Design, Implementation and Evaluation of SPOCs at the Universidad Carlos III de Madrid

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Abstract: The Universidad Carlos III de Madrid has been offering several face-to-face remedial courses for freshmen to review or learn concepts and practical skills that they should know before starting their degree program. During the last two years our University has adopted MOOC-like technologies to support some of these courses so that a "flipping the classroom" methodology can be applied in a particular small educational context. This paper gathers a list of issues and challenges encountered when using Khan Academy technologies for small private online courses (SPOCs). These issues and challenges include the absence of a single platform that supports all the requirements, the need for integration of different learning platforms, the complexity of the authoring process, the need for an adaptation of the gamification during the learning process and the adjustment of the learning analytics functionality. Based on these challenges and issues a design process is proposed for the implementation of SPOCs. In addition, some lessons learned are presented, as well as an evaluation and comparison of the different use of the different offered courses based on indicators such as the number of videos accessed, number of exercises accessed, number of videos completed, number of exercises correctly solved or time spent on the platform.

Keywords: MOOCs, SPOCs, learning platforms, learning experiences, remedial education, evaluation
Categories:

1 Introduction

After the New York Times declared 2012 “the year of the MOOC” we found our new favourite acronym, standing for Massive Open Online Courses, in every pedagogical higher education endeavour. MOOC is one of the new words describing all the actions and technologies that educators implement in different e-Learning environments and approaches. It seems that MOOCs are here to stay, looking for academic opportunities to implement the challenging pedagogical model that they encompass, but also to enrich traditional education. Now, we MOOCify teaching and learning practices, academic courses are getting MOOCed and some new pedagogies are called MOOCification. MOOCs have gained in popularity in less than two years, encouraging new and creative learning spaces. Online education and eLearning has been around for decades at many universities. The Universidad Carlos III de Madrid implemented its first Learning Management System (LMS) ten years ago, and since then it has been steadily building a blended learning educational model, where face to face classes and online educational resources and activities have merged.

Remedial courses (so-called level zero-level courses – “cursos 0” in Spanish) are basic courses that several universities teach on a regular basis before a degree starts, to ensure that all students are able to cope with a common baseline in disciplines such as Mathematics, Physics, Chemistry, or Biology. Those courses are not *strictu sensu* degree courses but “extra” university short courses. They are often considered expensive in time and resources for the academic organization. The Universidad Carlos III de Madrid (UC3M) wanted to experiment with MOOC-like technologies but in a small and controlled group of students (between 100 and 300 for each course) and in a private environment (our educational intranet), so these remedial courses were the perfect context to implement so-called SPOCs, Small Private Online Courses [Goral, 2013].

These SPOCs implemented at Universidad Carlos III de Madrid aimed at solving a problem with zero-level courses at our university. These zero-level courses are usually offered in only one week at the beginning of September. Many students need more time to review the different concepts covered. The SPOCs offer students the possibility of working during more time with the topics of the course and provides additional resources. Moreover, the SPOCs enable the possibility of making the face-to-face class sessions more productive as students can watch previously different videos and solve several exercises.

The efficacy of online learning has been discussed before the MOOC phenomenon. [Glance, 2013] showed that online learning pedagogy may even be superior in the overall effect on student performance. We are going to describe here how the Universidad Carlos III de Madrid improved traditional on-campus remedial courses through MOOC-like technology, using our own adapted instance of the Khan Academy (KA) platform [Khan Academy, 2012-013]. We will describe our experience with SPOCs in years 2012 and 2013, the different phases and the main issues: the selection of the supporting platform, the authoring of videos, the authoring of exercises, the gamification environment, and the evaluation. Decisions taken for the presented challenges are explained based on the proposed context of experiences. Moreover, a design process for the implementation of MOOC is presented based on these challenges and issues. Finally, there is an evaluation of the different SPOCs based on different indicators about the use of students of the platform. These indicators are useful to know about the success of these type of experiences.

2 Related Work

According to [Siemens, 2013], the MOOCs can be classified in three different types: xMOOCs which follow the traditional university model, c-MOOCs which follow connectivist pedagogical theories and quasi-MOOCs which include the ones supported by the Khan Academy. According to this classification, our course would follow between the categories 1 and 3, because the materials are supported with the combination of two platforms: Moodle and the Khan Academy.

Several researchers have pointed out the advantages of MOOCS such as the potentiality to extend education to everybody or the self-directed learning methodology [Nicorama, 2013]. However, several drawbacks have been cited such as the high dropout rates, sustainability, cheating or plagiarism [Siemens, 2013].

There are many MOOC platforms to support this new paradigm, each of the MOOC platforms has different functionality, e.g. even for video playing, and a comparison of the main features of them is in [Kay, 2013]. Learning Management Systems (LMSs) platforms might also be used for the MOOC paradigm and the differences with the MOOC platforms are not always clear [Kay, 2013]. Therefore, a challenge is the selection of the proper platforms for a specific educational setting.

