Experiences of Running MOOCs and SPOCs at UC3M

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Abstract—**The appearance of MOOCs has boosted the use of educational technology in all possible contexts. Universities are trying to understand this new phenomenon, while carrying out the first trials. Best practices are still scarce and will be developed in the coming months. In this paper, we present first experiences carried out at Universidad Carlos III de Madrid, both with MOOCs (Massive Open Online Courses) and with SPOCs (Small Private Online Courses), which are MOOC counterparts for internal use.**

Keywords- MOOCs, SPOCs, open, authoring, social networks, learning analytics

I. ONLINE COURSES

Massive Open Online Courses (MOOCs) have disrupted the higher education scene in the last two years. Elite universities, whose business model was based on scarcity, have released some courses for free to the world, attracting multiples of thousands of students. Even if the business model is not clear, many other universities have followed. After some startups in the USA (Udacity [1], Coursera [2], edX [3], NovoEd [4], etc.), other initiatives at national level have followed (MiríadaX [5] in Spain, iversity [6] in Germany, FutureLearn [7] in the UK, Open2Study [8] in Australia, FUN [9] in France, XuetangX [10] in China) and umbrella initiatives at the European level (OpenUpEd [11]).

It is not the case that the educational technology behind MOOCs has not been used before. There are many successful experiences, even complete universities, built on the idea of online education. But the MOOC fever has shaken up the world, leading to new models that emerge from the heart of traditional face-to-face universities.

However, many of these same technologies that allow reaching an immense number of students (higher quantity) can also be used to improve residential education (higher quality). The acronym *SPOC*, referring to *Small Private Online Courses*, reflects this trend. Some universities are already trying out this post-MOOC formula. Let us mention here ETHZ in Zurich with its TORQUE project [12], MIT, which has set up the Office of Digital Learning [13], or Harvard Kennedy School of Government plan to launch SPOCs [14]. Although there are some similarities between MOOCs and SPOCs regarding technologies, there are also important differences that mainly stem from the number of participants and their different profiles [12].

In this paper, we will describe experiences of running MOOCs and SPOCs at Universidad Carlos III de Madrid (UC3M), Spain. A comparison between these two kinds of courses is presented and discussed aimed at identifying their common elements and differentiators regarding authoring and preparation, deployment, and analysis. In particular, we will focus on two initiatives:

- The Genghis project [15], a set of SPOCs for freshmen to refresh their knowledge in basic sciences (mathematics, physics, and chemistry).

- The EDF course (*Educación Digital del Futuro*) [16], a MOOC on educational technology for the Spanish-speaking community.

These two initiatives differ in several aspects:

- Scope. Genghis was for local students that registered voluntarily before entering an undergraduate program, whereas EDF was open to the world.

- Platform. Genghis was deployed on a local instance of the Khan Academy platform at the UC3M, while EDF was deployed on MiríadaX, hosted by Telefónica Learning Services.

- Content. Genghis was about well-established STEM content, whereas EDF was about more up-to-date topics.

However, these two initiatives have also some common aspects:

- Video production. Both initiatives provided video-based content and, in both cases, videos were specifically created for the course (not just recording classroom lectures).

- Digital assessment. Both initiatives used assessment mechanisms based on providing immediate feedback, which has been demonstrated very effective for helping students take control of their own learning, and become self-regulated learners [17].

- Forum. Both initiatives had the support of a forum in which students could post questions that were answered by their peers.

Although most of these issues have been in place in some way or another, it is also true that the MOOC fever is putting pressure on universities, which now face the challenge of

improving the quality of their teaching, while at the same time positioning themselves among top higher education institutions, in a context characterized more and more by an open education.

