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Assessment Activities in MOOCs

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ABSTRACT

This chapter analyzes the different implications of the new MOOC paradigm in assessment activities, emphasizing the differences with respect to other non MOOC educational technology environments and giving an insight about the redesign of assessment activities for MOOCs. The chapter also compares the different assessment activities that are available in some of the most used MOOC platforms at present. In addition, the process of design of MOOC assessment activities is analyzed. Specific examples are given about how to design and create different types of assessment activities. The Genghis authoring tool as a solution for the creation of some types of exercises in the Khan Academy platform is presented. Finally, there is an analysis of the learning analytics features related to assessment activities that are present in MOOCs. Moreover, some guidelines are provided about how to interpret and take advantage of this information.

Keywords: authoring, authoring tool, assessments, Coursera, edX, evaluation, exercises, Genghis, Khan Academy, learning analytics, MiriadaX, MOOCs, peer review.

INTRODUCTION

Assessment is usually an important aspect for every learning process. Educational assessment can be defined as the process of planning and designing learning activities to collect students' data, as well as the interpretation and reporting of this data to have a deep understanding about students' learning in different skills. The assessment activities are typically divided into two types: formative and summative (Marsch, 2004). Formative assessment involves learning activities which are used to monitor student learning in different concepts and skills in order to provide feedback or advice to students so that they can improve their learning, but there is not usually an associated grade for their evaluation. Formative assessment usually involves activities to review specific concepts. On the other hand, summative assessment involves learning activities to know whether students have a certain required level. Summative assessment activities have an associated grade which counts for the evaluation and usually involves activities with several concepts (e.g. of a complete unit or a final exam).

The increased use of Massive Open Online Courses (MOOCs) as a mean to get to students and teach in ways that could not be done before is on the rise. More and more schools, universities and institutions are adopting or creating platforms for professors to get their content to their students wherever they are. The MOOCs imply a new paradigm which has an effect on assessment activities. In MOOC environments, new types of learning activities are more suitable for assessment and other usual assessment learning activities should be redefined. As courses are massive (with hundreds or thousands of students), teachers cannot monitor students one by one in each of the assessment activities and a redefinition of assessment activities should be done.

This required redefinition of assessment activities has technical implications but also teachers' implications. Technical implications include the development of machine learning algorithms, the design of authoring tools or the development of learning analytics systems. Regarding teachers' implications, although some evaluation tasks are automatic, teachers should devote more time in the design phase (e.g.

to configure peer review activities or define hints during the learning process) and in the execution phase (e.g. to interpret high level information provided by learning analytics modules).

This book chapter has the following objectives regarding assessment in MOOCs:

1. State the different implications of the new MOOC paradigm in the assessment process. An analysis of the MOOC features and conditions which make a redefinition of the assessment process necessary is done, emphasizing the differences with respect to other non MOOC educational environments. In addition, a list of required assessment changes in MOOCs will be given which is connected to the previous analysis.
2. Compare assessment activities in different MOOC platforms. Some of the most used MOOC platforms (e.g. edX, Coursera, or Khan Academy) are analyzed in terms of assessment activities. A comparison of these platforms is given, providing details about which assessment activities are allowed in each one of these platforms, and comparing their assessment functionality between them. At this point, it is worth to note that some authors consider the Khan Academy platform as a type of MOOC platform while others do not. We think that the consideration or not as a MOOC platform depends on the coverage of the definition. For example, an argument against the consideration as a MOOC might be that Khan Academy is not course oriented and does not offer a scheduling of resources within a course. If this type of scheduling was a requirement for being a MOOC then Khan Academy would not be according to it, but the term of course might be wider to include the type of Khan Academy instruction. In any case, regardless of the consideration of the Khan Academy as a MOOC or not, we are going to include it in the comparison of assessment in MOOC platforms, as it has several services which are similar to MOOCs.
3. Analyze and give solutions for the design of assessment activities for MOOCs. An explanation about the design process of assessment activities in MOOCs is given. In addition, issues for the design and creation of MOOC assessment activities are listed. Moreover, a specific authoring tool that was designed and created for the generation of a specific type of exercises within the Khan Academy platform is presented in detail from a technical point of view but also from a teacher's perspective. This authoring tool enables teachers without a high technological background to create exercises with hints without the intervention of experts, which are ready to be used by the Khan Academy platform. This example of authoring tool is just a specific case which illustrates this issue but does not try to cover all the difficulties of the authoring process at all.
4. Analyze and give solutions about the execution of assessments in MOOCs. In the phase of the execution of a MOOC, students and teachers should monitor the learning analytics modules to try to understand and improve the learning process, e.g. with visualizations about their constancy in learning, time distribution in the different topics or user profiles. We report on the main learning analytics features that are available at present in some of the main MOOC platforms. In addition, we give some guidelines about future interesting learning analytics features for assessment that would be nice to be available in MOOCs. We illustrate it with some learning analytics features for assessment implemented in the Khan Academy platform extending its learning analytics support such as for detecting behavior patterns when interacting with exercises.

The remainder of this chapter is organized as follows. The background section gives an overview of related work. Next sections about the implications of the new MOOC paradigm as well as the comparison of assessment activities in different MOOC platforms are not tied to any specific technical solution but contain a general analysis. Next sections about the authoring process and learning analytics give first a general analysis about the problems and next they explain specific solutions that are tied to the Khan Academy platform. Specifically, we use two examples of development we have done in the Khan Academy platform for the authoring process and for learning analytics. While we do not try to cover all aspects of authoring or learning analytics, we explain them as they might be useful for other contexts and illustrate the problems raised.

BACKGROUND

Assessment activities are a key component for learning environments. Assessment activities can be used in very different platforms and experiences. An analysis about different works on assessment activities can be seen in (Black & William, 1998) or (Olds, Moskal & Miller, 2005). Assessment activities are usually divided into summative and formative (Marsch, 2004). Summative assessment activities are focused on giving a final students' grade, while formative assessment activities main purpose is to give feedback to the student about their performance in some topics so that they can change and make the proper corrections.

When assessment is applied in online environments, traditional assessment activities can be used but also new ones can be introduced. The work in (Underhill, 2006) analyzed the connection of different traditional pedagogies and learning theories with online assessment and concluded that behaviorist leaning theories are related to self testing and feedback, while cognitivists learning theories are related to grades and learning outcomes. In addition, (Underhill, 2006) concluded that the communications tools in online environments bring new opportunities of assessment with respect to traditional classroom environments.

Different assessment online techniques have been proposed (Robles & Braathen, 2002) and concluded that several of them should be used for determining the different learning outcomes and that they should be used for each chapter. Nevertheless, different problems for online assessment have been reported such as plagiarism and cheating (Rowe, 2004).

There have been efforts to define and standardize some types of assessment activities in online environemtns, such as the IMS QTI specification (IMS Question and Test Interoperability). IMS QTI defines a set of assessment activities with a correspondent XML binding. Among these assessment activities are multiple choice, fill in the blank or matching questions. Although this standardization effort, many systems do not follow IMS QTI but their own proprietary formats and definitions.

Typical Learning Management Systems (LMSs) like Moodle (Moodle) do not support very complex assessment activities (e.g. with interactive exercises or complex adaptation). However, Intelligent Tutoring Systems (ITSs) include more complex functionality for assessment activities such as complex hints, adaptation, interactive exercises, or artificial intelligence for the automatic correction of open texts. However, ITSs do not have other important functionality for the support of whole courses. Functionality to help and guide students has been proposed and implemented in different systems such as for different hint support (Muñoz Merino, & Delgado Kloos, 2009), (Hume, Michael, Rovick & Evens). Adaptation of the learning process for hypermedia systems (Bruselovsky, 1996) has been proposed and the application for assessment activities is widespread e.g (De Bra, Aerts, Berden, de Lange, Rousseau, Santic, Smits, Stash, 2003), (Gertner, Conati & Vanlehn, 1998). In addition, there are many systems that implement advanced techniques for the automatic correction of exercises such as (Kanejiya, Kumar & Prasad, 2003) or establish a dialog with students such as (Graesser, VanLehn, Rose, Jordan & Harter, 2001). Even the own IMS QTI specification allows the definition of some of these additional features such as hints or adaptation, but they are not usually implemented for LMS platforms. There are also some dedicated platforms provided by publishers like Wiley-plus and Pearson, which offer the possibility of feedback and interactive tools.