Moreover, another challenge is to provide authoring support for teachers in the process of creation or course resources [Kay, 2013]. In addition, important aspects that are emerging in MOOCs are the application of gamification techniques and serious games, which might increase students' motivation and reduce dropout rates (e.g. a recent example of integration of serious games in edX is in [Freire, 2014], or the use of learning analytics to obtain information of the learning process in a large scale (e.g. [Kop, 2011] presents the importance of learning analytics in MOOC environments).

In this context, the report of experiences with MOOC technology is important in order to know how these experiences tackled with the different design and implementation challenges (e.g. selection of platforms, the configuration of the authoring process or the use of gamification) and to evaluate them in terms e.g. of dropouts rates. In this work, we comment on all of these aspects for a specific case study with the use of SPOCs for remedial education. The SPOCs have a set of differences with respect to MOOCs as presented qualitatively in [Delgado Kloos, 2014].

There have also already been different reports about MOOCs and SPOCs experiences. [Osvaldo Rodríguez, 2013] reports on two very different MOOCs at University of Standford with very different dropout rates (40% in the c-MOOC and 85% in the x-MOOC). The first MOOC in the edX platform about "Circuits and Electronics" has also been analyzed giving details about the use of resources by students and their time spent [Breslow, 2013]. Another report on the dropout rate of a MIT MOOC is in [Kay, 2013] with a 95%. There are also some experiences with SPOCs instead of MOOCs such as [Combefis, 2014] where the dropout rate is not given but there is an analysis of the student workload on exercises based on a student survey.

3 Context of the KA-UC3M Experience

The first selected zero-level courses for the experiences were Physics in Summer 2012 with Mathematics, Physics, and Chemistry following in Summer 2013. Table 1 gives an overview of the number of videos, exercises, students enrolled, and teachers participating for each of the SPOCs and years.

The total number of videos in each course was quite similar, ranging from 22 to 30. There was a specific video for each atomic topic, so the difference depends on the different number of topics to explain for each course. Teachers had to create at least one exercise related to each video. There were some topics that required more than one exercise, especially in Chemistry, so the number of exercises was more for this course.

Traditionally, freshmen who enrolled in the remedial courses received lessons on campus. These lessons ran for one week and took place at the beginning of September. The main problems of this model were the limited amount of time to study all the concepts, and a very compressed schedule.

Course	**# Students**	**# Teachers**	**# Exercises**	**#Videos**
Summer 2012 Physics	102	6	35	27
Summer 2013 Physics	181	10	30	30
Mathematics	278	16	30	25
Chemical	91	7	49	22

Table 1: Number of exercises, videos, enrolled students and teachers participating in the SPOC experience, by course and year

With the introduction of Khan Academy (KA) technology, a "flipping the classroom" methodology [Bergmann, 2012] [Tucker, 2013] was planned. Students can access the different resources prepared by teachers during the month of August anytime and anywhere. Students can watch videos, solve exercises or interact with other classmates before the face to face lessons. The lessons take place during the first week of September, and students can take more advantage of these class sessions as they already know the concepts that they studied in August within our particular KA implementation (KA-UC3M). Therefore, students can focus and ask the teachers about more advanced topics. In addition, students can devote more time to study the different topics as the educational resources are available in the platform during the time they are enrolled.

4 Implementation

In the process of the creation, deployment, and evaluation of MOOC-like technologies to improve our remedial courses, different issues and challenges emerged. This section describes a list of issues, decisions taken and lessons learned through the implementation of our private Khan Academy (KA-UC3M) installation, first in 2012 and in an improved implementation in 2013. In addition, a general design process for the implementation of SPOCs is provided based on our experience.

Based on the experience in 2012, Educational Technology and Teaching Innovation Unit was created in our university [UTEID, 2013]. Its purpose is to help in the development of MOOC technology and in the creation of educational resources. The existence of this UTEID technical unit made the process easier and more scalable in 2013.

The main educational requirements considered to MOOCify zero courses were the possibilities of watching videos; solving automatic exercises; provision of useful analytics of the learning process to evaluate the course; making a clear structure of contents; automatic help for students when solving exercises if they get stuck, and improving communication among students. The requirements for automatic help when solving exercises and the communication among students was stronger than in other typical MOOCs because these SPOCs run in August, the vacation month in Spain. Therefore, it was not planned that teachers would give any support during students' interaction, but the platform has to provide mechanisms to overcome this.

4.1 Selection of the Supporting platform

There are quite a few different platforms for supporting MOOCs. Each platform has a specific set of features. The platform should be selected depending on the educational context requirements and the learning outcomes to be achieved.