II. Experiences

A. The Genghis Project

The Genghis project was created in response to the need of new university students to refresh the fundamentals of some key science topics taught at High School. It turns out that the knowledge of STEM subjects freshmen have is often not enough to understand first year courses at the university. For years UC3M has been offering remedial courses for freshmen that consist of one week of face-to-face lessons about fundamental topics in STEM subjects before the start of the school year. However, the experience shows that these courses are not enough: the amount of time is limited (the courses only last one week) and the number of activities to practice in the classroom is low. To overcome these limitations, the Genghis project proposed to start a set of online courses in summer 2012 aimed at complementing the face-to-face lessons. These *remedial online courses* were available during 5 weeks before the face-to-face classes, so that students could access the different resources and complete the proposed activities. In this way, the "flipped classroom" model [18] was followed: first students learnt online, and then there was a face-to-face class aimed at solving the problems found

These remedial courses were only open to the UC3M freshmen registered for it (SPOCs). There have been two editions of the Genghis project so far: the 2012 edition where a Physics SPOC was created, and the 2013 edition where three SPOCs were provided: Physics, Mathematics, and Chemistry. Students had the possibility to register in several SPOCs during the same edition. More than 100 students participated in the first edition and more than 500 registered for the second one.

These SPOCs included videos and related exercises structured in blocks and topics. There was at least one exercise addressing the concepts explained in each video. Contents were not released at specific times; they were all available from the first day. Students had complete freedom to select the next resources they wanted to access, although professors recommended the most appropriate learning path. Learning contents were indexed in a structured way, and a tool for recommending the next exercises was also available in the Khan Academy platform.

The total number of videos for each course ranged from 22 to 30, while the total number of exercises ranged from 30 to 49. Videos and exercises were created by professors from the respective Departments with the support of a UC3M unit specialized in educational technology and teaching innovation (UTEID, *Unidad de Tecnología Educativa e Innovación Docente).*

Each video lasted approximately ten minutes, was focused on a specific topic and was uploaded to YouTube. Most of the exercises were of the fill-in-the-blank type and parametric (i.e. a student could repeat the same exercise several times, but every time the exercise was delivered the value of the variables

was different). Each exercise had associated hints that the student could request. A student needed to solve correctly several exercises of the same type without asking for hints and at first attempt in order to get the proficiency in that kind of exercise.

The Genghis project uses the Khan Academy platform to deploy the courses. An institutional instance of the Khan Academy platform was installed and configured at Universidad Carlos III de Madrid, personalizing it for the specific educational context. In this way, UC3M has total control of the platform, which does not depend on third-parties.

The Khan Academy platform enables visualizing videos linked from YouTube, posting comments and responses on videos, and solving exercises. In addition, the platform implements a specific gamification strategy, according to which students can earn energy points and badges by completing the different activities. There is also a powerful learning analytics module that helps students and professors understand better the learning process.

The Khan Academy was integrated within the institutional Moodle as part of the Genghis project to take advantage of features of both platforms (see [19] for details). Particularly, Moodle added the forum support to facilitate the communication among students. In addition, a single sign-on mechanism was implemented in both platforms to restrict the access only to those students that were enrolled in the remedial courses, since SPOCs are not intended to everyone.

B. The EDF MOOC

EDF is an open multidisciplinary nine-week MOOC produced at UC3M that addresses educational technologies. The first edition of EDF was delivered between February and April 2013 in the platform MiríadaX, and was taught by five professors and teaching assistants from the Departments of Telematic Engineering and Humanities. They all participated in the authoring and preparation of EDF, which also counted with a full-time facilitator to moderate the debate in the social tools, and serve as a liaison between students and the teaching staff. The course was supported by UTEID and audiovisual technicians, who provided assistance in the video recording, edition and post-production tasks.

EDF was structured in three modules. The first module dealt with the concept of interaction and its evolution as technology does. The second module addressed mobile technologies and their use to improve the educational experience in face-to-face and blended courses. Finally, the third module explored MOOCs and the sudden changes they are bringing to Higher Education institutions, stressing their affordances related to gamification and learning analytics. Each of the three modules lasted three weeks. There was also an introductory module that succinctly presented the course structure, the evaluation system and the social tools.

Learning contents included a set of nine short videos per week (about ten minutes each) covering the topics to be addressed during that week, plus additional recommended readings and the slides (if any) that were used in the videos. One of these videos was typically an interview with a leading

person in the field, who brought his vision of expert. Each video was preceded by a short text giving an overview of the content explained. All the videos were hosted in YouTube and subtitled for a better understanding.