The MOOCs (Massive Open Online Courses) are open online courses with free registration (McAuley, Stewart, Siemens & Cormier, 2010) to which a massive number of students can register. MOOCs are traditional divided into cMOOCs and xMOOCs (Siemens, 2013). The cMOOCs have a distributed oriented learning philosophy in which learners can acquire knowledge in a connectivism form with many social interactions. On the contrary, xMOOCs follow a more traditional approach in which there are some experts that centralize somehow the learning process. The massiveness of these courses makes it different with respect to traditional online courses such as the usual supported in LMSs. Indeed, the massiveness is a consequence of having open and free registration. The MOOCs can be seen as an evolution of traditional private courses. LMSs usually support traditional courses in an online basis (Martin, 2012). With the evolution of MOOCs, these LMSs might not be suitable for supporting this new paradigm.

At present, the differences between LMSs and MOOC platforms are not high regarding functionality (Kay, Reimann, Diebold, & Kummerfeld, 2013). In (Kay, Reimann, Diebold, & Kummerfeld, 2013) a list of MOOC plataforms were selected (edX, Coursera, Google Course Builder, Class2Go, udemy and Lernanta) and compared in terms of different functionality. In this work, we have selected a different set of platforms to make the comparison because e.g. some initiatives such as Google Course Builder or Class2Go have joined the edX platform effort. In addition, the list of features to compare in this work is different since we are focused in assessment activities for MOOCs, but the comparison in (Kay, Reimann, Diebold, & Kummerfeld, 2013) was about MOOC features in general, so our comparison has other specific elements.

There have been different works of assessments in MOOCs, most of them oriented to the peer review topic. The peer review assessment activity emerged with this massiveness environment. The paper (Kulkarni, Wei, Ley, Chia, Papadopoulos, Cheng, Koller, Klemmer, 2013) analyzes peer and self-assessment in MOOCs. In addition, different techniques to guarantee the correct grades have been proposed (Meyer & Zhu, 2013) (Piech, Huang, Chen, Do, Ng, Koller, 2013) but there are different studies that shows that peer assessment activities in MOOCs are not a good predictor of the final grades (Admiraal, Huisman, & van de Ven, 2014).

In addition, the importance of the social component in MOOCs has been discussed (Blom, Verma, Li, Skevi, & Dillenburg, 2013) (Purser, Towndrow & Aranguiz, 2013) and different social activities might be used for assessment. But more traditional individual instruction assessment can also be used in MOOCs such as the Thrun's work (Lewin, 2012) about Artificial Intelligence.

The data explosion of the last years and the inclusion of technology-enhanced learning make more necessary to learn from educational data in order to improve learning. The role of learning analytics can help to guide the reform of activities in higher education and assist educators in teaching and learning (Siemens & Long, 2011). The learning analytics cycle should be closed to feed the loop and improve the learning process in each iteration. Assessments can be considered as a special case of the learning analytics cycle and more complex indicators should be generated to value what really matters in the learning process (Clow, 2012). The application of analytics to the e-learning environment is seen like a key factor to be able to close the assessment loop in higher education and enter a continuous cycle of improvement (Mattingly, Rice, & Berge, 2012).

Regarding learning analytics, many research works have developed learning analytics tools to improve the support for teachers and students in different Virtual Learning Environments (VLEs) such as Moodle (Zhang, Almeroth, & Knight, 2006; Romero, Ventura, & García, 2008), BlackBoard (Mazza & Dimitrova, 2004), Khan Academy (Ruipérez-Valiente, Muñoz-Merino, & Kloos, 2013) or Personal Learning Environments (PLEs) (Govaerts, Verbert, & Klerkx, 2010). Nevertheless, although all these tools are based on different learning environments, the objective remains the same, which is to improve the learning process for students and educators. Additionally, new types of virtual learning activities are emerging making more difficult to assess the results because of the high level of interactivity in contrast to traditional assessments such as exams, watching videos or reading a document. Some examples of these open learning activities are peer reviewed assessments, circuit design, programming task or educational videogames. Learning analytics is situated as an adequate solution to assess the results of these new learning activities considering all the learning process taken by the student and not only the final answer. As some examples of the use of learning analytics to assess interactive learning activities we can find the assessment of students' behavior in open-ended programming tasks (Blikstein, 2011) or to assess the use of educational video games (Serrano-Laguna, Torrente, & Moreno-Ger, 2012). An important issue in this context emerges due to the marked differences between technology-enhanced learning (TEL) systems which makes very difficult the application of learning analytics solutions to different systems; in this direction Drira, Laroussi, and Le Pallec (2012) have proposed some guidance to design TEL systems which are interoperable. In addition utilizing contextualized attention metadata to capture behavioral information of users in learning contexts (Wolpers, Najjar, & Verbert, 2007) can be of help to design interoperable solutions.

IMPLICATIONS OF THE NEW MOOC PARADIGM IN ASSESSMENTS

Issues, Problems and opportunities

This section analyzes the issues, challenges, problems, opportunities and shift of paradigm that the introduction of MOOCs implies in the assessment process.

(Masters, 2009) described a list of changes that the introduction of the MOOC paradigm implies with respect to traditional instruction with LMSS. Some of the changes included in (Masters, 2009) are the following: distributed oriented philosophy of learning, change of the instructor role as facilitator, increase of active learner participation, more independent students learning, students select their own goals and learning outcomes to achieve, or students engage with others. Some of these changes but also others have an implication for assessments. The most prominent changes we have detected for assessment are analyzed next.

First, usual summative assessment activities that consist of assignments submitted by students to be viewed, analyzed and corrected by teachers are no longer feasible. Because of the massiveness, the high number of students registered in a MOOC makes difficult for teachers to correct and evaluate all students' assignments. While in a traditional course a teacher should make the correction of about 30 students, MOOCs can require the correction of hundreds or thousands of students.

Moreover, in traditional classroom sessions, teachers can usually give some feedback, recommendation and guidance to the students. This feedback and recommendation can be based on the analysis of specific formative assessment activities such as assignments or on the observation of the sequence and results of a set of activities and actions. This feedback and recommendation based on the teacher experience is again not feasible in MOOCs when the number of students increase, as a lot of time would be required to perform all of these tasks.

This effect of the massiveness that makes teachers not being able to perform all their previous traditional tasks, will have as a consequence the generation of new types of assessment activities, as will be detailed in the next section about the solutions. These new assessment activities need to be created and designed by teachers using some authoring tool. As there are new features for these assessment activities, the authoring process is made more complex than before and there is a need to create easy ways for teachers for designing and implementing the different assessment activities.

Although the massiveness brings limitations for assessments, it also brings new opportunities. As there are much more people, social activities can be emphasized and these social activities might be used in some way for the assessment process. In addition, gamification activities can have a more important role as the massiveness can originate new forms of games or e.g. the availability of games for people that are connected in a specific moment. The massiveness also brings the opportunity to have more precise evaluations, taking advantage of the power of all the generated data. In a traditional classroom, in many occasions the data is not relevant e.g. to generalize whether an educational resource was good or not. But with the power of data of thousands of students, more significant and relevant conclusions can be made for educational resources.

Finally, the idea that students should select their own learning outcomes and goals to achieve instead of a more guided and established process of learning objectives and goals, creates the need of incorporating a useful mechanisms so that students can select and track their own decided learning objectives for the assessment process.

As a summary, the list of challenges, issues and opportunities that we identify that MOOCs bring for assessments are the following:

- Assignment assessment activities corrected by teachers are not feasible.
- Continuous personalized feedback and recommendations for each student by teachers is not feasible.
- More complexity of the authoring process because of new assessment activities.
- New assessment activities based on social interactions.
- More opportunities for gamification features related to assessment activities.
- More precise evaluations of educational materials, students' behaviors, etc. because of the power of big data.
- Ways for students to set their own goals and learning objectives.