At that moment (Spring 2012), a platform that fulfilled all the previous commented main requirements was not found. We decided to use a combination of two platforms: Khan Academy and Moodle. The KA platform was used for watching videos, solving exercises, generating hints related to exercises, and providing useful analytics data about the learning process. The Moodle LMS was used mainly for communication between students.

Although watching videos and solving exercises can also be done in Moodle, the KA system provides a more powerful learning analytics module. The exercises and videos have to be related to the KA platform to enable this learning analytics support. In addition, the KA exercise framework adapted better to our purposes.

Although the KA platform provides some communication features (e.g. the possibility of inserting comments for each video), other features which are present in Moodle but not in the KA platform were required. These were the possibility of creating common forums where all the participants can contribute, and direct private messages among participants.

The content structure was provided by Moodle but also by the KA platform. In Moodle, the contents were divided by sections, subsections, and chapters. Each chapter usually had a related video and an exercise. In the KA platform the contents were presented using an index and a knowledge map was enabled so that students could go through the different exercises and see their different connections. The combination of both platforms enables different navigational paths. Users know Moodle better and it is also the default Learning Management System for all degrees at UC3M. Therefore, students may be more familiar with the Moodle content and navigational structure, and its interface can be better for usability purposes.

There were also some features of the KA platform which were used in the SPOCs, but that were not key requirements. Among these features are the possibility of configuring an avatar, the possibility of setting and tracking goals, and the use of a recommender for subsequent exercises. On the other hand, many different features of Moodle which were not used could be enabled in the future for enhanced experiences. Some examples are the assignment, the wiki or the glossary.

The KA platform was connected with Moodle. Some aspects integrated with this solution were single sign-on and the Moodle gradebook connection with the KA user interactions. Moodle enables administrators to set the teachers and students for each course, while the KA platform needs students to select their coaches, which is a similar role to a teacher. The single sign-on should not only a user logged into one platform to enter in the other, but also convert teachers in Moodle to coaches of all their students in the KA platform.

An important difference between Moodle and the KA platform is that Moodle is designed for private courses in which only a predefined number of enrolled students are allowed to enter and interact with the course materials (so a registered student can only access some courses), while the KA platform enables access to all videos and exercises for any students who are registered for any courses. This was an issue in 2013 as there were 3 different courses with different students enrolled in each one (students might belong to one, two or all of the courses). The solution adopted was to have one Moodle instance but 3 instances of the KA platform (one for each course).
In addition, Moodle was the initial platform to enter into the course, and Moodle had external links to the KA resources.

Although an initial concern was that students might get confused with 2 different interfaces from 2 different platforms, this did not present a problem for students. In any case, some links were adapted in 2013 to simplify going from one platform to another.

4.2 Authoring videos

The creation of videos posed two main challenges: 1) Find the proper methodologies and good practices to maximize students' learning. 2) Give homogeneous videos to students so that they perceive the same general rules, such as e.g. the inclusion of university logos in the same way. To achieve this, a rule document for the creation of videos must be available to teachers.

In 2012, teachers only received a few general rules about the process of video creation (e.g. about the recommended duration). People from the UTEID technical unit reviewed all videos from 2012 and some general conclusions were obtained. Based on these conclusions, teachers received more specific rules in 2013 edition. Some rules were related to e.g. combination of colors, or the applications to use for generating videos. Nevertheless, teachers had enough freedom to adapt their videos to their personal teaching style.

Another issue was how to provide resources to create the videos. Teachers were able to create videos on their own, but a place for creating videos was enabled in the library with all the necessary resources and with the support of the UTEID experts.
A final issue was how to deal with the process of receiving the videos, publishing them in the YouTube platform, and annotating them with meaningful tags. The UTEID created a tool to manage this process of uploading videos and annotate them. The tool could also receive videos selected by courses.

4.3 Authoring exercises

One of the main problems with generating exercises was that teachers were not able to create them directly using the KA format, which is an HTML one with specific tags. Average teachers feel it is quite difficult to create the exercises directly in this format. During the first year (Physics course, Summer 2012) this issue was tackled by creating a set of word file patterns for the different types of exercises considered: fill in the blank, multiple choices and multiple response. Teachers had to fill in the corresponding patterns and send these files to 2 experts who did the final conversion to the KA framework.

In summer 2013, as the number of courses and teachers was considerable, it was not feasible to follow the previous strategy: the experts would have had to format too many exercises. A scalable solution was required. Moreover, with the previous solution teachers were not able to see directly in the platform how the exercises run: they only had access to the word files. An authoring tool was designed and implemented to mitigate these issues. This tool enabled teachers to create exercises through a simple Web interface. The type of exercises that the authoring tool enabled was “fill in the blank” with the possibility of establishing parametric variables. Each time that a student accessed an exercise, the parametric variables had a different random value within a range until the student answered correctly. Furthermore, the tool enabled formatting the text with an HTML editor, to calculate formulae for the solution or adding hints. In addition, teachers can view the exercise being done on the KA platform during their exercise design. With this solution, experts did not have to format all the exercises because the authoring tool translated them automatically into the corresponding format. Nevertheless, there were some specific exercises that the authoring tool was not able to create (e.g. restrictions among variables). Experts had to do the formatting for these exercises.

