishing features of this kind of massive courses over traditional online courses. The proposed methodology integrates the learning strategies of xMOOCs and cMOOCs with adaptivity and knowledge management capabilities. In order to test the learning results of the methodology and the need of supporting technological framework for it, a MOOC was made based on the methodological proposal and using a MOOC platform called MiríadaX. The quantitative results have improved considerably the MOOC completion rate (compared to the average of the rest of MOOC MiríadaX) and the qualitative results show a great satisfaction with the learning outcomes of the learners. However, the technological environment did not allow us develop all the methodological capabilities and it was one of the main concerns of the MOOC attendances. Therefore, from the analysis of collected data and considering the limitations of current MOOC technology platforms, a technological framework has been designed. It may incorporate the proposed methodology in an efficient and effective way. Based on this proposed technological framework, a MOOC platform has been developed and delivered, used by three Spanish Universities to offer MOOCs. This new platform and the supported technological framework have been tested with a first pilot with promising results.

Keywords: learning management system, massive open online course, technological framework, instructivism, connectivism, adaptive learning
Categories: K.3.1, K.3.2

1 Introduction

Education has never before had such an intense social response. Hundreds of thousands of users on online platforms, thousands of enrolments each academic year and the most prestigious universities worldwide publish their academic resources in open environments [Group Edinburgh 13; Sharples 13; García-Peñalvo et al. 14b]. All of this is the result of what the Massive Open Online Courses (MOOCs) offer [McAuley et al. 10; Yuan and Powell 13a].

Relevant Higher Education (HE) related people think that MOOCs will revolutionize and transform education and their social success will change the approaches of open training (free software and open resources) [Yuan and Powell 13b] the growth of social networks [Downes 12] and the challenges to achieve education for everyone. Ideas of change arise which will have medium term consequences such as: new economic models for universities, new academic-social accreditation models, improvements in the quality of the universities' brand and a tendency to democratize education [Alraimi et al. 15].

Nevertheless, another school of thought, mainly academic, places its focus on aspects like: pedagogical design of the MOOCs, the roles of teacher and student in these massive course, the high rate of drop-outs in MOOCs, the difficulty to confirm the physical personality of the participants, the limited validity of the accreditations, etc. Those who question the validity of the MOOC model, as a transforming and disruptive effect in teaching and learning processes, hold on to these. [Aguaded-Gómez 13; Scopeo 13; Zapata-Ros 13a; Bartolome and Steffens 15].

Transformers of the teaching practice or educational bubbles, new learning or marketing model, the true is that MOOCs have for a great deal of prominence in conferences and scientific journals [Martínez Abad et al. 14; Chiappe-Laverde et al. 14]. There is an enormous amount of interest in having with reliable data that allow us to understand the MOOC phenomenon and its possible impact on the HE models and the learning strategies.

MOOCs present extreme educational characteristics, such as massive usage, heterogeneity and the absence of tutors, which add difficulties to the design of the educational strategy and the technology used.

But one of the most negative aspects of the MOOCs is their low rate of ending, which, according to diverse experiences, is between 5% and 15% [Belanger and Thornton 13; Jordan 14; Alario-Hoyos et al. 14a]. In this sense, some studies have been done in order to know what aspects influence on the high drop-out rates in order to know if this aspect should concern or not. This failure is attributed to the academic subject, the heterogeneity of participants, the curiosity that is awoken in persons that have no a real intention to do the course, etc. Although some studies do not really think it is an important problem, because of the new role of “visitors” instead or “participants” in MOOCs [Guetl et al. 14], this factor is taken into account by other authors as one the barriers that MOOCs must overcome to build a sustainable model [Hill 12] in order to improve the methodological and technological MOOCs characteristics.

As examples of this concern, technological frameworks are being worked on [Alario-Hoyos et al. 14b], as well as contributing new pedagogic models [Grover et al. 13; Siemens 13; Rosselle et al. 14; Raposo-Rivas et al. 15]. There are currently two main types of MOOCs, the type X models (xMOOC): instructivist, individualist and use platforms that are similar to the Learning Content Management Systems (LCMS) [Bali 14] and the type C (cMOOC), that are based more on the social learning, the cooperation and use of the web 2.0 [Downes 08], [Downes 12]. Many authors have introduced the two tendencies [Hill 12] with extensive lists of references [Mackness et al. 10].

The pedagogical model and the technological support define the possibilities of both types of MOOC. The xMOOC technologies enable a classic learning; while the technologies based on social software allow new ways of study [Zapata-Ros 13b]. A simple collection of the different technologies should not be the main concern, but collecting the learning methods that those technologies make possible managing the knowledge produced through each learning method [García-Peñalvo et al. 10] and adapting the selection and organization of those resources with respect to different participants profiles [Barbosa and García-Peñalvo 05; Barbosa et al. 12].

xMOOC technologies are the most commonly used: Udacity, Coursera, Mtx, Edx and Future Learn, evolving from Stanford xMOOCs. The technological evolution is therefore focused on the X platforms, which are developing learning analytics and data mining techniques [Long and Siemens 11; Ruiperez-Valiente et al. 14; Jordan 13]. Both the learning analytics and the techniques based on data mining are key tools for shedding some light on the behavior of the participants in the MOOC, as well as for knowing the reasons why it leads to a high rate of dropout. Nevertheless, these do not support new pedagogical models.

In addition, a technological framework is being worked on for MOOCs to improve the MOOC from both design and learning. The existing frameworks are conceptual and are based more on administrative and design aspects like the MOOC Canvas Model [Alario-Hoyos et al. 14b], instead on the elements that a MOOC should have.

Some studies deal with defining new conceptual models and improving the platforms. However, there is a lack of studies that are centered on proposing a technological change that integrates advantages for each type of MOOC, together with technology that allows a more efficient management the MOOCs characteristics such as heterogeneity (profiles, age, teaching objectives, academic level) and the massive usage. [Fig. 1-A] presents the current situation: there is a pedagogic model linked to a technological model. The pedagogic models of the xMOOCs are based on instructionism and individualism and the cMOOCs are based on connectivism and cooperation. Either one of the models are chosen [Bates 13].

