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The adoption of cloud-based tools in MOOC settings - advantages and challenges

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Abstract

MOOCs have become a widely used form of online education offering open education. Cloud-based tools are broadly used for business and private purposes, and can also enrich learning experiences and engage learners. In this paper, we pursue the original ideal of c-MOOCs and explore the advantages and issues – on both the teaching and the technological dimensions - of using cloud-based tools in a MOOC setting. To this end we have conducted research as part of the MOOC Maker project combining a literature survey and the instrument of questionnaires among the project partners. Our findings reveal advantages, such as enlarging the variety of learning activities and outsourcing of services. The drawbacks include security and privacy issues plus the effort involved in administering several external tools.

Keywords: cloud-based services, massive online learning, service composition, service orchestration, compatibility

Resumo

Os MOOCs tornaram-se uma forma amplamente utilizada de educação online que permite levar a cabo uma oferta de educação aberta. As ferramentas baseadas na nuvem, que são amplamente utilizadas para fins comerciais e particulares, também podem enriquecer as experiências de aprendizagem e promover o envolvimento dos estudantes. Neste artigo perseguimos o ideal original dos c-MOOCs e exploramos as vantagens e os problemas - tanto ao nível do ensino como no que diz respeito às dimensões tecnológicas - da utilização de ferramentas baseadas na nuvem num ambiente MOOC. Com esta finalidade, realizámos pesquisas (como parte do projeto MOOC Maker) combinando revisão de literatura e aplicação de questionários entre os parceiros do projeto. Os nossos resultados revelam vantagens, como ampliar a variedade de atividades de aprendizagem e a terceirização de serviços. As desvantagens incluem questões de segurança e privacidade, além do esforço envolvido na administração de várias ferramentas externas.

Palavras chave serviços baseados na nuvem, aprendizagem online massiva, composição de serviços, orquestração de serviços, compatibilidade.

Introduction

Over the course of the past few decades, our civilization has transformed into a globalized and knowledge-based society with the need for changing skills and rapidly adopting knowledge. As a consequence modern education has changed from repetitive learning to active, self-guided and problem-based learning in context. Technology has influenced and also been adopted by educational settings. In particular, advances in computer technologies and web-services have strongly influenced learning and teaching approaches. (Gütl & Chang, 2008)

Open source and open content initiatives have initiated the beginning of open education (Pisutova, 2012). Not only have freely available tools and content been adopted in educational settings, but also open learning resource repositories have emerged, such as MIT Open courseware in the USA (Gütl & Chang, 2008) or the Open educational resources programme in the UK (Wikipedia, 2018). With the beginning of Massive Open Online Courses (MOOCs), access to education has, with some limitations, become open and the organizational barriers to enrolling in courses and taking advantage of their content can now be widely eliminated. (Fini, 2009; Siemens, 2012)

The Web has moved from a static content consumption to a dynamic and content sharing technology, which has also become known as Web 2.0 (Gütl & Chang, 2008; Hernandez, Linares, Mikroyannidis, & Schmitz 2012). New tools and services, such as social media, have become available as a consequence. These new evolving technologies and services have also been adopted in modern learning settings (Pisutova, 2012).

Most of the available MOOCs follow the xMOOC approach, which follows closely aligned to the layout of a conventional course design. The original idea by Siemens and Downes, however, was to allow learners to make use of various cloud-based tools and social media, and elaborate and share knowledge in a collaborative way. Despite the early success of the approach, they also report on issues using external tools. In this they state among other points that it has not only been difficult for the teachers but also for the student peers to keep track on new contributions available on different external tools (Fini, 2009; Siemens, 2012).

In this paper, we explore the advantages and issues – in both the pedagogic and the technological dimensions - of using cloud-based tools in a MOOC setting. To this end we have conducted research as part of the MOOC Maker project (MOOC Maker, 2018) combining a literature survey and the instrument of questionnaires among the project partners.

The remainder of the paper is structured as follows: Chapter 2 covers briefly background and related work on MOOCs and cloud-based services. Chapter 3 outlines and discusses cloud-based tools for online learning – addressing both single tools and the combination of tools. Chapter 4 highlights the adoption of cloud-based tools in

MOOC learning settings, discusses advantages and issues, and concludes with recommendations – both on pedagogical and technological dimension.