Based on the first SPOC for Physics, during Summer 2012, other lessons were learned: for example we realized that multiple choice exercises with long texts as options presented problems with visualisation, because long texts as options had to be in a narrow column on the right. For this reason, in 2013, the preferred types of exercises were fill-in-the-blank. Multiple choice exercises were only used in cases where fill in the blank exercises did not make sense, with limits on the length of the possible options.

The authoring tool works without any registration and anyone with Web access can log into it to create exercises. This tool was integrated to the video authoring tool created by the UTEID. In this way, the creation of exercises is restricted to the teachers of the course, and exercises are grouped by the different courses.

An important aspect to note is that teachers create videos and exercises and upload the created resources to the servers using the authoring tools, but the educational resources are not automatically uploaded to the platforms. Instead experts needed to do this task. To do this final step, experts need to know the knowledge structure of the course and which exercises are related to which videos. This is given by the teachers to the experts.

4.4 Gamification

Although gamification was not one of the initial main requirements, the KA platform brought this important feature. Gamification might motivate and encourage students to learn more and better by earning points and badges during the learning process [Li, 2013]. The KA platform provides a set of five different types of badges by default (meteorites, moon, earth, black hole and challenge patches). Each type of badge is identified by a different image. These badges were adapted to the context of the Universidad Carlos III de Madrid. The initial images were replaced by five different names and images of Madrid monuments from the times of king Carlos III . The highest achievement badges (previously the challenge badges) represented one of the buildings in our own university.

The KA platform can give badges for mastering a set of different topics. A student must achieve proficiency in a topic in order to master it. As the contents of the KA platform were personalized, the conditions for achieving badges related to topics had to be redefined. Three different levels of content hierarchy were defined: section, sub-section, and chapter. Students who achieved proficiency in all chapters of a sub-section received one type of badge, while students who achieved proficiency in all sub-sections of a section received another type of badge. Teachers of each course had to fill in a form with the structure in the three levels of hierarchy so the badges could be awarded in this way. The number of badges for each course was different as there were a different number of sections and sub-sections in each one.

Moreover, some of the KA badges not related to achieving proficiency in exercises had to be removed, because they did not make sense in our context. Others had to be adapted (e.g. badges for watching some amount of time of videos because the total number of minutes for watching videos was quite different from the original KA educational materials). These adaptations were made in the 2013 KA-UC3M remedial courses, based on observations from the 2012 experience.

4.5 Learning analytics

KA provides learning analytics support as important functionality. The platform generates many reports about students' interactions, students' performance, results divided by topics, etc. For example, teachers can easily see the number of students that struggle in an exercise or obtain the proficiency, and students can see the time spent on different topics, divided by videos and exercises. This type of information helps students and teachers to understand the learning process, evaluate it and try to improve it. This is particularly important when there are many students in the platform, which is the case even for a small course.

The learning analytics process has a set of phases [Clow, 2012]. Collecting the data from students' interactions is done in a very detailed way in the KA platform. This data is stored in different tables within the Data Store of the Google App Engine. The KA platform processes this data to obtain useful information and provides some nice display about the learning process.

Although the learning analytics support of KA is useful, we needed to extend it to include other parameters and to personalize some specific information such as the criteria for a student to progress on the platform. Some examples of proposed parameters and how to use them to evaluate the learning process are shown in

[Muñoz-Merino, 2013]. Some of these parameters are related to learning effectiveness, learning efficiency, students' time distribution, gamification habits and exercise solving habits. A new learning analytics module for the KA platform was developed for this purpose which is named ALAS-KA (Add on for the Learning Analytics Support in the Khan Academy platform). This module generates individual but also class information about the learning process. This information is available for teachers and experts evaluating the learning process and trying to improve it. The information is helpful for improving the face to face sessions but also for improving future editions of the courses. Technical details about this extension can be seen in [Ruipérez-Valiente, 2013].

4.6 The Design Process

Based on the previous experiences of the implementation of SPOCs during two course editions, we can generalize the different steps for the design of the SPOCs experiences. Figure 1 gives an overview of this generalization. The different boxes represent actions during this process, while the arrows indicate the time flow of the different steps. From the previous sections and our explanations, the relationship of the different phases with our case study is straightforward.