The knowledge management is always an important aspect to bear in mind in any learning process, in special with a big amount of students and in online learning. Not only with respect to keep a big amount of information but with respect to the access of the students to that information. In that sense, one of the problems, derived of the integration of formal and informal activities in a MOOC, is the management of the knowledge generated by the teachers (before starting the MOOC) and the participants (during the activities).

On the–other hand, there is a broad agreement with respect to the need of the applying adaptive methodologies in order to improve the learning by means of the personalization [Berlanga and García-Peñalvo 04; Berlanga and García-Peñalvo 05; Berlanga and García-Peñalvo 08; Fidalgo et al. 13]. The current information technologies allow building learning itineraries to adapt the learning process to the characteristics of each student. Characteristics such as profile, previous knowledge, learning style, rhythm of learning, etc. The massive usage and the heterogeneity of the participants in a MOOC are important factors that justify the usage of adaptive methodologies.

The aim of this paper is to build a technological framework based on the following aspects: 1- the adaptation of the learning strategy for activities type X (formal) and type C (informal) to the profiles and preferences of the participants, 2- the management of the knowledge generated through both types of activities and their integration in the learning space of the type X, and 3- the integration of a learning analytics system as a help tool, in order to monitor the cooperative work.

This technological framework is suitable for working like cMOOCs, or like xMOOCs or, more interesting, integrating the characteristics of both types. In this proposal the pedagogy is aligned with the technology and this technological framework allows adaptivity (personalized training), massive cooperative work, integration and management of resources produced in the formal and informal training, instructionist and connectivist, see [Fig. 1-B].

In the next section, the proposed learning model is presented, by including methodological and pedagogical approaches. Then, the technological framework is defined to support the characteristics of the learning model, as well as the learning analytics and knowledge management modules. A case study is presented to check both the model and the need for having a specific technology to support the model. This study is completed with the discussion and the conclusions.

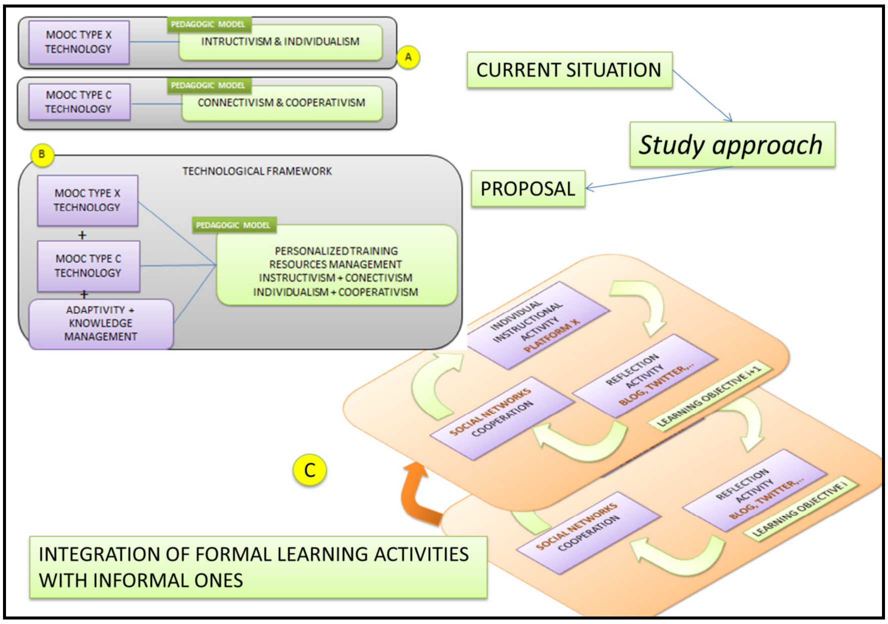


Figure 1: Study approach and integration of formal with informal activities

2 Learning model

This section does not include a new learning model, but it only presents a model that integrates learning characteristics of the MOOC type X with type C, with adaptive learning and knowledge management.

The predominant technology in the MOOC gives support to those of the X type and continual improvements are carried out in their provision, both in the management of concurrent access and the analysis of the interaction of the participants of the MOOC with the platform. Those platforms are also including technologies of the MOOCs type C such as forums, blogs, social networks and PLE (Personal Learning Environments) [Castaño-Garrido et al. 15]. The mentioned advances are important but insufficient in order to solve the current problems of the MOOC.

New pedagogical, methodological and technological approaches are needed. The pedagogical aspects (learning strategy) are based on the integration of formal learning (xMOOC) with the informal learning (cMOOC). The methodological model is based on the adaptivity learning (in activities type X and C) and the integration and management of knowledge generated during activities type X and C (by using the knowledge generated in activities type C for the activities type X) . The technological model must give support to the methodological model (adaptivity and knowledge management) in order to get new pedagogical approaches [Zapata-Ros 13a].

The key of the proposed model is the integration of these three approaches and it is similar to a pyramid. The base is the technological framework; the technology allows applying knowledge management and adaptivity (foundations of the methodological model) with the help of learning analytics tools. The methodological model is located in the medium level of the pyramid; and the top is occupied by the learning strategy (pedagogical aspects). In this case the pedagogical model is not limited by the technology because the medium level (methodology) allows combining personalization, integration of formal and informal activities, knowledge management and even decision making.

In the next subsections the learning strategy (integration of formal and informal activities; integration of instructionism and social learning; and sustainable products: the learning communities) with the management of the flow of knowledge will be presented.

2.1 Learning strategy

The xMOOC contains a methodology very similar to online academic courses, close to formal teaching without a tutor (self-training). Those of type C have a strategy that is closer to informal and social learning. Each strategy has its advantages and limitations.