Assignments were presented as multiple choice tests or peer assessment activities. Multiple choice tests served both for formative and summative assessment. After every video, students answered a question that was not considered to calculate the final grade (formative assessment). After each week, students answered a brief questionnaire that scored up to 5 points (summative assessment). Each module also contained a more elaborated activity that students had to submit following a predefined schedule. This activity was evaluated using a peer assessment method: students evaluated their peers' work according to a given rubric facilitated by professors; each peer assessment activity scored 10 points maximum. There was a final multiple choice test that gathered questions from the three modules, and in which students could get up to 25 points. Students could get a total of 100 points as part of their summative assessment; they passed the course if they got at least 50 points.

Every week the learning contents and assignments that were due in the next seven days were released. Students were notified by email at the moment in which materials were ready, and received regular communications reminding deadlines. Once learning contents and assignments were released in MiríadaX, they remained open for the rest of the course (except for summative assessment activities). The registration process was active during the whole course, so that latecomers could join and learn, even though they had missed some deadlines.

III. Life Cycle

Both MOOCs and SPOCs follow a life cycle that typically includes three stages: authoring and preparation (in which the course is designed, and learning contents are prepared and uploaded to the course platform), deployment (in which the course starts and runs) and analysis (in which professors see learners' performance and detect which actions were successfully supported and which were not). It is noteworthy that the analysis stage does not necessarily occur after the end of the course and can overlap with the deployment stage.

A. Comparison of Genghis and EDF

This section compares the Genghis SPOCs and the EDF MOOC, highlighting the similarities and differences among them. These similarities and differences are classified according to the three stages defined in the life cycle: authoring and preparation, deployment, and analysis. Table 1 summarizes the comparison.

B. Authoring and preparation

The authoring stage consisted mainly of designing the course, and preparing the videos and exercises in both the Genghis SPOCs and the EDF MOOC. Moreover, there was an important workload to generate the final course structure in both the Khan Academy and MiríadaX (e.g. creating the blocks/modules, or uploading the videos to YouTube and linking them afterwards from the platform).

TABLE I.   COMPARISON OF GENGHIS SPOCs AND EDF MOOC

Stage	Genghis (SPOCs in Khan Academy)	EdF (MOOC in MiríadaX)
Authoring and preparation	Restricted to UC3M freshmen	Open to the world
	Instructional design: videos lectures + exercises	
	Videos uploaded to Youtube and linked from the platform	
	Home-made	Semi-professional
	Handwriting on a tablet	Talks, interviews, professor explaining on PowerPoint
	Most exercises were parametric fill-in-the blanks. Some of them were multiple choice	Multiple choice tests and peer assessment activities
	Cumbersome generation of exercises: need for an authoring tool	Authoring tool for the generation of exercises included in the platform
	Need for coordination among teaching staff	
	6-15 professors	5 professors
	5 weeks	9 weeks
	Formal	Non-formal
	Well-established STEM topics	Up-to-date and exploratory topics
	Creation of gamification elements: badges	Lack of gamification elements
Deployment	All the materials available from the first day	Weekly release of materials
	No deadlines, self-paced	Regular deadlines
	100-200 participants per course	> 5000 participants
	Medium drop-out rate	High drop-out rate
	Homogeneous profiles	Heterogeneous profiles
	Social tools for the communication among students	
	Forum	Forum, Q&A, Facebook, Twitter, MentorMob
	No facilitator	Facilitator to promote discussion in social tools
	No certification	
Analysis	Platform installed in internal servers: total data availability	Platform provided by third-party: restricted access to data
	Detailed analytics of students' performance provided by the platform	Poor analytics of students' performance provided by the platform
	Proper visualization of analytics within the platform	Need for new strategies to visualize at a glance analytics from thousands of students
	No external tools	Additional analytics from external social tools

Regarding the creation of videos, the total duration of each video in both courses was approximately 10 minutes. The video production in EDF was semi-professional, carried out in collaboration with audiovisual technicians in charge of the editing and post-production. Furthermore, some videos, such as the introduction of the course and the interviews with experts, were recorded with high quality cameras. In contrast, the video creation in the Genghis SPOCs followed a more home-made style, but following the best practices for video creation provided by UTEID [20].

Another important difference in the creation of videos was their format. While in the Genghis project most videos used handwriting on tablet, EDF relied on professors explaining with the support of PowerPoint presentations, and informal talks. The different video formats were chosen according to: (1) the topics delivered, with more exploratory topics in EDF and well-established STEM topics in Genghis, and (2) the tone of learning: non-formal in EDF and formal in Genghis.