First, the proper stakeholders should provide a list of educational requirements according to the company or university needs. This list of educational requirements should direct the institution actions. Based on these requirements, the institution has to decide among the different technological platforms in the market. In a usual case, none of the platform will fulfil all the desired educational requirements. A possible solution is to select and combine several of them, making the proper integrations. In addition, new developments and implementations of additional components to the technological platform can be done in order to be according to more educational requirements. The addition of platforms and new educational components implies an effort for the organization. The key stakeholders should make decisions in a trade-off between desired functionality and costs for the organization.

The authoring process should start once the technological platforms and the additional pieces to implement have been decided. This is because the provided functionality conditions the educational resources and processes, so the type of educational resources and processes has implications on the way the authoring process should be done. For example, the available functionality on the platforms will condition the types of exercises or the design of the gamification elements during the authoring process.

Regarding the authoring process, there are many aspects for which the authoring is needed (e.g. videos, exercises, content structure or the gamification elements). For each one of this aspect, the general authoring process is similar. First, course creators should take into account what they can do according to the platform functionality. In addition, they should follow a list of good practices and methodology in order to improve the learning process. These rules can be given by the organization for the design and creation of different resources. Next, the organization can provide a list of criteria for making homogeneous resources along the organization. These aspects are not usually related to the quality of the resources but to institutional aspects (e.g. inserting a logo at the end of each video) or other homogeneity aspects (e.g. using certain colours for the exercises). These general rules (about methodology and homogeneity) are necessary as these SPOC environments have a lot of teachers and course creators and there is a need of resource quality and general coordination.

Each educational resource can be created with a specific authoring tool. The authoring tool can be an existing software component or a new software created component. Moreover, the authoring tool can also be a set of patterns that course creators should fill in. The type of the authoring tool will depend on the specific aspect to tackle (difficulty for teachers, type of resources, expected output, etc.)

Once each of the educational resources is created, all of them should be storage and managed in a uniform way. In addition, the different resources should be properly related (e.g. which exercises are related to each video and topics of the content structure).

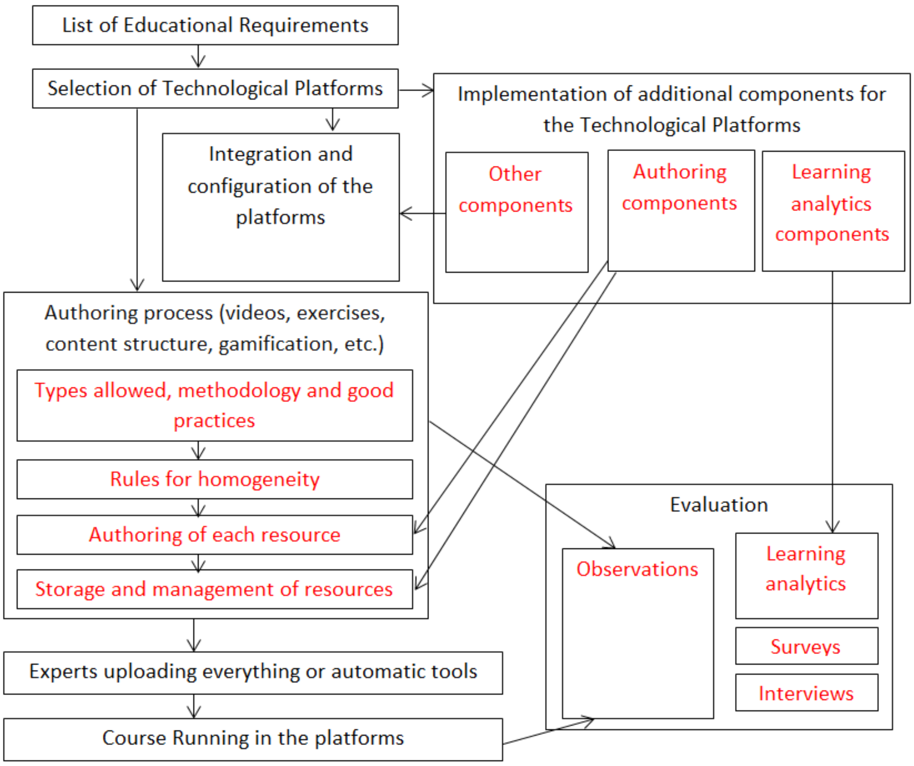

Figure 1: The Design process for SPOCs

The final created resources should be usually uploaded by experts into the platform. In the case of the Khan Academy platform, the own teachers cannot make this final step as it was too difficult for teachers without a technological background. The final step of uploading all the created resources (e.g. videos, exercises, content structure or gamification challenges) must be done by experts. Alternatively, an automatic software might be created to manage all this uploading process.

The evaluation of the course should take into account direct observations on the platforms, on the authoring process and the courses running. In addition, surveys, interviews or the results from the learning analytics modules should be taken into account. The desired learning analytic measures should be implemented as an additional component if they are not present in the selected platforms. With all of the results, conclusions should be done to propose the proper modifications for next editions in the authoring process, new components to develop or the platform configuration.