The learning strategy of the xMOOCs is not prepared to support heterogeneity, because all of students should adapt to the prefixed course planning, objectives and materials. This could be one of the reasons for the high rate of dropouts because there is a greater involvement of the participants whose interests must coincide with the design of the MOOC. The learning strategy of the cMOOCs presents the difficulty in managing cooperation, maintaining the teaching objectives and managing the knowledge produced by the participants. The learning strategy, proposed in this study, allows the advantages of each type of MOOC to be used, solving the problems that each one presents. This model has three dimensions, which are included in the following subsections: integration of formal and informal activities, integration of instructionism and connectivism and creation of sustainable products throughout the duration of the course and subsequent to its completion.

2.1.1 Dimension 1. Integration of formal and informal activities

The strategy of this learning model is based on combining and integrating formal teaching activities (considering the characteristics of massive usage, heterogeneity and the absence of a tutor) with those of informal teaching (considering the difficulty of organizing the learning resources). The inclusion of a knowledge spiral is contemplated, based on the interaction between the formal and informal learning activities. This is repeated throughout the implementation of the course, creating different levels of knowledge. [Fig. 1-C] presents this spiral, composed by a formal learning activity (learning a concept through a video and a questionnaire) and two informal learning activities (usage of a social network to participate in a debate with people of different profiles and to identify, organize and share useful resources related to a specific concept).

2.1.2 Dimension 2. Integration of instructionism and social learning

The knowledge spirals have a continual effect on the learning and on each level a specific learning objective is fulfilled. The individual formal learning activities are based on instructionism methods. They are used for theoretical and conceptual teaching and are based on the contents. The reflection activities reinforce the formal learning activities. See the integration of conceptual teaching and skills in [Fig. 2-A]. The cooperative activities are based on social learning. The cooperation is based on sharing resources between equals, although teamwork can also be included. These activities are designed so that skills and competencies are produced that are more greatly suited to the particular interests of each participant in the MOOC. All of the activities, those based on instructionism and those based on social learning, can be adapted; in other words, they are proposed according to the profile and learning needs of the participants.

2.1.3 Dimension 3. Sustainable products: Learning communities

Resources produced in the MOOC are understood as those that are provided by the teaching staff prior to the start of the course, those that are produced by participants throughout the course and the useful resources for the course that are available on internet (provided by participants and teaching staff). The previous dimensions produce an intensive and continuous creation of resources, mainly on behalf of the participants. These resources are normally created and organized in social networks, forming learning communities. The use of the learning community during the course is carried out in dimension 2 and, once the course has been completed, the learning communities grow in number in terms of both individuals and resources.

2.2 Managing the flow of knowledge

The cooperative and connectivist activities, as well as the reflection activities, produce knowledge and resources. The creation of learning communities and resources, in a continuous manner, allows new knowledge will be available at the same time that the MOOC is being carried out. This knowledge, created by means of informal learning (type C), should be integrated with formal learning (within the type X). If it is not integrated, the learning is not as effective as it could be.

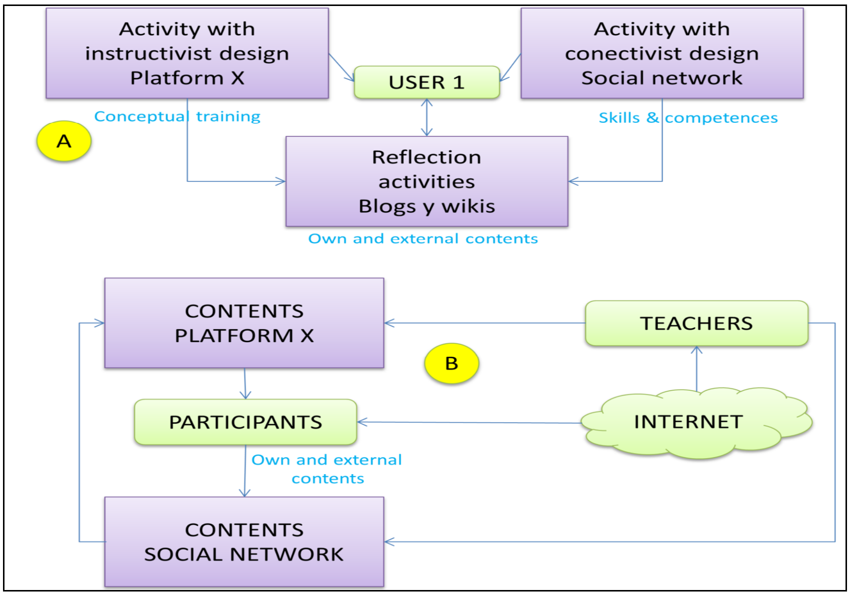


Figure 2: Dimension 2 and flow of knowledge of learning strategy

[Fig. 2-B] shows the continual flow of knowledge that takes place from the start until the end of the MOOC. Before starting the course, the teaching team provides a group of learning resources, which are normally included in the X platform and are used for the formal learning activities. The inclusion of those resources is also contemplated, for example, by professionals related to the topic of the MOOC. These resources can be included in the X platform and/or in the social networks. By means of the activities type C, for example on a social network, the participants of the MOOC create new resources (guided by the learning activities), which can be used in the X platform. The resources of the X platform can also be used in the C platforms (called here to social environments); therefore a continual flow of knowledge is established, due to the cooperation between the individuals. This vision is even more effective when more varied resources are produced; therefore, the existence of many individuals on the MOOC with different profiles further strengthens this action. In this study a cooperative work is used, based on the continuous flow of learning resources among the different platforms and learning activities.

In the next section the technological framework, which support the introduced learning methodology, will be presented, including the modules of adaptivity, knowledge management and learning analytics.

3 Technological framework

In this section, the technological framework is described, in order to convert a X platform into an adaptive platform that allows: the personalization of learning, the management of the knowledge that is created (in the course and in social networks) and the management of cooperative work between thousands of people (with the help of learning analytics).

The design is structured and adaptive in such a way that allows instructionism together with participation, as well as teaching and learning strategies and individual and community actions. Therefore, the framework should support the advantages of both cMOOCs and xMOOCs.