List of solutions and changes for assessments in MOOCs

In order to solve the presented issues, and react to the different opportunities of the previous list, we have identified a set of solutions and changes for assessments in MOOCs with respect to traditional online courses, which are explained next.

Automatic evaluation systems for summative assessment with a low intervention of teachers should be enabled. Traditional fill in the blank exercises, multiple choice, multiple response, ordered elements, or other types of automatic correction exercises e.g. provided by the IMS-QTI specification can be also used in MOOCs. However, in many situations, there should be more complex exercises like open text ones because these types of activities might allow a better evaluation in several cases. These more complex exercises are harder to be evaluated automatically. It is required the integration of intelligence artificial systems that can automatically make the evaluation of e.g. open text exercises. Traditional Learning Management Systems (LMSs) do not usually include this type of functionality. Some Intelligent Tutoring Systems (ITSs) include these types of functionality but ITSs are not usually suitable for MOOCs as e.g. they do not include features for a complete management of courses.

Moreover, intelligent systems for recommendations and more powerful automatic feedback systems for formative assessment should be enabled. Formative assessment should provide automatic guidance or help for students with the use of feedback, hints, etc. This way, exercises will be more complex for their design and creation. In addition, intelligent systems should track students' actions and give proper responses. In this way, a teacher intervention is not required for every student, but an intelligent system can make the proper decisions to guide students and make them interact with activities.

Furthermore, assessment activities that involve students should be enabled. As teachers are a limited resource for a so big amount of students, a solution is to involve the own students in the process of reviewing other students' work. For example, peer review activities where students' work is evaluated by other peers is a key feature for MOOCs. Students can learn by doing the own assessment activities but also by reviewing other students assessment activities. An issue about this solution is that students might not evaluate in a good way (e.g. because they can increase the grades or they cannot have the proper skills to evaluate well). In order to solve these issues, additional mechanisms can be enabled such as the author opinion about the evaluations, take more into account evaluation of students with high scores, partial evaluation of teachers to some reviews, etc.

Gamification is also important. Assessment activities can be gamified to take advantage of the big amount of people e.g. for enabling big leaderboards or competition among students who are online in a moment.

Regarding authoring tools, new authoring tools and methods should be enabled to allow the easy creation of materials by teachers and course designers. More details about this aspect will be given on another section.

The power of learning analytics can be used to reach significant and relevant conclusions about the learning process. For example, an accurate evaluation of learning materials can be done or the detection of students behavior that need to be corrected. Students and teachers can also be given with useful visualizations so that they can interpret the learning process in an easier way that if they have to look at low level interactions. More details about this aspect will be given on another section.

Finally, new mechanisms should be enabled so that students can set their own goals and learning objectives with freedom. For instance, students can be aware of all the possible learning objectives they can include in their assessment process and select some of them, their order, level of achievement, own selected deadlines, etc.

COMPARISON OF ASSESSMENT ACTIVITIES IN DIFFERENT MOOC PLATFORMS

Comparison and current limitations of the MOOC platforms

This section compares four MOOC platforms (edX, Coursera, MiriadaX and Khan Academy) in terms of assessment functionality. Table 1 shows this comparison. Each feature for every platform can be rated as None (if it is not present), Low, Medium or High. The different features for the comparison are based on the previous list of solutions for assessment functionality in MOOCs. The edX and Khan Academy platforms have already included rich additions to exercises in order to make them with better feedback and more interactive (e.g. an equation editor in edX), so these are the only two platforms that include at present features such as hints or interactive exercises. Regarding the adaptation of the learning process and recommendations, the only platform which has already implemented something is Khan Academy with a recommender of exercises based on competencies. The automatic correction of exercises with artificial intelligence is only supported in the edX platforms for some specific types of exercises such as code programming in python.

Regarding the peer review process all MOOC platforms support it except the Khan Academy one. This is because the Khan Academy platform is based on more specific exercises that can be automatically evaluated but do not require the intervention of other people to evaluate them. In addition, the Khan Academy follows the criteria of having all resources available all time without a time planning so it is difficult to have peer review activities with these criteria as not all students are synchronized making the course, so there is a difficulty of setting dates for peer review activities.

The only platform that includes gamification for assessment is the Khan Academy one, and students can earn energy points and badges by solving correctly different assessment exercises. Students have to solve correctly the same type of exercises several times in order to obtain the proficiency. When a student obtains the proficiency in a set of exercises, then the student will obtain a badge. The Khan Academy platform is also the only one that provides a high learning analytics support, providing powerful visualizations for assessments, while the others just have simple indications of the grades of students in the different activities.

The edX platform is the only one that provides an authoring tool for supporting the creation and edition of complex assessment exercises. This authoring tool is called Studio. The Studio tool enables the generation of different types of exercises and activities, the establishment of hints or the provision of feedback. Studio also allows organizing the different assessment activities in the different sections and subsections of the course.

Table 1. Comparison of the assessment functionality for MOOCs.

Different assessment features / MOOC platforms	edX	Coursera	MiriadaX	Khan Academy
Hints, adaptive exercises, etc.	High	None	None	High
Automatic correction of exercises with artificial intelligence	Medium	None	None	None
Interactive exercises	High	None	None	Medium
Peer review	High	High	High	None
Gamification	None	None	None	Medium
Adaptation of the learning process and recommendations	None	None	None	Low
Authoring tools for complex assessment activities	High	None	None	None
Learning analytics	Low	Low	Low	High
Social interaction functionality that might bring assessment activities based on it	High	High	Medium	Low
Setting students own learning objectives and goals	None	None	None	Medium

Regarding the social interaction functionality that might bring assessment activities, most platforms offer e.g. the possibility of online forums. However, the Khan Academy platform does not offer this possibility but enables the use of comments for each video resource.

Finally, the possibility of enabling students setting their own learning objectives and goals is only enabled in the Khan Academy platform at present. In other MOOC platforms, students can select their courses and the materials they will access but there is not the possibility of explicitly set their own goals and objectives.

Recommendations for the evolution of MOOC platforms regarding assessment functionality

At present, MOOC platforms are at an early stage of what they should be according to the requirements to support full assessment functionality for MOOCs (as can be seen in table 1). New developments are required to make a perfect solution for assessment in MOOCs and these platforms need to improve in the different aspects and features of table 1 where they have lacks. Table 1 shows that there is a great effort to do. All of the platforms can greatly improve the automatic correction of exercises using artificial intelligence techniques, the adaptation of assessment activities or the gamification features, although some platforms have already done some initial steps in these directions. These MOOC platforms can be even improved in the aspects marked as “High” support. For example, the Khan Academy platform has a high learning analytics support but additional very interesting functionality can be added.

Indeed, many of the different assessment required features for MOOCs have already been implemented in other systems as seen in the background section: e.g. some ITSs include features for automatic correction of exercises with artificial intelligence algorithms, interactive exercises, or adaptation of the learning process. In addition, other systems which are not ITSs include functionality for helping in the authoring process or for a detailed learning analytics support. MOOC platforms should incorporate these other features which can be seen in other platforms which are not MOOC oriented. This inclusion might be though as an integration with external services or as new implementations taking advantage of previous developments in other platforms.

The main reason why the different MOOC platforms have different assessment features is because their focus is different. Depending on their aims, these MOOC platforms should evolve to include all the different functionalities selecting first the functionality that is close to their objectives.

THE AUTHORING OF ASSESSMENTS

The authoring process problem for the creation of MOOC assessment activities

The new complexity of assessment activities in MOOCs makes more difficult the design and creation of assessment activities by teachers. The assessment activities can contain new elements such as hints, adaptive exercises, graphical interfaces, interaction points, etc. All of these elements imply a greater effort for the design and creation process.

Teachers are able to create easily typical exercises such as fill in the blank or multiple response ones. But teachers have difficulties when they have to define more complex elements such as the commented previously. For example, the creation of an adaptive path of exercises involves teachers in defining complex relationships among these exercises and the different conditions to go from one exercise to another. Or for example, the creation of interactive exercises opens teachers the ways to define these interactions.