Background and related work

Online learning on a scale

Since 2012 when the MOOC (Massive Open Online Courses) adoption reached a high peak being nominated as the "Year of the MOOC", several improvements enriched the results and brought about active participation from relevant higher education institutions. At the present time, it can be affirmed that the MOOC movement has reached the stage of the productivity plateau in terms of the Gartner technology hype cycle (Gartner, 2018). MOOCs were conceptualized as artefacts to democratize education and let the world know about the quality of education generated by the institutions involved. The maturity of the MOOC movement is evident from the great number of well-known platforms now available such as edX, Coursera, FutureLearn, MiriadaX, Udacity, among others (Yousef et al., 2014; Sanchez-Gordon & Lujan-Mora, 2014). Moreover, the media has recently reported extensively on a group of MOOCs that provide specialized competences for the learner. Examples of this can be identified Nanodegrees (Udacity), Specializations (Coursera) or MicroMasters, XSeries or Professional Certificates (edX). These series courses confer certification or credit equivalent diplomas in specific and narrowly defined topics. (Waks, 2016).

In terms of the pedagogical approach, it is interesting to highlight that the first MOOC offered by Siemens and Downes (n.d.) was designed with a connectivist approach and had the aim of connecting learners in order that they would be able to learn from each other through peer reviewing, open discussion and collaborative joint projects. This approach based on connectivism was titled as cMOOC. The higher education institutions then designed more traditional courses with a common configuration based on a specific syllabus, pre-recorded lectures, learning material and self-test assessments with a clear outlook aimed at the concepts of massiveness and scale, leading to the term xMOOC (Fidalgo-Blanco et al., 2016). At present, various different strategies are in use to improve the learning experience with the purpose of adopting the best practices. The most relevant approach is to reduce the number of participants and prepare blended experiences with face-to-face and online instruction using MOOCs as variation named SPOC Small Private Online Courses (Fox, 2013).

Cloud-based Services

Broadly speaking, the term "Cloud Computing" encompasses the whole concept of the applications offered as services and the infrastructure that provide those services over the Internet. The strong computing capacity and high-speed connection that Internet is providing at present is enabling an ideal scenario for developers that no longer require to invest in hardware to deploy innovative ideas rather than on specific services (e.g. Amazon Elastic Computer Cloud – EC2, Amazon Web Services – AWS) (Amazon, n.d.). Based on this highly scalable approach, it is worth mentioning four classes of services: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS) and Backend as a Service (BaaS) (Armbrust et al. 2010). The concept of Cloud-based services is part of the category Software as a Service (SaaS) and can provide great value and impact in different settings. In the case of an educational setting, the focus is on the pedagogical approach rather on new technical functionality in the virtual learning environment.

Cloud-based tools for online learning

A Taxonomy on cloud-based tools for learning

The term Cloud-based Tools (CBTs) is used to define cloud-based services or web applications with a set of functionalities. CBTs offer new opportunities for online learning while promoting a change in the way people learn based on the creativity of the teacher who designs the learning activity. The use of CBTs provides a revolution in the teacher's role and attributes, providing new resources for the development of various pedagogical approaches (Chang, Gütl & Ebner, 2018). These tools offer a high degree of scalability and flexibility by "on-demand" provisioning of resources, accessibility and interoperability. CBTs are managed over cloud computing, allowing the possibility of sharing them between peers and hence promoting the collaborative work. The main benefit for learners and teachers is the possibility to access their resources at any time and place. Another important aspect to note is that CBTs can be integrated into learning environments through their application programming interfaces (APIs). In general, CBTs promote the creation of an appropriate environment for social education aimed at collaboration and interaction among all participants in the learning process (MOOCMaker, 2016).