Regarding the creation of exercises, there were big differences in both courses due to the types of exercises supported by each platform. EDF included multiple choice tests and peer assessment activities, which were the two types of exercises available in MiríadaX at the time of uploading the materials. Genghis SPOCs included mainly parametric fill-in-the-blanks exercises instead, which were natively supported by the Khan Academy platform. In addition, some multiple choice exercises were also included in the Genghis project. The Khan Academy platform allowed additional features in the exercises, such as the possibility of hints, or formulas for parametric exercises (unlike MiríadaX). Nevertheless, while MiríadaX provided a user-friendly interface to add multiple choice tests and peer assessment activities to the course, the Khan Academy platform did not. Therefore, the creation of exercises was more burdensome and error prone in the Genghis SPOCs.

In order to facilitate the authoring of exercises an ad hoc authoring tool was developed as part of the Genghis project. The Genghis authoring tool was aimed at avoiding professors dealing with low level technologies, such as XHTML formats, and extensive use of JavaScript and LaTeX for math operations and formula display. It is important to note that this would have been an important hindrance for professors to prepare the exercises themselves, since most of these professors had no programming experience. The Genghis authoring tool enabled professors to log in with their university accounts and access an array of tools to create Khan Academy exercises, and also manage any exercise they (or their department) had previously created; all this without programming background. Figure 1 shows screenshots of the Genghis authoring tool. Professors were able to create complex exercises and hints with formulas, images and graphs in a simple, intuitive way they were familiar with (as the editor, TinyMCE, is the same one Moodle uses). It is also worth noting that some TinyMCE plugins were developed exclusively for the Genghis authoring tool to further simplify the use of the editor, including one plugin for LaTeX and a drop-down list for managing variables.

Apart from the efforts in the line to develop authoring tools that facilitate professors the preparation of SPOCs deployed in the Khan Academy, UC3M has also been working on a conceptual framework to support educators in the authoring of MOOCs from scratch [21], taking in consideration the experience gained after running EDF. This framework is complemented by best practices and recommendations from UC3M professors [22] and UTEID staff [23] about how to face the design of a MOOC.

An additional important issue when preparing both MOOCs and SPOCs is the management of the many videos and other materials produced. A simple organization where a professor sent an email to the technicians after having produced a video was efficient but messy. To support the organization of videos

Fig. 1. *Screenshot of the authoring tool developed to facilitate professors the preparation of exercises in the Genghis SPOCs.*
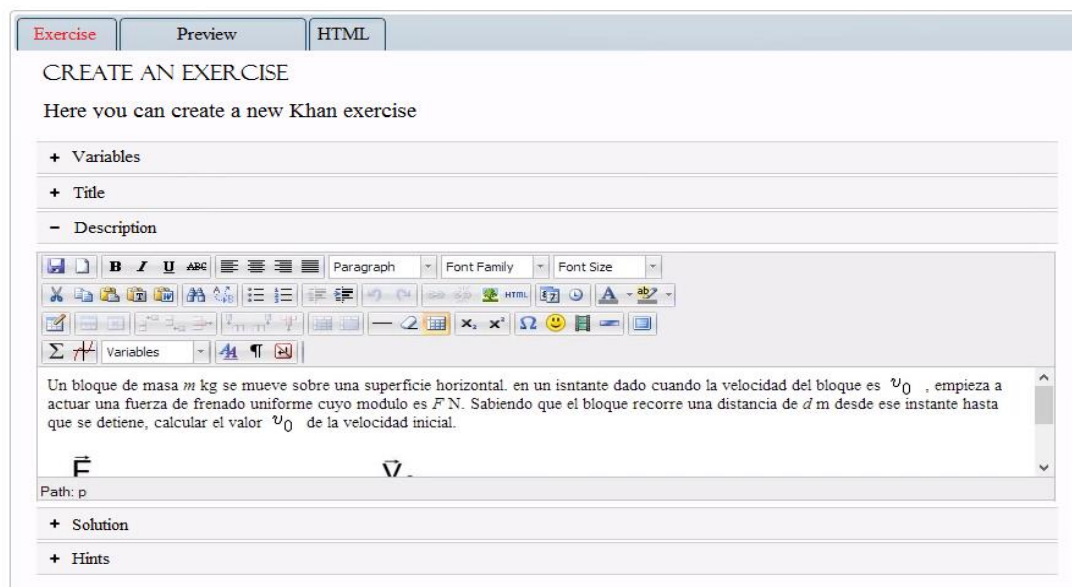
and other materials, UC3M software developers at UTEID designed a tool, called GE-L+, where professors can define the structure of a course and upload the educational material produced, so that further processing (e.g. subtitling, uploading to the video hosting platform, etc.) is easily organized. Figure 2 shows a couple of screenshots of GE-L+.