Although there are existing authoring tools for the creation of assessment activities, e.g. based on the IMS-QTI specification, the existence of new and specific types of assessment activities in MOOCs make the challenge of building new authoring tools for the creation of such exercises. Indeed, these assessment exercises might be quite specific to the topics covered so very different specific authoring tools should be defined for each case. Moreover, a framework to join all the different authoring tools or methodologies might be required.

Similar authoring problems have already been treated for other functionality different to assessments, such as for the instructional design of a course using the IMS LD (IMS Learning Design) specification. Solutions for the authoring of this aspect have been proposed such as a solution based on patterns in (Hernández-Leo, Villasclaras-Fernández, Jorrín-Abellán, Asensio-Pérez, Dimitriadis, Ruiz-Requies, & Rubia-Avi, 2006).

Specific solutions for the authoring of assessments in MOOCs

For the aforementioned reasons, new authoring tools are required that allows to define new assessment exercises with their new functionality. The authoring tools might not only be web based or client based solutions in which users have to fill in a set of forms, but they might also be other solutions such as pattern based ones.

The challenge is to make the easiest authoring tool possible so that teachers can use it in an easy way with the more powerful functionality possible so that the materials that can be created by them include all the possibilities.

The edx platform provides the Studio authoring tool. Studio allows teachers the definition of assessment activities but also other aspects of the course such as their structure. Regarding assessments, the Studio authoring tool enables the creation of exercises such as checkboxes, conditional module, drag & drop exercise, multiple choice, fill in the blank or problem with adaptive hint among much others. The different screens of the Studio tool are designed so that teachers and professors can make directly their own definition of the assessment exercises.

A similar issue is also encountered in the Khan Academy platform where there is a need of creation of assessment exercises by teachers. Next, we show a solution of authoring tool that we created for the Khan Academy platform for solving the creation of a specific exercise in the platform. This authoring tool solves a specific problem but other authoring solutions must be enabled for other cases. Therefore, this is not a general solution even for the Khan Academy types of exercises but just a solution for some specific types of exercises that illustrates the problem and how was solved.

The Khan Academy platform has a lot of types of exercises, but the authoring tool tried to solve the authoring problem for exercises of type of figure 1.

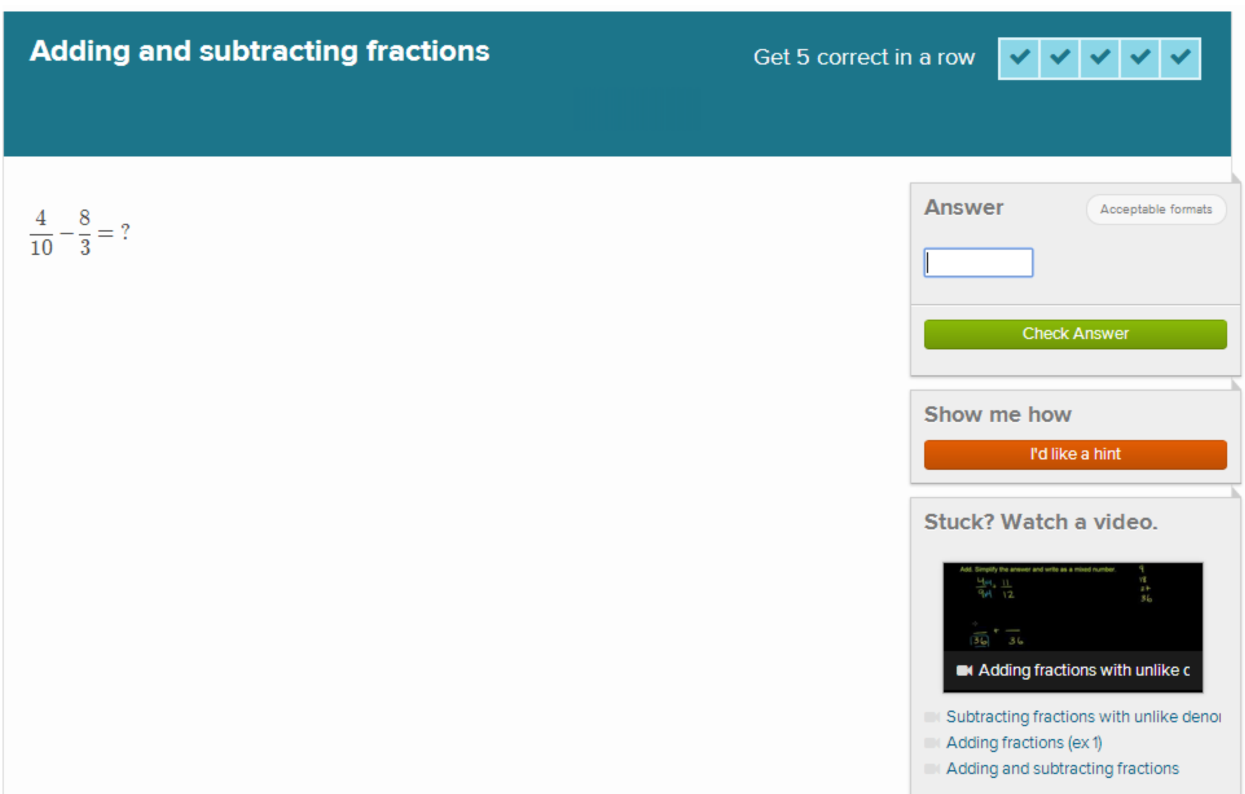

Figure 1. Simple Khan Academy exercise example.

As a reference, Figure 2 shows the HTML and JAVASCRIPT code the professor would have had to write to get the previous exercise.

```
<!DOCTYPE html>
<html data-require="math math-format">
<head>
    <meta http-equiv="Content-Type" content="text/html; charset=UTF-8">
    <title>Adding and subtracting fractions</title>
    <script src="../khan-exercise.js"></script>
</head>
<body>
    <div class="exercise">
    <div class="vars" data-ensure="D1 !== D2">
        <var id="N1">randRangeNonZero( -9, 9 )</var>
        <var id="N2">randRangeNonZero( -9, 9 )</var>
        <var id="D1">randRangeExclude( 2, 9, [ N1, -N1 ] )</var>
        <var id="D2">randRangeExclude( 2, 9, [ N2, -N2 ] )</var>
        <var id="LCM">getLCM( D1, D2 )</var>
    </div>

    <div class="problems">
        <div>
            <div class="question">
                <p><code><var>fraction( N1, D1 )</var> + <var>fraction( N2, D2 )</var> = {?}</code></p>
            </div>
            <div class="solution" data-type="rational"><var>N1 / D1 + N2 / D2</var></div>
        </div>
    </div>

    <div class="hints">
        <p>First, we need to find a common denominator. The least common multiple of <code><var>D1</var></code> and <code><var>D2</var></code> is the smallest possible common denominator.</p>
    </div>
</body>
</html>
```

Figure 2. HTML code for a simple Khan Academy exercise.

The code itself is not too hard to understand and it is also quite simple to see that the exercise is separated (code wise) in the following sections:

- Title.
- Variables.
- Question.
- Solution.
- Hints.

The exercise can contain variables which is not straightforward from figure 1. The professors can add, delete and modify variables from the Genghis authoring tool in a simple and comprehensible user interface. This way, the exercises are parametric and the same exercise can be repeated several times but changing the values of variables according to definitions.

Figure 3 shows the look and feel of the authoring tool, which is structured in the commented five areas.