The proposed technological framework creates tools that allow optimizing the conceptual models and provides adaptivity, knowledge management and learning analytics tools, all of which can be integrated with the LCMS. In a generic way, the technological framework is shown in [Fig. 3-A].

The LCMS proposed in this study should be a system with the classic functions of a LCMS that allows student management, organization of resources (file, label, web, etc.) and activities (questionnaire, task, forum, workshop, book, enquiry, task, etc.). But the LCMS should also allow its integration with other tools that provide adaptivity, knowledge management and learning analytics.

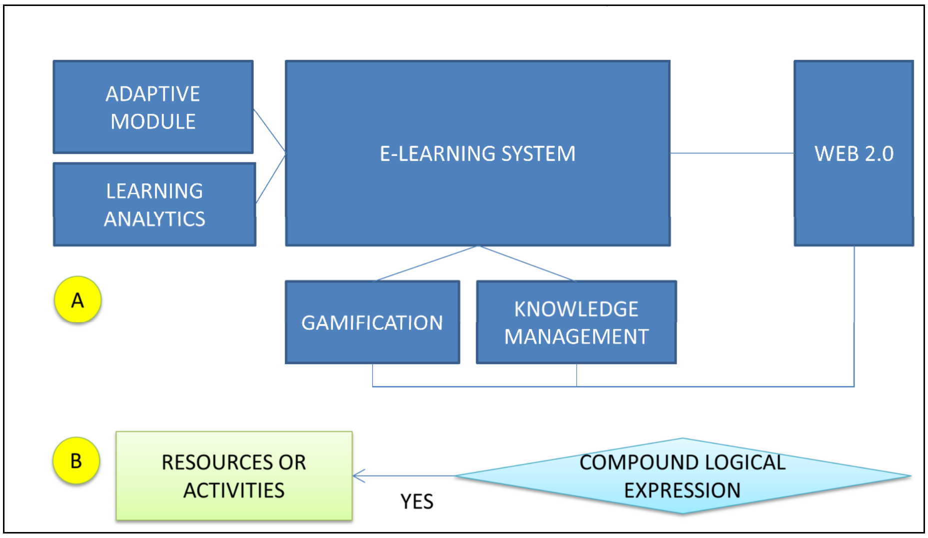


Figure 3: Framework structure & adaptive module

3.1 Adaptive module

Adaptive MOOCs have been carried out based on structuring the content in such a way that the same content is designed depending on a specific learning style [Sonwalkar 13]. The framework proposed here should cover more cases of adaptivity, such as the educational interest, learning objectives, academic level, professional profile, etc.

The idea is the following: for each resource or activity of the LCMS a condition is associated with it. If the condition is met, the resource is viewed, and if it is not met, the resource is not viewed. This condition is formed of a compound logical expression.

The logical operators that it should allow are "and", "or" and "not" and the simple logical expressions can be the result of the user interaction with any resource or activity of the LCMS system. For example, a compound expression would be:

(answer 3 of the questionnaire q1 = "yes") and (answer 5 of the questionnaire q4 >6) or (answer 6 of the questionnaire q4 < 3)) and (participated in the forum "Cooperation")

If this logical expression is complied with, then the resource or activity, associated to the logical expression, is shown. If the logical expression were not complied with, the resource/activity would not be viewed [Fig. 3-B].

The composition of logical expressions forms an algorithm. The learning itinerary followed by students depends on the activities and their results. However, a diagnostic assessment could condition the personal itinerary of each student, automatically chosen by the system, or even the LCMS could give a recommendation for the next step and the student should choose one option.

This module provides the technology with functionalities to:

- Create individual itineraries based on: learning styles, academic level, profession, learning objectives, available time, skill level acquired, achievement of learning objectives.
- Integrate teaching based on instructionism with teaching based on cooperation. Therefore it allows the synchronization of individual and community activities.
- Integrate the general teaching strategies with strategies adapted to each user.

In this case, the conditionals Moodle system (LCMS system considered here) was developed by the CICEI [CICEI 14] and it carried out diverse experiences [Sein-Echaluce et al. 11] for the version 1.7 of the platform Moodle [Moodle 14]. These conditionals have been maintained up until the version 2.3. The mentioned Moodle version already includes, in the official version, the conditionals system with the same approach as this framework, but with the following limitations: from version 2.0 to version 2.6 it does not allow operators "or" and the simple expressions do not allow interactions with all of the resources and activities of the Moodle (for example with the specific answers to a questionnaire). Moodle 2.7 has already included the operator "or".

An example of usage of adaptive module taking into account the heterogeneity in MOOCs is presented here. Consider the profile of "teacher" (people who are working as a teacher) and the aim is encouraging the participants with that profile to participate in a learning community to talk about educational innovation. It is assumed that they will prefer a community or a group around the subject of teaching or interest. In that case the adaptive system asks about that subject and what innovation field is the preferred. Depending on the answers, the systems choose a specific community/group. Besides, the system asks about the technological previous knowledge in order to give automatic support to do certain actions (log in, upload a file, etc.). Thereby learning community, topic and activities are being personalized.

3.2 Knowledge management module

The knowledge management system, which is own developed is currently an external module to Moodle. It allows the multimedia resources to be managed by teaching staff and users, independently of their origin (from teachers or created on the social networks, blogs and wikis). This system offers the possibility of managing the resources, provided by the participants on social networks, in a group manner, together with the resources provided by the teaching staff in the instructional teaching.

As Fidalgo says in [Fidalgo et al. 13] "Knowledge management classifies, organizes and enables semantic search mechanisms by means of ontologies in order to spread and apply the organizational knowledge created in the ontological spiral. The use of ontologies is based on the CSORA method, which is characterized by using ontologies to classify, search for, organize and relate knowledge. *Classification:* All elements that enter the repository are classified based on the ontologies. *Search:* The ontologies are used as search criteria; logical expressions of ontologies can be made. *Organization:* The ontologies are used to organize the search results. *Relation:* Part of the ontologies are used to relate knowledge" [Sein-Echaluce et al. 13].