5 Evaluation of the SPOCs

One of the key points is the necessity to know whether the SPOCs experiences have been carried out with successful results. This section offers an evaluation of the results in the different courses based on some selected parameters such as the number of exercises accessed, number of videos accessed, number of exercises correctly solved, number of videos completed or time spent on the platform. We try to compare and offer hypotheses of the different results. It is important to be able to evaluate the outcome of these first experiences in order to gain valuable lessons learned, so that we can improve future courses. As a part of this evaluation, we need to know whether students have interacted enough taking into account the considerations which have been commented in previous sections (such as optionality for doing the course activities). Another interesting point is to compare the results in the different courses to find the reasons of the differences. In addition, the results might reveal differences in the use of the educational resources (such as exercises and videos) that can be used to detect problems and future improvement.

Many metrics can be valid to infer different results to evaluate these experiences. We have chosen first to analyse the number of exercises accessed and solved at least one time correctly. Similarly we also offer statistics about the number of videos that have been accessed and the number of videos completed. Finally we make an analysis of the time spent by users in exercises and videos separately. All these metrics are represented in percentage of students for each course separately and also on average (taking into account all courses). For all these metrics we have taken into account only users who logged at least once into the Khan Academy platform; a total number of 81 students for Physics 2012, 163 students for Physics 2013, 73 students for Chemistry and 243 students for Mathematics; additionally this implies that 79%, 90%, 80% and 87% of the students who enrolled in the degrees, also accessed the Khan Academy platform respectively.

Regarding the percentage of exercises accessed and completed for each of the courses on average, results show a 36%, 33%, 36% and 40 % of exercises accessed on average per user and 32%, 29%, 27% and 32% of exercises solved correctly at least once on average per user, for the Physics 2012, Physics 2013, Chemistry and Mathematics courses respectively. These results show that the course which had more students accessing the different exercises is Mathematics (40%), whereas the courses which were more successful in terms of exercises correctly solved are Physics 2012 and Mathematics (32% both). However, it should be noted that Physics 2012 collection of exercises were composed of many multiple choice exercises which makes easier to solve them than parametric ones. In addition, some interesting details can be noticed. We can check that the percentage of exercises accessed for Physics 2013 and Chemistry is 33 and 36% respectively; however the percentage of exercises correctly solved is 29% and 27% respectively. Therefore, although more exercises where accessed in the Chemistry course than in the Physics 2013 course, Physics 2013 course was more successful in terms of exercises correctly solved. This might be an indicator that the exercises in the Chemistry course were more difficult than Physics 2013 or it could also be related to the fact that the Chemistry course had 19 exercises more than the Physics 2013 course.

A more detailed analysis is proposed now. Figure 1 represents the percentage of exercises which have been accessed in each course and also on average. We have divided all the next graphics in five intervals that indicate by a cumulative bar chart the percentage of students in each case (less than 20% of exercises accessed, between 20 and 40% between 40 and 60%, between 60 and 80%, and more than 80%). In an analogous manner, figure 2 shows the same information for the percentage of exercises that have been solved at least once correctly. At a first glance we can check that the distribution of exercises accessed is very similar for all courses (maybe a bit different for Physics 2012), so students have behaved similarly in all courses. In addition, it is noticeable that some intervals (less than 20%, between 20% and 40% and more than 80%) are always higher than others (between 40% and 60% and between 60% and 80%), these results seem to indicate that students usually have the tendency of working a little or a lot, but not in the middle.

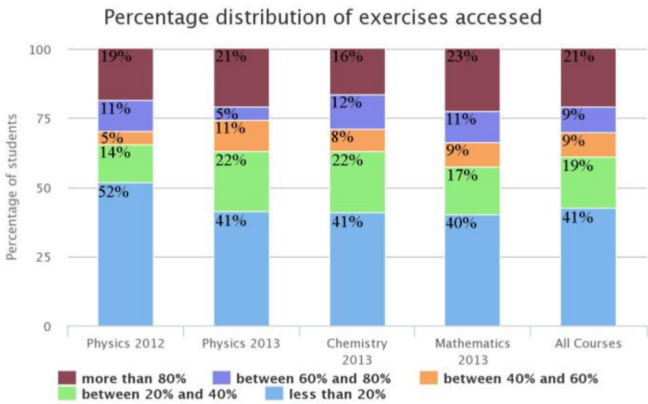

Figure 1. Cummulative bar chart for the distribution of exercises accessed.