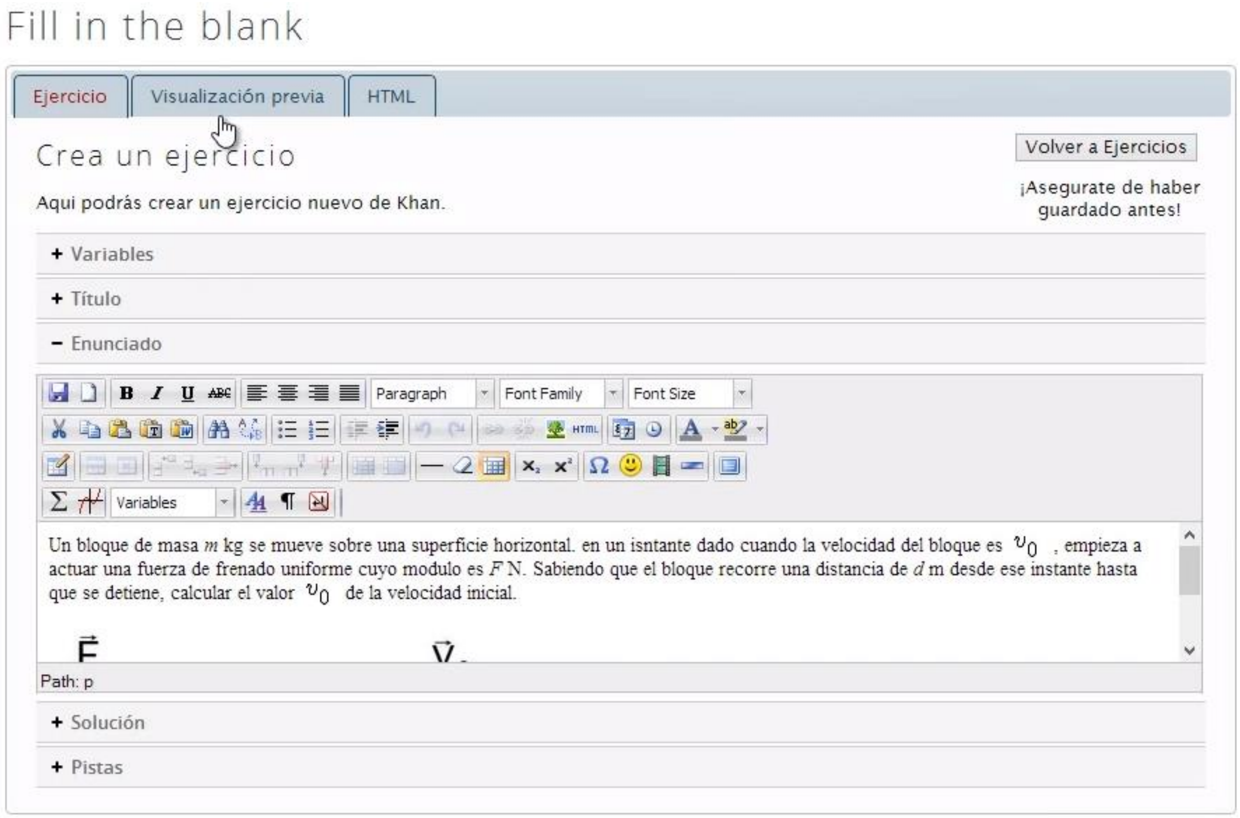

Figure 3. Genghis authoring tool's main editor.

At the very top there are 3 tabs which separate the exercise's three ways of displaying the information to the user:

- **Exercise tab:** This is the only tab where the user can edit the exercise in five sections that will be explained shortly next.
- **Preview tab:** Users can get a preview of what their exercise will look like. This tab sends the generated HTML code to a Khan Academy Exercise server which will return the full page for the user to evaluate. This is refreshed every time the user saves any field in the exercise tab.
- **HTML tab:** This tab was originally developed just for debugging, but was later decided that it should be left in production for users to use as reference in case they wanted to write their own exercises independently.

Variables are the key feature, together with hints, of this type of Khan Academy exercises, mostly because without them we will be solving a static exercise with no variability between executions. It is the variables ability to make every instance of an exercise unique to the students.

Figure 4. Exercises editor: variables.

Figure 4 shows the edition of variables. The first column shows the actions: to edit the variable in case any mistake was made and a small trash to delete the variable. Right afterwards there are the columns of variable name, and the properties, which can be:

- Whole number or decimal.
- Variable's range: The 'to' and 'from' fields are set to specify the range the variable can take
- Step (not shown in Figure 4): Depending on whether a whole number or a decimal was selected before, an extra numeric field will be shown where the user can specify the step at which the variable can take a random value. For example setting a decimal number from 3 to 7 with a 0.2 step can return numbers 3, 3.2, 3.4, 3.6, 3.8, 4.0, 4.2 … and so on all the way up to 7.0

As a quick note, editing the variable will reopen the editor used in variable creation but auto filled with previous values.

The title section holds a single text input for the user to specify the title the exercise should be saved with for further retrieval and also to be presented to the student once the exercise is completed.

As shown in Figure 3, the statement holds the main editor, where professors can create very complex and well-structured exercises using the many tools available in the What You See Is What You Get (WYSIWYG) editor. This editor has been modified for the Genghis Authoring Tool to provide further functionality to users, including a LaTeX editor which will automatically render the image of the formula, while keeping it usable and editable and a variable dropdown where all the previously added variables can be selected and automatically inserted into the main body so the user can not make any typo while writing the exercise.

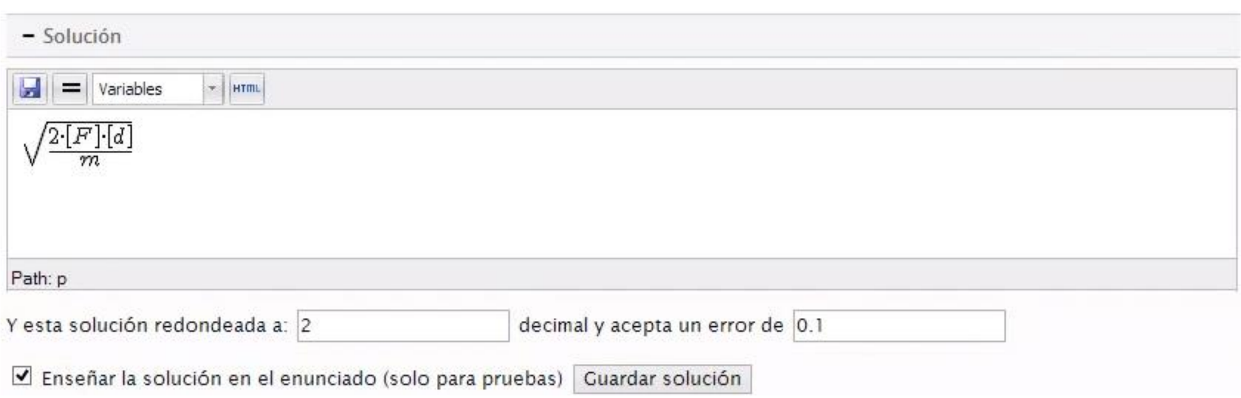

Figure 5. Exercise editor: solution.

Figure 5 shows what the solution editor looks like. In a way this editor is similar to the statement editor but it holds significantly less buttons, mostly due to the fact that it was designed to hold just numbers and equations, with no text nor formatting. It is also worth mentioning that the equation button hold different options as its exercise counterpart, since these formulas are actually going to be calculated, compared to the exercises where the formulas are only for display (the value will not be calculated). The editor also has a variable button for the insertion of variables in the text body that works identically to the exercise box. This way, professors do not have to remember the exact names given to their variables. By request it was also added the option to allow a percentage of error in the solution and the rounding of the number (it could get to more than six decimal numbers, proving troublesome for students who were told to round to two significant figures.

The final section of the five areas that compose an exercise is the only optional one. Professors may choose to set some hints for the user to see and use if they find themselves stuck with the problem. The handling of the hints is the other key feature of Khan Academy Exercises, not showing any at first and giving users the options to request a new hint at a time.

We designed and developed the Genghis Authoring in Universidad Carlos III de Madrid back in 2012. As stated before, the team's main objective was to make a simple authoring tool professors with no programming knowledge could use to make some Khan Academy exercises for use in any of the MOOCs which professors participate in.

The Genghis Authoring tool was initially developed in plain PHP with some JavaScript but was later moved to a PHP implementation using the Laravel Framework (a framework which is fairly similar to Symfony, in fact it uses some of its plugins and extensions). Persistency was done using a MySQL database, which will be explained now with more detail.

The very first draft of the site was simply a small website with the Twitter Bootstrap library for quick scaffolding and mostly to get the basic functionality working, leaving design for later. Once the design of where each of the five sections should be, the variables were the first thing to get done, originally being only whole numbers within a range specified by the user.