Based on the possible broad application of CBTs in the learning process, a classification of the tools can help to organize and plan the application in learning experiences. The taxonomy is based on an extensive literature review presented in (Chang, Gütl & Ebner, 2018) and (MOOCMaker, 2018). The proposal describes seven types of CBTs: (1) Course design and authoring; (2) Collaboration; (3) Content creation; (4) Hands-on (practical and interactive experiences); (5) Assessment and feedback; (6) Knowledge and auxiliary services; and (7) Learning management and support tools (Chang, Gütl & Ebner, 2018). A brief explanation and examples of available tools for each category is presented in Table 1.

Table 1: Taxonomy of cloud-based tools and selected examples of CBTs based on a review of existing tools (taken and adapted from Chang, Gütl & Ebner, 2018).

Cloud-based tool types	CBTs examples
Course design and authoring tools: Cloud tools of this kind support instructional designers and learning content authors to create and maintain educational content.	Udutu [1] EasyGenerator [2] Lectora Online[3]
Collaboration tools: This group of tools allows learners to work together with their peers. This tool type includes synchronous and asynchronous communication applications.	Wikispaces[4] Google Docs[5] MindMeister[6]
Content creation tools: This group of applications is specially to support the creative process for learners and teachers while creating educational content in learning activities.	Google Drive[7] Evernote[8] Creately[9]
Hands-on tools: The aim of these tools is to elicit active involvement and engagement from learners. These CBTs provide simulations and learning scenarios for a practical virtual experience.	TEALSim[10] BodyViz[11] Blockly[12]
Assessment and feedback tools: This group of tools enables assessment of knowledge and skills, complemented with feedback facilities, guidance and follow-up.	Quizlet[13] Educaplay[14] WizIQ[15]
Knowledge and auxiliary services: These tools provide background knowledge and references from open learning repositories and knowledge databases.	Global-Geography[16] LEO[17]
Learning management and support tool: This group of tools helps learners and teachers to keep track of the learning activities.	TalentLMS[18] GameEffective[19]

Advantages and challenges

The added value of CBTs in the teaching and learning process (through the design of learning activities that involves appropriate use of CBTs) has proven to be meaningful. CBTs have the potential to develop a wide range of activities with the help of the

[1] www.udutu.com
[2] www.easygenerator.com
[3] https://trivantis.com/products/lectora-online-authoring/
[4] http://www.wikispaces.com
[5] https://docs.google.com
[6] https://www.mindmeister.com
[7] https://drive.google.com/
[8] https://evernote.com/
[9] http://creately.com/
[10] http://web.mit.edu/viz/soft/visualizations/tealsim/
[11] http://www.bodyviz.com
[12] https://developers.google.com/blockly
[13] https://quizlet.com
[14] https://www.educaplay.com
[15] https://www.wiziq.com
[16] http://global-geography.org
[17] http://www.leo.org
[18] https://en.talentlms.com
[19] http://www.gameffective.com

creativity of the teacher and the best practices of the education community. CBTs allow the students to interact, solve case studies, produce reports, and create conceptual designs even collaboratively. Selected advantages using CBTs in learning scenarios are briefly discussed as follows (MOOCMaker, 2016):

- The use of CBTs in the learning and teaching process contributes to the effective learning (Washington & Sequera, 2015). The effective learning encompasses key activities as reflection, dialogue, collaboration, and application of the theory learned into practice among others. In this sense, CBTs provide different features for up-to- date applications that enhance the learning experience.
- The use of CBTs in learning settings improves motivation to learn and complete courses through innovative activities.
- The social interaction between learners is enriched through the inclusion of popular tools, which they use on a daily basis.
- The interactivity among learners is powered by social networks and CBTs specialized in active participation of peer in real time.
- The use of the cloud ecosystem offers high scalability in terms of capacity that is outsourced to the external app provider infrastructure.
- CBTs provide the benefit of including engaging activities for less cost or free without the need to have the own development team program the functionality.