3.3 Learning Analytics module

This learning analytic (LA) module, combined with the teamwork method CTMTC [Lerís et al. 14], allows monitoring individual and group competencies needed to carry out teamwork. The module was developed in 2014 for Moodle and has been confirmed in more than 100 work teams (around 600 students) [Fidalgo et al. 15].

A learning analytics service, called *Group Competency,* has been created and includes functions to recover information from: courses on the platform, forums of the mentioned courses, threads for a group and a particular forum, specific information from threads and the users of those threads, the number of messages per group, information of a post based on its identification, user information per group, number of views per discussion and views per discussion and user. The learning analytics system, of own development, analyzes all of the information from the forums based on the interactions of the users by means of the forum threads (its relation with the learning results have been studied by [Agudo-Peregrina et al. 14]). It also helps decision making for the evaluation of individual and group evidence.

This information is consumed by a client that allows the navigation by the structure of the information. To do so, it allows the user to select the course, forum and group of the learning platform and, depending on the selection; it provides specific information of the interaction in the forum and thread. It also provides specific information for a specific user. All of this enables the teaching and overall evaluation of the group competency.

As an example, the mentioned adaptive system allows to make groups with the MOOC participants (for example, for common interest topics). The LA system allows identifying the progress and the implication of each team member. It also detects if a team member has a weak participation in the team activities. It seems to be a convenient way for a dropout early detection and the subsequent decision making to avoid it.

3.4 An example of technological framework implementation

Based on the framework, the platform for MOOC called i-MOOC (Intelligent-MOOC) has been designed [i-MOOC 14] and developed by three universities: the Polytechnic University of Madrid, University of Zaragoza and the University of Salamanca, in collaboration with the research groups LITI (UPM), GIDTIC (University of Zaragoza) and GRIAL (University of Salamanca).

They have currently prepared three MOOC: "Applied educational innovation", "Free software and open knowledge" and "Social networks for learning". All of the MOOC have been developed in the MiríadaX platform, in such a way that when they are taught they can serve as contrasting courses with the new technological platform.

A test has been carried out with 270 students in order to check the flows of knowledge between different framework services. Figure 4 shows the services and flow of information between them in more detail. The designed test consisted of establishing 6 profiles of participants. Depending on the profile, a different survey is assigned and, upon completing the survey, a specific resource is assigned to their profile. Figure 4 shows the diagram of the i-MOOC test based on the framework proposed.

There is the same initial "identification" activity for all of the people that are entered in the system. The identification consists of choosing one of the 6 available profiles: 1GTM, 2GTM, 3GTM, 4GTM, GIE1 and GIE2. Depending on the profile selected by each student, the "teaching plan" is personalized. In this case, the teaching plan is based on establishing a questionnaire that is adapted to each profile and a specific resource for each profile.

The specific resource is only accessible when the student has completed the survey (in other words, the previous activity). In [Fig. 4], the example is shown for the individuals that chose the "GIE2" profile. 60 individuals completed the survey and 52 assumed the resource. The framework has worked properly with different operating systems (30,34 % for visitors and 7.706 Hits with Windows 7) and Browser (58.91% of visitors and 14,660 hits with Google Chrome). The total number of hits is 21,671.

Next, a case study is presented. It involves the "Applied Educational Innovation" MOOC (AEI MOOC) taught with the specific technology of an X platform and a social network. In the same MOOC the proposed learning model, of the section 2, was included.

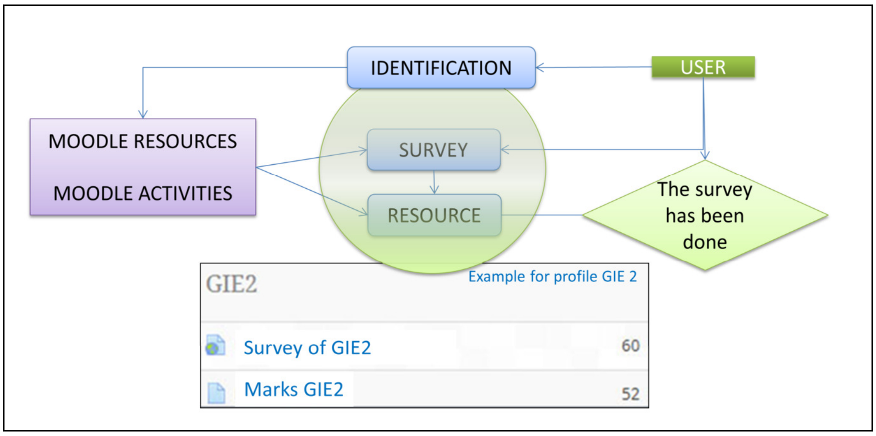


Figure 4: Partial test of the technological framework

4 Case study

The case study integrates the two MOOC models, for the X type, the MiríadaX platform has been used and for the C type, the social network Google+ has been used. The integration of the case study with the MiríadaX platform allows results to be compared (like for example the rate of completion) with the average of these same results obtained in the MOOC of MiríadaX [MiríadaX 14].

The social networks LinkedIn and Google+ are used in this model. With respect to LindkedIn, the debates and the resources on the network were included, by the teachers, in the X plataform (MiriadaX) (this social network offers the profile of each participant in a debate, which is an advantage). The social network Google+ allows individual references of the provided resources by the participants themselves. It allows the knowledge to be organized using categories that can also be used as contents. In this way, the same structure can be used for the resources of the two types of MOOC.

The proposed learning model has been applied to this technology in this study, which is based on integrating formal learning activities (type X) with informal learning activities (type C). Similarly, the cooperation is used to create a continual flow of knowledge between the participants.

For this study, the quantitative data has been obtained from the MiríadaX platform, following the criteria of the mentioned platform, and the qualitative data has been obtained from a survey about the satisfaction of the participants in terms of their learning. Next, the description of the case is presented, the used learning model, the created products and the quantitative and qualitative results gathered throughout its execution and upon its completion.