It was when creating the statement text area that the decision on how the user could make rich text paragraphs was made. After some time looking at various options, the team decided to use TinyMCE, the same What You See Is What You Get editor Moodle use since most professors use Moodle daily and the least number of new things they would have to learn the better. One of the reasons TinyMCE was chosen was also that it supported plugins, which would be very helpful when adding more custom functionality to the editor for our tool, specifically the LaTeX editor and the variable dropdown.

TinyMCE is a free WYSIWYG editor written in JavaScript available online at their website which offers among other things, the possibility to extend its functionality by the means of plugins also written in JavaScript, possibility we used to create two plugins:

- Variable Dropdown: As it was originally developed to have no AJAX, the fetching of variables was done upon reloading of the website when a variable was added. This was solved later by the addition of AJAX calls that made the tool much more user friendly.
- LaTeX editor: One of the most complex parts of this project, this editor presents the user with a small box where the user can either type LaTeX or select a wide range of already defined inputs (such as fractions, trigonometric functions and some symbols) to create the formula they want to display while also adding the variables they may need form the variable dropdown explained above.

The TinyMCE window for the solution input is, as mentioned before, stripped of many options to leave the editor to its simplest level, after all it would only take formulas as input. The LaTeX editor is slightly different than the one above as it presents a smaller array of options for the user to choose, since not many of the snippets offered in the exercise editor could be computed using the Khan Academy calculator.

The previewing tab was done running the Khan Academy exercises module in a Tomcat server inn one of the University's machine, which would run full time parsing any new document added to its folder structure, which is where the Genghis Authoring Tool would save the exercises.

LEARNING ANALYTICS FOR ASSESSMENTS IN MOOCS

Issues about learning analytics for assessments in MOOCs

Students are usually evaluated by their interaction while solving assessments. However, each platform has different types of assessments and also they usually have different tools available (such as hints, glossary, forums…). Instructors need to monitor the activity of the students to evaluate their performance and also detect problems. In addition, students should know about their progress for self-awareness. Therefore it is important that virtual learning environments provide proper visualizations and additional information to fulfil these requirements. In addition, the massiveness of MOOCs makes even more necessary the fulfilment of these needs because instructors cannot spent much time with each student. Instructors need to have the tools to make easier the task of monitoring hundreds of students quickly and students need to know how they are progressing and if the objectives of the course are being fulfilled.

However, we can face different issues taking into consideration the existing MOOC platforms. The first one is caused by the difference between the types of assessments and tools available in each platform which makes that the information that can be inferred very different. For example Khan Academy supports hints but not peer review assessments whereas Coursera includes peer review assessments but not hints. Therefore, the learning analytics information that can be provided should be adapted to the functionalities of each platform. In addition, the data model and the implementation of which interactions of the student are captured are usually different even though two platforms might have assessments functionality very similar. Therefore, the data available can differ greatly which makes more difficult to design learning analytics solutions applicable to different learning platforms.

Other questions arise such as what indicators for assessments are necessary to properly evaluate the learning process of students. Different authors propose different indicators, for example Dyckhoff, Lukarov, and Muslim (2013) have made a study of the indicators that have been addressed in the literature for learning analytics by others works, and many of them are related to assessments. Some of the indicators which are addressed are "Number of assignments submitted per student", "Average overall quiz score" or "Clusters of students who made a (specific) mistake". However most of the works establish their own indicators taking into account the functionalities of their learning environment and there is still no common framework that everybody could use. In addition there are works which present more complex indicators for behavioral patterns when solving assessments such as hint abuse and hint avoidance (Aleven, Mclaren, and Roll, 2004), or video avoidance and unreflective user (Muñoz-Merino, Ruipérez Valiente, and Delgado Kloos, 2013). However these complex indicators are usually strongly associated to how assessments are built in each learning platform, for example the existence of hints in assessments (Aleven et al., 2004) or an association of a video to each assessments (Muñoz-Merino et al., 2013), therefore these indicators for assessments might not be applicable to others contexts. An additional current technological challenge is the management and processing of all the educational data. This last issue is even more important when we are talking about massive platforms like the ones addressed here.

Once the indicators and the information have been obtained it is time to be transferred to the stakeholders of the learning process. This step is also critical because the informations need to be available in an easy way by non-technical users, otherwise it will not be useful. Information visualization represents one of the most important fields of research of the last 15 years and it is a very interdisciplinary research field (Chen, 2006). In the context of assessments there are not yet any common practices but the main objective remains the same; to effectively transfer information by visualizations. Some tools have used complex graphics to assess the interaction of students with virtual learning environments; for example CourseVis (Mazza & Dimitrova, 2004) uses performance matrix to evaluate assessment performance or TrAVis tool (May, George, & Prévôt, 2011) which uses spider web charts help students evaluate their own activities. Finally others tools provide alternative ways to transmit information.

Next, we present a comparison between the learning analytics functionalities of the four MOOC platforms that are being analyzed in this work. The comparison has been divided in two parts, table 2 shows the comparison related to the learning analytics functionality for students and table 3 shows the functionality designed for instructors. The learning analytics functionality of most platforms is very plain and short. Coursera, edX and Miriada X have little functionality, only to check on their last attempts and very simple information. On the other side Khan Academy has incorporated a very completed system for students where they can easily gain awareness about how they are progressing in each of the skills, to see how much effort they have put in each of the skills, or learn about how they have distributed their work time in a period of time. There is a significant difference with the functionality implemented for students in Khan Academy which is much wider than the other platforms.

Table 2. Comparison of the learning analytics functionality for students in the four MOOC platforms.

MOOC platform	Basic functionality	Advanced functionality
edX	Students can check the score obtained in each module (in the case that the module has any assessment). Students can check their last attempt to solve an assessment to see their mistakes, however they cannot check on attempts previous to the last one.	The specific assessment modules for chemistry, programming or circuit design contain a bit of helpful feedback when students attempt to solve the assessment. A bar chart visualization is enabled where each bar represents the score (from 0 to 100) obtained in each assessment of the course The final score of the course is also included in the bar chart taking into account the weight of each assessment.
Coursera	Students can check the scores obtained in each assessment of the course.	Students can access all the previous attempts to solve an assessment and not only the last one, to review all their mistakes. There are not any visualizations enabled. The final score of the course cannot be accessed until the course has finished and the system calculates it.
Miriada X	It only includes an overview tab where there is an indication of the percentage of the module completed.	You can check your previous answers, but only if you passed the assessment, either way your answers and mistakes are not available.
Khan Academy	Students can check on the status of each of the skills (it is similar to an assessment) of the course to see their knowledge level.	Students can access to all their previous attempts to solve assessments to check their mistakes. The progress report on skills provides a visualization in which the progress on each

		skill of the course is codified by the color. The progress report on activity provides a line chart where all the assessments, videos or badges achieved in a temporal interval are shown. The progress report focus provides a circular visualization in which the student can check on the percentage of time inverted in each assessment. All the visualizations can be configured by the student to retrieve the information for different time intervals.

The functionality implemented for instructors in edX and Miriada X is equally shorter than the students functionality. In the case of Coursera, it has been impossible to obtain this information for this work. On the other hand, Khan Academy additionally to all the individual visualizations commented in table 1, enables new visualizations to check on all the class at the same time such as a grid of all skills and students, or a temporal chart where the evolution of all the students in a class can be checked.

Table 3. Comparison of the learning analytics functionality for instructors in the four MOOC platforms.

MOOC platform	Basic functionality	Advanced functionality
edX	Some course at a glance are shown such as the gender distribution, level of education…	Instructors can access through a grade book the assessments scores for each student of the course.
Coursera	N/A	N/A
Miriada X	Very basic information is available for the instructors of the course.	-
Khan Academy	-	Instructors can access to all the individual visualizations commented in table 1 for each one of the students of the class. Instructors can access a class progress visualization where they can check on the status of the entire class in each one of the assessments separately. There is also a grid visualization available where each cell represent the status of one student in one assessment codified by colors. Finally there is also a line visualization where the interaction of all the students can be watched in a temporal interval

After this comparison is very clear that only Khan Academy has a learning analytics module powerful enough to properly support the learning process for students and instructors in a MOOC platform. The different Learning Virtual Environments (and not only MOOC platforms) should be aware of the necessity of this support and start taking steps towards the development of learning analytics functionality. EdX has already shown their support on this topic and they have an open project called

Insights[1] whose goal is to develop a common learning analytics framework in Open edX. However other platforms have yet not taken these first steps.