Fig. 2. *Screenshots of GEL +, the learning content management tool developed.*
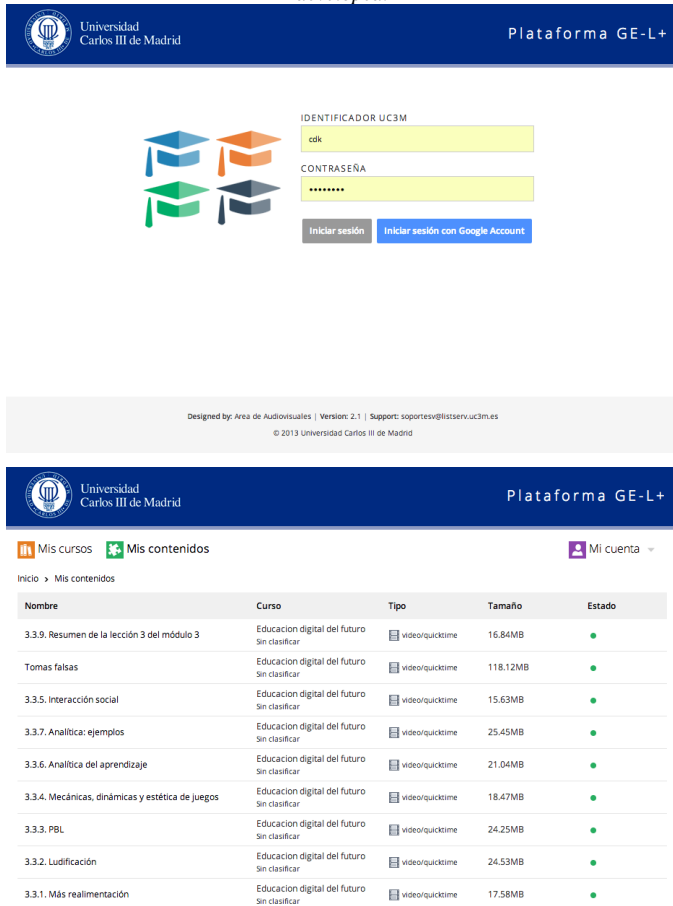
One of the advantages of this tool is its independence of the deployment platform. In this way, GE-L+ can be used to manage Genghis content that needs to be deployed in the Khan Academy instance, or EDF content that needs to be deployed in MiríadaX. GE-L+ has been already tested in a course deployed in Google Course Builder and there are plans to use it in upcoming edX courses. GE-L+ is instrumental in organizing the production of material in a very smooth way. The fact that the tool is platform agnostic is an important advantage in this dynamic field, where the decision about the platform to deploy a course might change very rapidly.

An important burden that only professors in Genghis SPOCs had to assume at design time was the preparation of gamification features (there were no gamification features available in MiríadaX during the preparation of EDF). Professors had to divide the videos and exercises in blocks and sub-blocks so that the successful acquisition of proficiency in all the exercises of each sub-block implied the achievement of a specific type of badge, while for each block implied the achievement of a higher level badge.

On the other hand, there were some common lessons learned from both experiences regarding authoring and preparation. For example, the importance of timing was significant. The required amount of time for the preparation of videos and exercises was much higher than expected. This fact caused that some professors did not plan to devote the required effort in advance, and ran out of time. Therefore, it is important to have someone who can assume the role of coordinator of professors. This coordinator must set specific deadlines (not only a final deadline) to assure that all the materials are ready on time. This is particularly important considering that multiple professors were involved in the EDF MOOC (5 professors) and in the Genghis SPOCs (6-15 professors per course). Another lesson learned is the importance of agile authoring with reasonable quality. Videos can always be improved, but this improvement can take a lot of time to professors, and so, a trade-off should be achieved between the invested time and the degree of improvement.