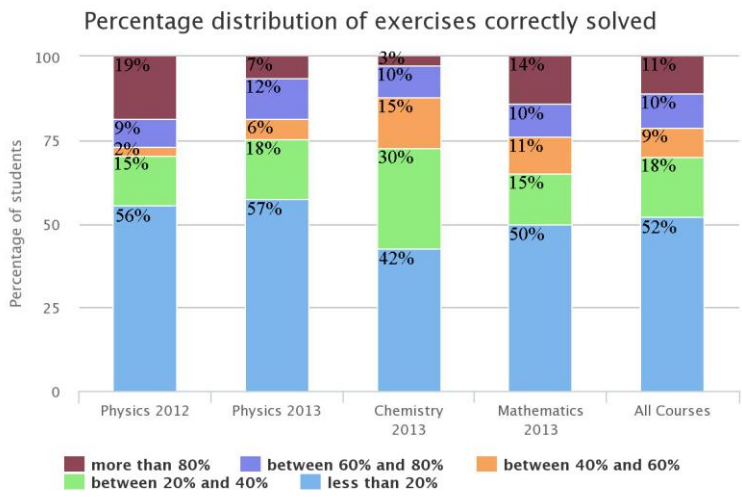

Figure 2. Cummulative bar chart for the distribution of exercises correctly solved at least once.

As for figure 2 which represents the distribution of exercises solved correctly at least once, we can notice that the distribution of each course is not as similar as in figure 1. Some interesting details for example is that the distribution of Mathematics is the most uniform in all intervals and also the most similar to the average distribution (taking into account all courses) and Chemistry has a distribution which decreases monotonically in each interval. A surprising result is that Physics 2012 was better than Physics 2013 in terms of solving exercises, one might think that the experience results would have improved the next year with lessons learned. However this is probably related to the fact previously stated that Physics 2012 had many multiple choice exercises which were easier to solve whereas Physics 2013 had none.

Next, we provide a similar analysis for the videos accessed and videos completed. Results show that 37%, 35%, 38% and 41% of videos were accessed on average per student and 27%, 25%, 27% and 27% of videos were completed on average per student, for the Physics 2012, Physics 2013, Chemistry and Mathematics courses respectively. It is interesting to find that the exercise and video access results are similar on average but exercises solving percentage are slightly above videos completed percentage. Also, we can note that the biggest difference between videos accessed and completed is in the Mathematics course. Figure 3 shows the distribution of videos accessed by cumulative bar chars. We can see that the four courses are slightly different, but there are not huge differences. More importantly, we can see in figure 4, the percentage of videos completed which appear to be even more homogeneous than figure 3. This can be interpreted like the students have behaved similarly when interacting with videos in all courses.

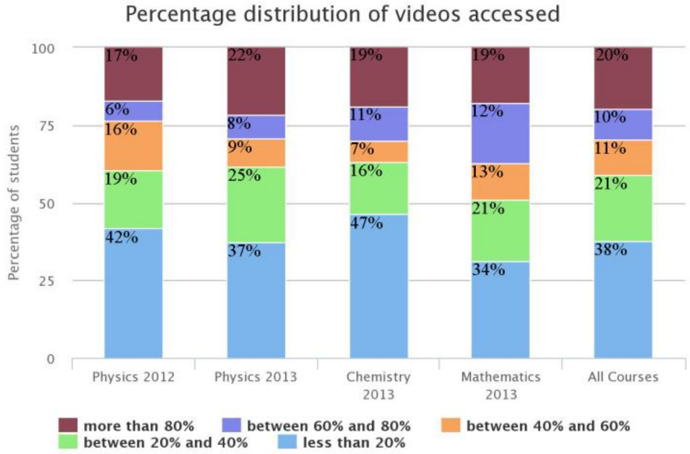

Figure 3. Cummulative bar chart for the distribution of videos accessed.

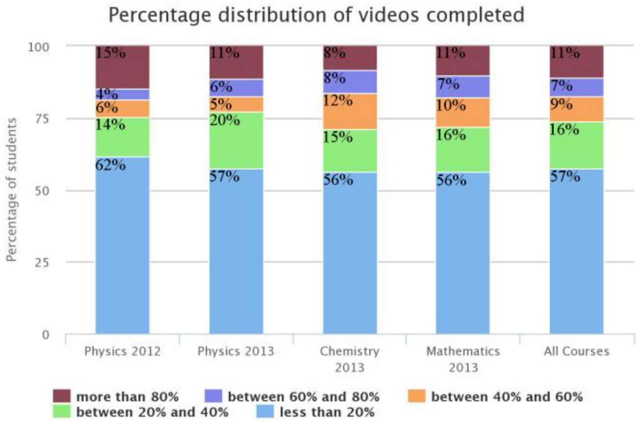

Figure 4. Cummulative bar chart for the distribution of videos completed.