4.1 Description and conditions of entries

Applied Educational Innovation MOOC Objectives: To identify and relate the components of educational innovation, to know their processes and for the teaching staff to apply educational innovation on the day-to-day work. Duration: 6 weeks (from 6 March - 10 April 2014). Structure: 6 modules, the first one is a presentation. Platform: MiríadaX. The information in [Fig. 5-A] reflects the results of an initial survey that was carried out by the participants of the MOOC in order to detect their profiles. The quantitative data confirm the extreme conditions of the MOOC: massive usage (more than 6,000 students), heterogeneity (ages, where they are from, profession, level of studies and educational interest) [Fidalgo et al. 14a; García-Peñalvo et al. 14a].

4.2 Learning model of the case study

As has already been explained in the proposed model and in relation with the technology, X platform and C environments are used. MiríadaX is used as the X platform and Google+ is used for cooperative and informal learning and a blog, as an element of reflection for resources and activities, both formal and informal ones.

The previous proposed learning model, included in section 2, is based on the integration of formal learning activities (type X) with informal learning activities (type C) creating a flow of knowledge between participants, the teaching staff and professionals of the sector. *Formal learning activities:* each module includes short videos, recorded professionally, and tests on MiríadaX to check whether the knowledge imparted in the videos has been acquired. *Informal learning activities:* Reflection activities concerning the topics dealt with in the formal activities and reflected on the social network (mainly the blog), cooperation activities (to construct in a cooperative way using wikis or the social network itself), and finally application activities and activities to identify useful resources.

The knowledge spiral for each module starts with formal activities then they are followed by informal activities and subsequently with a new formal activity (between 2 and 6 groups of formal and informal activities for each spiral). In terms of the cooperative strategy, the resources created by participants, teaching staff and professionals of the sector are integrated in relation with the subject of the MOOC.

The technological platform MiríadaX has led to an important impediment in the dimension 3 of the proposed model. The teaching staff was not able to edit the course once it had been started, therefore the contents created by the participants were not be integrated within the X platform. This aspect was alleviated somewhat by organizing the content of the social network into categories with the same name as the course modules on MiríadaX. Therefore, part of the MiríadaX course content was also included on the social network.

4.3 Products of the case study

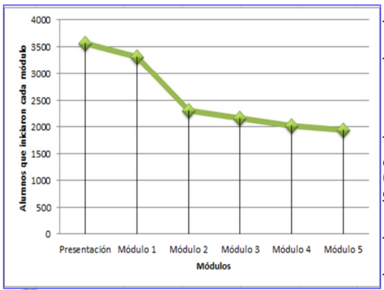
The learning community was created on the first day of the course. Therefore, the participants of the community were able to share resources related with MOOC from the very first day and also establish contact with people with similar interests. The learning community organizes the resources, provided by its members, in the same way as the subject contents of the course. In this way, access to the resources is enabled. This methodology creates two products: *a learning community* and *a space where the resources created are organized.* With respect to the evolution in terms of participants, since the course ended and to date (3 months), in April 2014, upon completing the MOOC, the learning community had 2,107 participants and in July 2014 it had 2,650 participants (an increase of 30.04%).

A

Enrolled in the MOOC	6149
Completed the survey	3236
Gender	
Male	58.03%
Female	41.97%
Countries. Top 7	
Spain	55.62%
Mexico	10.35%
Columbia	7.69%
Peru	5.62%
Argentina	3.71%
Venezuela	2.69%
Brazil	2.44%
Professions	
Teachers	50.40%
Students	21.82%
Non-teaching	27.78%
Educational interest	
To know what it is	16.01%
To apply it	53.92%
To have a new vision	24.07%
To have the materials	6%
Level of studies	
Primary	0.34%
Secondary	5.62%
University	52.75%
Post-university	31.15%
Professional	10.14%
Age of participants	
<20	0.88%
20-29	30.47%
30-39	31.12%
40-49	24.23%
50-59	11.30%
>60	2%

B

Indicators	Values
Number of individuals enrolled in the course	6149
Percentage of completion for students enrolled in the course (information from MiriadaX)	28.2%
Percentage of completion on the X platform with respect to those that saw at least one presentation. (information from MiriadaX)	46.4%
Percentage of completion on the platform with respect to those that started teaching modules (information from MiriadaX)	53.7%
Percentage of participation on the C platform with respect to the students enrolled on the X platform (information from the social network)	32.8%



D

Participation information	
Total number enrolled	6149 individuals
They have completed the survey / % with respect to the number enrolled	1050 individuals / 17.08%
Amount of participation in the course (with respect to those that completed the survey)	
I have not participated	3%
I have barely participated	10%
I have participated a little	27%
I have participated often	32%
I have participated very often	28%

Figure 5: Case study information

4.4 Results of the case study

Two types of results are presented: quantitative and qualitative. The quantitative results are provided by the platforms themselves, like the rate of completion, participation and the evolution of abandonment. The qualitative results come from a learning satisfaction survey completed by the participants of the platform.

4.4.1 Rate of improvement and evolution of abandonment

Statistics are used for the X platform (in this case MiríadaX), in order to share them with those of other MOOC of MiríadaX, as well as internationally. In [Fig. 5-B], the rates of completion for the course are included for the total number of enrolled individuals, the total number of those that have entered the platform at least once, and the total number of those that have started at least the first teaching module. Similarly, the percentage of participation for the social network is included.

The main indicator, from which a standard measure has been established in the success of the MOOC, is the rate of completion for the total number of individuals enrolled on the X platform [Onah et al. 14]. Worldwide, this rate is between 5% and 15%. The result of the MOOC of MiriadaX is approximately 13.95% in February 2014 (between 121 courses) [Aranzadi 14] and in this case study is 28.2%. This percentage has also been obtained in other two MOOCs implemented by this research team with very different topics, "Free software and open resources" and "Social networks" [Fidalgo et al. 14b].