C. Deployment

The deployment stage corresponds to the period from the start of the course to the end. The courses of the Genghis project started in late July (2012 first edition, 2013 second edition) and lasted 5 weeks, while EDF started in early February (2013) and lasted 9 weeks. But the length of the courses is not the only difference between both deployments; also the way in which deadlines were set and the delivery of materials differ from one course to the other. In the Genghis project, all the materials were available from the beginning of the course and there were no intermediate deadlines to complete them. Students could organize their time and self-regulate their participation according to their needs and availability. In contrast, in EDF materials were released weekly, and regular deadlines at the end of each module were scheduled, forcing students to advance together.

There is also contrast between the Genghis SPOCs and the EDF MOOC in relation to its scale and the characteristics of the students enrolled. On the one hand, while Genghis counted with a group of 100 to 200 students per SPOC, more than 5000 students registered to EDF. On the other hand, students in the Genghis courses were very homogeneous, as opposed to the heterogeneity that characterized the population of EDF. For example, in Genghis students had similar profiles: most of them aged between 18 and 20 years and with a single learning objective (review fundamental science concepts to prepare for first year degree courses). However, in EDF, the range of ages was very varied; students came from different countries and had different literacies and cultural backgrounds (see [24] for a detailed analysis). Differences in background and students' learning objectives in MOOCs and SPOCs is closely related to drop-out rates, they being much higher in EDF than in Genghis.

A common feature of the Genghis SPOCs and the EDF MOOC was the use of some sort of social tool to centralize students' queries, contributions and discussions. However, the number and type of social tools employed in each case and how they were used differ from one approach to the other. Genghis offered a single forum for all the students so as to let them ask questions that could be answered by other students.

Professors did not answer questions since the SPOCs ran in a vacation period. Most of the questions registered in this forum were related with the course contents and with the resolution of particular exercises. In contrast, the EDF course included a set of built-in MiríadaX social tools (forum and Questions & Answers) and three external tools (Facebook, Twitter and MentorMob), so that students could ask questions, contribute with interesting opinions and raise concerns about the course topics. Professors in EDF chose to include widespread external tools, such as Facebook or Twitter, aiming to increase the offer of discussion channels and keep students' interest in the course, letting them select the social tools that best fitted their profile and habits.

Although including several social tools in a MOOC seems a good idea, it has also a counterpart: the huge number of contributions made it very difficult for the EDF professors to follow the discussion threads on the different social tools. Also, as the course registration process remained open throughout the entire course, new students caused a lot of noise, asking for methodological aspects related with the topics covered at the beginning of the course, and hindering the detection of weekly hot topics. Students' questions and concerns were addressed by a full-time facilitator. This facilitator was in charge of filtering the information and discussion threads taking place in the social tools, and identifying the most problematic issues. The role of facilitator is particular to MOOCs, where the vast amount of information generated by students requires a burdensome filtering in order to separate the sheep from the goats.

Finally, a common aspect between the two types of courses is that none of them included formal certification mechanisms. Genghis courses were developed in a formal setting in which students typically receive certificates recognizing their achievements, but, in this case, students did not receive any diploma because these SPOCs were proposed as a formative stage to reinforce high school concepts before the first year degree. Those students who successfully completed EDF received a "certificate of participation" with a note stating that UC3M did not recognize credits of any type, and that the identity of the student (as well as the authoring of his works) could not have been proved. Certifying online courses is not only a problem in MOOCs [25], but also in SPOCs. Finding a way to certificate Genghis SPOCs would allow taking additional measures, such as forcing students to pass the SPOCs before registering in the degrees. However, the race for the certification in MOOCs and SPOCs will remain open until technical challenges such as identifying who is behind the computer are solved and more suitable evaluation mechanisms are found.

D. Analysis

The interaction of the students with the course materials and among them in both MOOCs and SPOCs generated a huge amount of raw data that remained stored in the platforms. This large educational data set can be used during the course deployment (or later) to extract and analyze information about how students progressed through the course. This data, when processed using learning analytics techniques, can be useful to infer higher level indicators related to students' performance. Previous studies carried out at UC3M show how to infer indicators from raw data, such as the gamification habits or exercise-making habits [26]. These indicators are particularly relevant in MOOCs where professors cannot easily track progress or detect problems due to the huge number of participants; but are also important in SPOCs, where being aware of how students' advance throughout the course can be useful to organize the university course curriculum.