The last analysis is related to the time spent in exercises and videos. The average time students have spent solving exercises are 99, 105, 143 and 123 minutes whereas for videos the average student have spent 120, 139, 110 and 125 minutes watching videos for the Physics 2012, Physics 2013, Chemistry and Mathematics courses respectively. For Mathematics, the time spent in exercises and videos is very similar, thus it indicates that the amount of exercise and video work has been well balanced for students. In the case of Physics 2012 and Physics 2013 the amount of time spent in videos has been considerably greater than the amount of time spent in exercises. On the other hand, the amount of time spent in Chemistry has been much greater in exercises than in videos. This increase of time makes sense because Chemistry has 49 exercises which is more than the others courses; anyhow this should be further investigated because exercises could be too demanding and students might be struggling. In addition table 2 shows the percentage distribution of students in five intervals of time for exercises and table 3 the distribution of time spent in videos. Approximately half of the students who logged in the platform have invested less than 60 minutes in exercises and other 60 minutes in videos. We can notice some differences, such as Chemistry has the highest percentage of students spending more than 240 minutes in exercises or Physics 2013 having the highest percentage in students spending more 240 minutes. Most of these results are strongly related to the distribution that we have seen previously about exercises and videos.

Table 2. Percentage of students in each time interval for the time spent solving exercises.

Percentage of students	*Physics 2012*	*Physics 2013*	*Chemistry 2013*	*Mathematics 2013*	*All Courses*
[< 60] min	56,8 %	46,7 %	46,6 %	47,7 %	48,6 %
[≥ 60 & < 120] min	11,1 %	19,8 %	15,1 %	19,8 %	17,9 %
[≥ 120 & < 180] min	12,3 %	14,4 %	9,6 %	10,3 %	11,7 %
[≥ 180 & < 240] min	9,9 %	7,2 %	8,2 %	6,6 %	7,4 %
[≥ 240] min	9,9 %	12,0 %	20,5 %	15,6 %	14,4 %

Table 3. Percentage of students in each time interval for the time spent watching videos.

Percentage of students	*Physics 2012*	*Physics 2013*	*Chemistry 2013*	*Mathematics 2013*	*All Courses*
[< 60] min	46,9 %	43,7 %	47,9 %	45,7 %	45,6 %
[≥ 60 & < 120] min	18,5 %	15,0 %	15,1 %	16,5 %	16,1 %
[≥ 120 & < 180] min	9,9 %	10,2 %	11,0 %	9,5 %	9,9 %
[≥ 180 & < 240] min	6,2 %	10,2 %	11,0 %	10,7 %	9,9 %
[≥ 240] min	18,5 %	21,0 %	15,1 %	17,7 %	18,4 %

Finally we want to present some general numbers taking into account all courses. The average student has accessed 38% of exercises and the 39% of videos. In addition the average student correctly solved 30% of exercises and completed 26% of videos. We believe that taking into account these courses context (such as optionality, taking place in summer) these are good numbers that indicate the success of these first experiences. In addition the average user has spent 117 minutes solving exercises and 127 minutes watching videos; which makes a total sum of 244 minutes (a bit more than 4 hours) per user on average. That amount of time indicates that the average user has made substantial time effort working in the platform.

6 Conclusions and Future Work

This article presents a list of different challenges encountered while MOOCifying zero-level courses at the Universidad Carlos III de Madrid during the last 2 years. Some solutions adopted and lessons learned from the experiences are explained. In addition, a generalization of the design process of SPOCs is provided.

Among the challenges for the creation of educational resources (videos and exercises) are providing teachers with best practices, homogeneity of materials, enabling teachers with authoring tools which they find easy to understand, providing teachers with continuous support during the process, and centralizing all generated materials so that experts can do the final upload. These challenges require a structured methodology for the creation of educational contents. Authoring tools had to be implemented to enable this process.

As a single platform did not cover all the requirements, two platforms were combined. The combination of both platforms was a success, as they were effectively complementary. Although the use of the Moodle platform communication tools was not high during the first year, it was high during the second year, which is important as it enabled social learning.

The specific setup of the experiment implied adaptations to the gamification features of the original platform, and specific evaluation needs required specific learning analytics for which new development had to be done.

Apart from teachers, resources are required: for helping teachers to create videos and exercises, for formatting some types of exercises, to set up the platforms, or for making software adaptations to the KA platform. Based on these experiences, an educational technology unit UTEID was created to help in these tasks.

The evaluation in terms of use of videos and exercises revealed that the dropout rates in these SPOCs are not so high as in other MOOC platforms. The analysis of the amount of use and completeness of the different activities should take into account that it was a voluntary activity and in vacation time for students.

Some of the lessons learned can be applied to other educational contexts, but others are very specific to this educational setting. The Universidad Carlos III de Madrid plans to continue developing these experiences and improving contents, methodologies and platforms for remedial courses. Furthermore the experience gained with these courses might be extended to other learning environments within the UC3M.

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