[Fig. 5-C] shows the evolution of dropout; in other words, the time when this occurs. It shows the participation of the individuals enrolled on the X platform, when starting the different modules. There is a high rate of students enrolled that do not even start the course, as well as those that are enrolled and abandon the course at the beginning of module 1. It can be observed that the most important decrease of participation corresponds to the presentation + module 1.

3.4.2 Satisfaction results

A satisfaction survey was undertaken upon the completion of the AEI MOOC, which is an adaptation of the SEEQ questionnaire (Student's Evaluation of Educational Quality), designed by Hernert Marsh and already confirmed [Marsh 82]. The survey was sent to all of the students enrolled in the AEI MOOC and measures the three following grades: participation (see [Fig. 5-D]), learning and cooperation in the AEI MOOC. It is interesting to remark that people, who did not finish the MOOC, also answered the survey. Between people who answered the survey, the percentages were the following: 3% did not participate in the course, 10% had a weak participation, 27% participated with regularity and 60% had a strong participation.

In [Fig. 6-A] the results for questions Q13 to Q15 are included, which refer to the learning undertaken. Questionnaire with Likert scale 1 (strongly disagree) to 5 (strongly agree)

Q13. I have learnt and understood the course content.

Q14. I have learnt things that I consider to be valuable.

Q15. My interest in the topics dealt with has increased by doing the course.

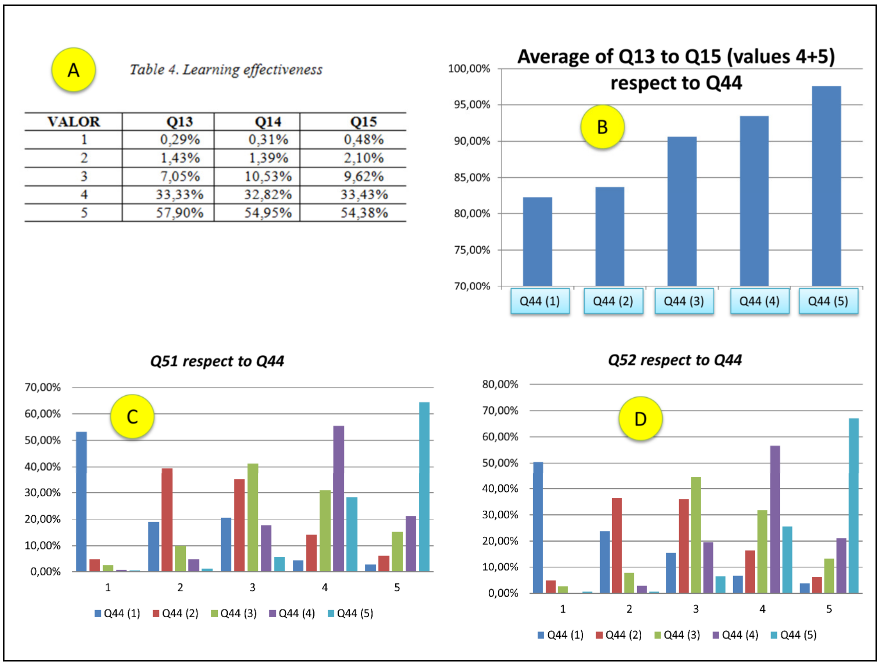
[Fig. 6-B] represents the average of the answers (value 4 and 5) of Q13, Q14 and Q15 with respect to the values given to the question Q44 (*I have participated in the learning community*). The Q44 (1) is the number of users that selected the value 1 for Q44, namely, they did not participate in the learning community), Q44 (2) have chosen the value 2 for Q44… till value (5) with the users with a high participation in the learning community. It is observed that, in general, the perception of users about their learning continues being high; and even it is higher for those who participated in the learning community in comparison to those did not participate. Therefore, these results support the model.

The questions, which are presented below, aim to measure the amount of cooperation of the participants in the AEI MOOC and the influence of it on the learning results. The limitation of the technology should be remarked if it does not allow the integration of the flow of knowledge produced in both platforms. In [Fig. 6-C], [Fig. 6-D], the answers are included for the following questions, with respect to the values given in Q44:

Q51. Sharing resources and interacting using the social networks improve the learning of the course

Q52. Sharing resources and interacting using social networks improve the initial course content

In this survey, the results demonstrate that the cooperation is useful, both for the learning and for the improvement of the course content. If we take into account the individuals that consider that the cooperation does not improve the learning, or it improves it a little, it is 22.10%, versus those that think that it improves somewhat, a lot, or quite a lot, which is 77.90%. Similar percentages are those that think that it also improves the content, 20.44%, that think that they do not improve them or hardly, versus 79.56% that consider that it improves it somewhat, quite a lot or a lot. If we analyze the results of the survey in accordance with the participation of the users in the community, it is observed that the persons that have not participated are those that have answered that the community does not help, or hardly helps, both in terms of the improvement of the learning and the improvement of the initial course content. Nevertheless, a very high percentage of the individuals that have participated in the community have expressed that the participation in the community helps to improve both the learning and the course content.



VALOR	Q13	Q14	Q15
1	0,29%	0,31%	0,48%
2	1,43%	1,39%	2,10%
3	7,05%	10,53%	9,62%
4	33,33%	32,82%	33,43%
5	57,90%	54,95%	54,38%

Figure 6: Results of satisfaction survey

Based on the results, it is demonstrated that the application of a methodology, that integrates the specific characteristics of each type of MOOCs, significantly improves the results. It is also demonstrated that the current technology is not usually prepared for supporting the extreme conditions of the MOOC and limits the application of this model. On the other hand, the technology impedes activities, effective for heterogeneity, like adaptive learning cooperation using work teams and decision-making using learning analytics [Fidalgo et al. 15; Lerís et al. 14].

All of this justifies the need to have a specific technological framework that allows the inclusion of the latest advanced technology (learning analytics, adaptivity and knowledge management) together with the technological characteristics of the xMOOC and cMOOC. In this study, the design of the framework is presented for the presented technology and a first prototype has been developed on which tests are starting to be carried out in order to confirm this.