Solutions for learning analytics in assessments in MOOCs and overview of the ALAS-KA extension for the Khan Academy platform

In the previous section we introduced the most important issues and problems regarding learning analytics for assessments in MOOC platforms, and in addition we made a comparison between the learning analytics functionality for students and instructors of the main MOOC platforms. Next we provide first some recommendations and ideas about how to face these problems.

Each of the learning analytics steps have issues associated; now we propose some ideas to solve each of them. The first stage is the acquisition of educational data but before that we need the MOOC platform to capture the maximum amount of events related to assessments as possible. It is necessary to design platforms that collect as much data as possible regarding to students' interaction. In the case that we are designing a new MOOC platform it would be useful to implement an extended log tracking module to capture all the events possible when students are resolving assessments. For example timestamps about whenever a student access or solves an assessment, all the attempts or if he asks for hints and their timestamps and much more. In the case that you have to design a new learning analytics module for an existing platform it is mandatory to make an in-depth analysis of the data available to learn what information can be inferred.

Secondly we should design what indicators or metrics related to assessments can be inferred from the low level data taking into consideration what information will be useful for students and instructors. Students are mostly interested in checking their progress through the course and know how much left they have to do in order to pass the course. In addition, students should be able to revise their own mistakes when solving assessments and receive feedback about their errors. They should know if they are behind or ahead schedule in case they have to work harder. Instructors also should be able to control the progress on assessments of the entire class and each of the students individually to detect problems. In addition, some additional indicators should be made available to detect bad behaviors for learning or indicators associated with high possibilities that a student drop out the course. The system should help instructors to detect these negative behaviors so they can intervene by the most appropriate channel (such as email, notification by the platform or face-to-face). In addition future complex learning analytics modules might enable automatic recommendations, for example if the student is falling behind the course schedule and the risk of dropping out the course is rising exponentially. The information provided should be also included separately for each assessment of a course to detect potential problems in assessments. The information acquired through the analysis of the indicators should be used not only to just-in-time interventions and self-awareness but also to enhance future learning experiences improving assessments of a course and solving problems or for example to cluster students with similar behaviors or capabilities for future practice hours.

The next step is to make this information available to students and instructors. This stage is also very important because even if the information processed can be very useful, if it is not properly transmitted it will not be put into a good use. The possibility of using tables to transmit the information is not the most adequate because it is not as visible and easily interpreted as visualizations. However visualizations can be tricky also and the design should be made keeping several considerations in mind. The interface should be made as simple as possible and following a usability recommendations guideline to make it user friendly. In addition visualizations should be focused into transmitting easy and simple information instead of focusing into complex and artistic visualizations. The indicator itself can be complex if the

[1] https://github.com/edx/insights

information is clear but the visualizations should be easy to understand. The colors should be used meaningfully along the entire learning analytics module, for example using different degrees of the same color to express more or less. It is also noteworthy that it is helpful to maintain the same standards in the complete interface to avoid confusing. Finally the information provided by each indicator and visualization should be very clear and easy to understand, even if the users have non-technical knowledge or knows the platform at all. A good advice can be to add explanations of what information is being provided by each visualization and possible advice to how interpret it, instead of letting the user make up their mind on their own.

Along with the previous issues we can find different technical problems. For example, related to managing enormous databases with millions of rows. In order to solve this problem, most of the MOOC platforms use non-relational databases (such as MongoDB or Google App Engine Datastore) which have some benefits over traditional relational databases (such as Oracle or MySQL) when talking about "Big Data". In addition, it is necessary to evaluate if it is possible to offer visualizations of the selected indicators in real time. Some of the heaviest indicators might need a processing time too high to be adequate for the user experience. For example imagine a hint abusing indicator which needs about 30 seconds to be processed; the user cannot wait all that time whenever he/she makes the request. A possible solution when talking about indicators which have a heavy processing is to divide the processing parts into smaller tasks. These task can be executed in regularly intervals and store the results so that whenever a user request a result, it can be prompted immediately.

An overview of a specific solution we have implemented for the Khan Academy platform which is called ALAS-KA (Add-on of the Learning Analytics Support of the Khan Academy platform) is presented next. Many of the functionality and visualizations available in ALAS-KA are related to assessment, although there are also other types of indicators. As we introduced previously, Khan Academy has a very powerful learning analytics module. However, taking into account all the data available in Khan Academy courses there is still a lot of room for improvement. We think this solution of ALAS-KA is a good illustration of how to apply learning analytics in MOOCs: several of the parameters can be reused in other MOOCs, while others are specific and need to be defined according to each context.

A complete explanation of the architecture of ALAS-KA with specific details can be retrieved from Ruipérez-Valiente, Muñoz-Merino, & Kloos (2013). Anyhow we provide next the main ideas to develop this tool and overcome the problems previously addressed. Khan Academy stores a lot of interactions of the user when solving assessments, therefore there are a lot of data available to obtain additional indicators useful for the learning process. ALAS-KA has been implemented as a plug-in for Khan Academy using the same infrastructure that is Google App Engine (GAE). We have included a total set of 21 different indicators which have been divided in 6 different functional modules: Total Use of the Platform, Correct Progress on the Platform, Time Distribution of the Use of the Platform, Gamification Habits, Exercise Solving Habits and Affective State; specific formulas of how to infer many of these indicators have been reviewed in Muñoz-Merino et al., (2013). Grouping the related indicators in modules makes easier and more intuitive for the user to browse the interface and find the information required. Many of the indicators are related to assessments, others to videos and more diverse things such as gamification or emotions. The set of indicators have been designed after an in-depth analysis of the existing educational data and taking into account the necessities of the stakeholders who intervene in these courses. Some of these parameters have been addressed in other works but others are completely new.

The interface of ALAS-KA has been kept as simple as possible. There are only four different tabs to be selected. *Home* tab has a description of all the modules and indicators so that users can have a clear knowledge of what information is provided. *User* tab have individual visualizations and tables whereas *Class* tab has visualizations of all the students in the class at the same time. Finally *About* tab have contact information related to the authors of this tool. The idea is that students can access only their own individual visualizations for self-awareness and instructors can access all individual and class visualizations to control the learning process. We have followed several rules to design the interface such as to use colors meaningfully, to divide the functionality into smaller parts and to use the same standards in the entire application. Figure 6 shows an example of individual visualizations of the module *Exercise Solving Habits* for one student. We decided to use information tables and visualizations to transmit these indicators. The table describes the user verbally giving a description for each indicator. Individual visualizations are bar charts which always display the value of the indicator from 0 to 100, this makes easy to understand all visualizations because there are no different units or charts. In addition, each indicator has also an additional bar which is the mean of the class; this way the instructors can compare each student with the entire class. ALAS-KA also enables class visualizations for each of the indicators, which give an overview of the class status by using pie charts. In addition, some different charts have been enabled to fulfill concrete necessities.