One of the important aspects to consider for the analysis stage is the features of the platform in which the course is being deployed. Each e-learning platform has a different course format and a different interaction data set. Thus, the information about students' learning process that can be inferred varies from one platform to another. For example, UC3M installed and configured a dedicated instance of the Khan Academy platform for the Genghis project. Having a dedicated installation ensured a total control of the platform, facilitating the access to all the data generated throughout the course. On the contrary, EDF relied on the third-party MiríadaX, limiting the access to part of the data stored.

There are several course characteristics that are relevant for guiding the analysis stage. Examples of these characteristics are: the student's profile (undergraduate, postgraduate, post-doctoral…), the course context (fees, openness, compulsory nature…) or the course contents (parametric exercises, built-in tests in videos, number and length of videos, peer assessment activities, fill-in-the-blanks exercises, multiple choice tests…). Each platform manages to capture interaction events related to these factors in a different way, dictating the number and precision of events to be captured. For example, the Khan Academy has one of the most powerful learning analytics modules compared with other existing platforms, and includes functionalities mainly focused on capturing very complete data sets of students' interactions with the course materials (videos and exercises). In addition, we extended at UC3M its learning analytics support to include new useful information through visualizations [27]. On the contrary, MiríadaX provides limited analytics about students' performance and almost no information about interaction with the materials.

To alleviate the limited analytics provided by MiríadaX, professors in EDF benefitted from the analytics offered by the external social tools included within the course (particularly Facebook and Twitter), in order to have a better understanding of students' behavior. A detailed analysis comparing the usage of the different social tools in the EDF MOOC can be found in [24]. Concretely, this study shows that the forum built-in tool was preferred by the students to contribute to the course, although external tools like Facebook also had an important impact for maintaining conversation threads.

Another important difference between the Khan Academy and MiríadaX is the visualization mechanisms that each of them provides for representing the data sets with students' interactions, in order to inform professors or facilitators about the course progress. While the Khan Academy provided a huge variety of visualizations in Genghis, MiríadaX only provided textual tables indicating students' individual activity with the videos and exercises in the case of EDF.

Fig. 3. *Progress Report visualization in the Khan Academy platform.*

To provide an overview of the level of detail in Khan Academy analytics compared to MiríadaX, we give some details about the views offered by the former. The Khan Academy differentiates between class and individual visualizations. Class visualizations give an insight about the entire class progress, while individual visualizations provide the details about each student's performance. Figure 3 shows an example of the type of visualizations provided by the Khan Academy platform. This example is based on the data from the pre-graduated mathematics SPOC for freshmen that took place in August 2013. This figure shows the progress status per course skill and per student using colors. In white, the graph shows the exercises that has not started yet, in light blue the ones that are "Started", in blue the skills where the student has a "Proficient" level, in light red the exercises that need a "Review" and finally in red the exercises where students are "Struggling".

IV. CONCLUSIONS

The implementation of a curriculum is far from an ideal system. Let us see some examples of these imperfections. Students are expected to enter university with some base knowledge. But often this knowledge is not as thorough as it should be, be it because of the choice of particular subjects at high school, be it for some other reason. Further, to pass a subject it is not required to have a perfect knowledge of the syllabus: normally achieving some percentage of the maximum score is sufficient to pass the course. This might have a negative effect at subsequent courses. It is not mastery that is required, but average knowledge. For solving all these imperfections SPOCs can play a decisive role.

In addition, there is a need to continue learning, updating our knowledge and skills throughout life, even after successfully completing Higher Education. This is especially critical in sectors related with technology or finances, where changes occur rapidly and knowledge quickly becomes outdated. In life long learning, specialization and learning based on personal interests is where MOOCs are positioned as a leading alternative, facilitating also the creation of a network of people across the globe that share common interests.

MOOCs and SPOCs are two different ways of addressing the learning demands of today's society. But they are also two disruptive innovations that will transform common practices in education. Even if it is the case that MOOCs disappear at some point, their existence will for sure change Higher Education, as we know it today. Therefore, experimentation and the development of best practices are very much recommended. We hope that this report is useful to other universities finding their way in the new context.

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