5 Discussion

The integration of the pedagogic models of the two types of MOOC (X and C) presents advantages faced with a single pedagogic model. In the study, it has been compared whether the students of the same MOOC, using two types of technology, have a better perception of improving learning (questions Q1, Q2 and Q3 of the survey). These results support the Siemens proposal [Siemens 13] with respect to the conceptual framework, where pedagogic characteristics of the two types of MOOC are integrated. The integration of the pedagogical model requires management of the knowledge, produced in the learning communities, to integrate it in the instructionist process.

The mentioned integration is positive in the learning process and it has been proved by the qualitative data of questions Q51 and Q52 of the satisfaction survey. People who have participated in the learning community (43.24% have used it a lot or quite a lot) express, in a high percentage, that the learning community improves both the learning (53.10%) and the initial course content (53.81%).

The information about profiles demonstrates the high degree of heterogeneity between the participants of the IEA MOOC. Numerous studies demonstrate the effectiveness of the personalization of learning for different profiles. Those validate the inclusion of an adaptivity module in the technological framework. In this sense, there are studies that partially cover this topic, for example, when including adaptivity in the types of content, depending on the learning styles but with the same participant profile [Sonwalkar 13]. Nevertheless, there are no references in which the system adapts to the profile (academic level and profession) or to the teaching objectives that, with so much heterogeneity, are necessarily different. Even a study with 76 randomly selected MOOCs shows that the majority scored poorly on most instructional design principles and most MOOCs scored highly on organization and presentation of course material [Margaryan et al. 15].

The usage of two technological platforms (one of each type) has been necessary in order to demonstrate the effectiveness of the pedagogic model. However, this technology presents various deficiencies: the lack of adaptivity and the possibility of managing and integrating the flows of knowledge created in the learning communities. Therefore, a technological framework is necessary. In this sense, the current studies are based, to a greater extent, on defining methodological frameworks and conceptual frameworks [Alario-Hoyos et al. 14b] therefore this study provides new knowledge to be taken into account for the development of the MOOC.

Cooperation is necessary for learning [Downes 08], however the massive usage of the MOOCs means that it is impossible to monitor the learning. The application of learning analytics allows the cooperation to be monitored, as well as a teaching evaluation to be carried out. These methods have already been tested successfully and applied to the monitoring of the teamwork competency [Leris et al. 14]. All of this can lead to new possibilities in the MOOC.

The technological framework, in addition to giving support to the instructionism and connectivism, should contain functionalities in order to carry out adaptivity (necessary with different profiles), in order to manage the created formal and informal knowledge and in order to carry out the monitoring of the cooperation between the participants.

Previous studies suggest studying dropout, considering as reasons for it the dates that the course is offered, the country where students are from, culture, etc. [Jordan 14; Guetl et al. 14]. The information of the case study presented here shows that there are two types of dropout, one that occurs before the start of the course (40.03%) and another that occurs during the first few weeks of the course (23.05%). The social and cultural reasons, as well as the circumstances themselves for the teaching of the MOOC, like the dates that the course is offered or the enrolment process, could influence the first type of dropout. However, the second type of dropout would occur due to the lack of suitability of the course in accordance with the different profiles and the educational interests. This second level of dropout can be more greatly related with the adaptivity than with the assumptions, which are indicated in other studies. The technological framework will allow a more intensive deepen at the research of dropout rates, an important element which should be solved in MOOCs.

6 Conclusions

A model has been designed that takes into consideration the interaction between pedagogy and technology; referring to the methodological approach and the technological framework. The current technological platforms considerably limit and influence the pedagogic model. For this reason, in this study a learning model has been proposed that integrates the advantages of each type of MOOC (X and C) together with learning strategies designed to deal with the diversity of the users of a MOOC (adaptivity), the thousands of resources that are produced by the participants (knowledge management) and the help in monitoring the cooperation (learning analytics). All of the foregoing takes part of the technological framework, in which the adaptivity, learning analytics and knowledge management are the main points of focus. The underlying learning model has been checked in the case study.

The current platforms limit the learning model; therefore the quality of the educational product is committed. The results of the dropout (average of 90%) of MOOCs clearly indicate this situation. A design for a learning model that is more greatly adapted to the characteristics of MOOCs (diversity, heterogeneity and massive usage) has demonstrated that it improves the quality of the educational product (dropout around 70%).

It has been demonstrated that the learning model and the technological framework should be aligned in order to achieve real success in a MOOC. If technology limits pedagogy, the specific needs of MOOCs will not be able to meet. Methodological proposals and conceptual frameworks have advanced for MOOCs, however without suitably adapting the technology, these proposals will not be able to be implemented due to the limitations deriving from the platforms. In this case study the union of the technological and pedagogic models of xMOOCs and cMOOCs are supported by the quantitative results (rate of completion) and qualitative results (satisfaction surveys). The rate of completion has doubled the average rate of completion of the rest of MOOCs (121) for the same technological platform. Therefore, it demonstrates that the MOOC are sensitive to the integration of technological models, both type X and C.

It is necessary to reconsider the technology of the MOOC platforms. The predominant domain of the X platforms does not consider the connectivism and the cooperation. These methods are important when a great variety and a large number of different profiles exist, and because they produce the improvement in generic competencies (starting with digital competencies). The MOOC single model cannot be adapted to the profiles and this could be a reason for the high rate of dropout. On the other hand, it is necessary to investigate the creation of MOOCs that offer different approaches in accordance with the participants' profile. The proposed framework allows a MOOC to be carried out with multiple approaches, adapted to the different profiles. The optimum management of all of the knowledge produced during the MOOC contributes to the improvement of the learning in its informal contexts. The inclusion of the two types of MOOCs (X and C), adaptivity and knowledge management, as well as the support of learning analytics in order to carry out monitoring of the cooperation, allow new focus points to be considered in the teaching process, really necessary to improve the current conditions of the MOOCs.

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