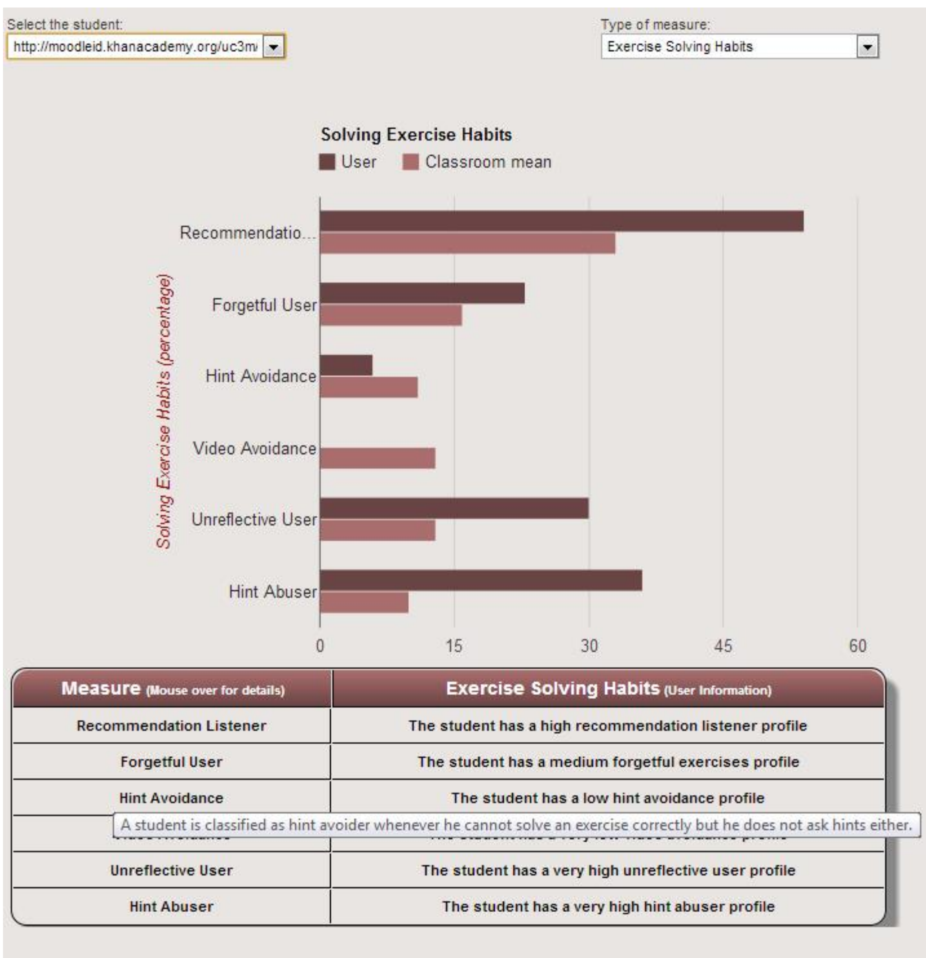

Figure 6. Example of individual visualizations and description table in ALAS-KA.

One of the main problems of this development has been the data processing design. Some of the indicators included in this module apply algorithms that need to process much data. Therefore is not possible to provide an instant response to each request in real time. Our decision was to process all the indicators in a regularly basis and store the results in the database. To accomplish this, we divided the entire processing module into smaller tasks which can be handled as background jobs by the server without collapsing normal functionality. Concretely, we have used the Task Queue API and the Cron

Service of Google App Engine to implement the background data processing design. Every time a user requests some information, the system just needs to retrieve the results from the database and show them which make the user experience very satisfactory.

FUTURE RESEARCH DIRECTIONS

The MOOCs might imply the appearance of new types of exercises or the wide adoption of others that have been proposed. These new exercises for assessment can take advantage of interactivity, social features or gamification. Research can be done in determining this new generation of exercises for assessments in MOOCs. Particularly interesting is research on specific exercises for specific topics instead of generic exercises. These specific exercises might take into account the specific topics and their semantics.

Moreover, the needs of more intelligent systems to help and guide students can bring further research to make more precise feedback generators or recommenders. Technologies such as the ones based on semantic web can be explored for this purpose.

Another interesting research line is the integration of MOOC platforms with existing external services such as with ITSs or external authoring tools. This way, the lack of some functionality of present MOOC platforms might be complemented with these external tools.

The peer review activities are one of the key differences for assessment in MOOC environments. There have been previous works about this topic such as functionality, fair grades, etc. but much more can be investigated.

Another important research line can be the authoring of the different assessment activities in MOOCs. As there can be a lot of heterogeneity of types of exercises and activities, each one with a different authoring tool solution, then new solutions that can bring all of the independent authoring tools together can make sense, in addition to research on specific particular solutions for the authoring of each specific activity.

Moreover, it would be important to know which of the offered assessment tools are really used in practice by teachers and in which contexts. We think this would be an interesting study to do as a future research direction.

Learning analytics is a very promising area of research so there are a lot of future ideas to be developed in the next years. To establish a common data model framework that could be used in all types of virtual learning environments would be an important advancement with respect todays' solutions. A common framework would facilitate the task of using a learning analytics design in different MOOC platforms. More specifically related to assessment it would be useful to analyze what types of activities are best for the learning process through assessment data acquired from different virtual learning environment. In addition, researchers should learn about what early indicators can be used to detect important outcomes such as success, poor marks or dropout to prevent bad outcomes from happening or encourage others students' actions. Finally some work should focus on learning what type of information and the best way to transmit is required from the point of view of instructors and students through surveys.

CONCLUSION

This book chapter lists a set of challenges, issues and opportunities about assessment activities in MOOCs, which bring a list of required changes in assessments for MOOCs with respect to traditional assessment activities in other learning environments. Among the required changes for MOOC assessment activities are the extension of current exercises with more in depth features such as hints or precise feedback, more powerful interactive exercises, introduction of gamification in assessment, automatic correction for more complex exercises, the inclusion of peer review, enabling useful authoring tools for these richer exercises, or the application of powerful learning analytics techniques.

Present MOOC platforms do not have all the required features to support this type of assessment activities and are not mature enough. Each MOOC platform has some of the required features but not others. But not all of them have the same assessment features but are more advanced in some of them depending on their focus. Therefore, there is a lot of room for improvement and MOOC platforms should incorporate these new assessment features according to the list of requirements. For example, the Khan Academy platform has a strong learning analytics support or hint support in assessment activities, but lacks a peer review system or lacks powerful functionality related to cMOOCs as the only social interaction possibility is the comments on videos but there are not e.g. structured forums.

Some of the required assessment features for MOOC platform should be implemented from scratch, while there are others that might have insights from other ITSs, authoring systems or dedicated learning systems where similar features have already been implemented. There is a need of incorporating different knowledge from different disciplines (intelligent tutoring systems, authoring design, semantic web, etc.) in order to make MOOC platforms progress. So far, MOOC platforms are not so different of LMS platforms in terms of assessment functionality, but when all of these assessssment features will be incorporated, this will define a difference between MOOC and LMS platforms.

Related to the conclusions about learning analytics of assessment we can state that the information that can be inferred about assessments strongly depends on the semantics of each platform. One of the main problems is that the data model of each MOOC platform is different even if they have the same type of assessment, therefore the learning analytics solutions are not applicable to different platforms. We have made a comparison between the learning analytics functionality of the main MOOC platforms. The conclusion of this comparison is that Khan Academy is the platform which has the strongest learning analytics functionality to support instructors and also self-awareness for students whereas the others have very few elements integrated and there is still a lot of work to do. Nevertheless we have provided some directions and ideas that should be of use for people who want to develop new learning analytics solutions for assessments in existing or new MOOC platforms.

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KEY TERMS AND DEFINITIONS

Assessment activity: Any learning activity that can be used to assess student knowledge level in a specific set of topics.

Assessment: The process of assess student knowledge level in the different topics of a course, using different assessment activities.

Evaluation: The process of giving a result about the success or failure of some learning activity. The evaluation of an assessment activity is the final conclusion and a part of the assessment activity, while the assessment activity involves a higher level process such as the students' interactions.

Exercise: A type of assessment activity that has some question for which the students need to find the solution.

MOOC: Massive Open Online Course. This is a course that can be accessed anytime anywhere usually through the Web, in which the course is open so that anyone can register it, and is massive as there can be thousands of students enrolled in it.

Authoring tool: It is a tool for helping in the creation and design of course materials.

Genghis: It is the name of a project at Universidad Carlos III de Madrid. This project aims at introducing MOOC technologies to private online courses for improving freshmen students initial skills in physics, mathematics or chemical. The Khan Academy platform has been used for this purpose.

Gamification: It is the procedure of introducing games to a process that is not a game. For example, the gamification of the learning process is the procedure to introduce game elements for learning activities.

Learning analytics: Learning analytics[2] is the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs

Educational data: Data generated by students when interacting with learning activities and can be used to improve the learning process.

Visualization information: It is the study of visual representations in order to reinforce the transmission of knowledge to people.

[2] https://tekri.athabascau.ca/analytics/