On the other hand, the implementation process of learning activities including CTBs involves several challenges. A selection of issues is outlined briefly below (MOOCMaker, 2016):

- The use of CBTs requires a considerable investment of time and resources by the teacher while selecting suitable tools from the myriad of those in existence. In this sense, the proposed taxonomy could ease the process of identifying new tools and matching the functionality with best practices from past experiences.
- A vast array of CBTs is available and new ones will continue to be published in the future. In this sense learners and teachers face the challenge involved in devoting a learning process to both the existing and the new tools for use in their learning activities.
- Taking changes in tools into consideration is inevitable, and this might affect not only the learning experience and outcome but also the technical integration of the tool. Some tools include advertising, and therefore students are exposed to commercial or even to erotic or adult content.
- Special attention should be devoted to security and privacy aspects of the learners using external tools. This involves the fact that content created by students, as well as their behavior could be tracked stealthily and unnoticed by third parties.
- Created assignments and contributions by students need to be archived due to universities' policies, but access and control over the content might not be given for granted because of possible changes of the tools or their accessibility.

Combining cloud based tools to learning experiences

Basic concept

As discussed above, single CBTs can support many aspects of learning experiences and can also offer motivational and engaging learning activities. Taking this idea further, several CBTs can also be combined in learning experiences, introducing added value by the combination of features and functionalities. Based on our previous experience, the use case of collaborative writing in second language training will illustrate the advantages and challenges in this context. Apart of the support of collaborative writing, additional and specialized tools for spell checking, word synonyms, discussion as well as feedback and guidance by the teacher is taken into account. A proof of concept is included in the following CBTs: Liferay portal, Public pad, Cambridge Online Dictionary, Lingro Dictionary and Pixies Translate. (Gütl et al, 2013) Experiences and lessons learned revealed that isolated tools do not sufficiently support the learning process, thus data exchange between tools and a common user interface is necessary to support the learning tasks efficiently. It also showed that the fine-grained features configuration of the tools needs to be supported depending on the learning goals, e.g. enable spell checking in the training phase and disable the feature for advanced activities. It should also be noted that this learning scenario involves some issues, such as that the users should have valid accounts in the external cloud-based tools and some users may not be familiar with the interfaces.

The identified advantages and challenges together with a proposed solution are presented in a generalized view, in the following sections.

Advantages and challenges

The selection of the most important advantages for combining CBTs in learning settings are as follows (MOOCMaker, 2016):

- It is evident that a specific CBT is specialized in a selected task (e.g. mind map tool) and could be recognized as the best of its kind. The possibilities offered by combining two or more great tools for learning activities are a positive feature to enrich the learning process.
- The collaboration among learners is enhanced by the combination of cloud-based tools, enabling real-time communication and a common learning space where a group of participants are aware of the contributions of their peers.
- The combination of tools allows the teacher to avoid the monotony in the learning process and at the same time provides the possibility to present new challenges that keep the students motivated.
- The combination of cloud-based tools saves valuable time to learners while offering common services that should be found in a different tool, but the combination enables the learners to have all the tools in a common learning space.

- The teacher can have the possibility of enabling and disabling the features offered through use of a specific tool according to pedagogical concepts or learning goals in a specific activity.

The combining CBTs that must be solved or mitigated are summarized in terms of the challenges involved in the following (MOOCMaker, 2016):

- There is a need to have a common interface or working space that will be able to have the results and learning objects generated in different learning tools for the purpose of being combined in a learning path designed by the teacher.
- The combination of CBTs implies that the learner will have different accounts and will need to sign-in to several tools to enable the collaboration, hence a proper management of credentials for authentication must be taken into account.
- In technical terms there is a need for interoperability. While we are combining CBTs there is a need to have a common language, or an interpreter that can share the input and results between the tools and translate the results to the learner in a transparent interface that will help to achieve the learning goals.
- The combination of CBTs for learning activities should deal with an appropriate management of ownership and sharing permissions. In such learning scenarios other learners and the teacher will have access to the work of a specific learner. Special attention should be devoted to the management of deadlines and editing rights, because the teacher will not have full control of learner’s environment. In traditional VLE, the teacher sets the deadlines but in new learning scenarios it is possible for the learner to continue working after the homework has been delivered.

Middleware supporting cloud-based service composition

Most of the identified challenges in the use of cloud-based tools in learning settings are focused on the need to orchestrate the heterogeneous scenario in a transparent approach. Also a user and group management, as well as a unified user interface complemented with a fine-grained feature configuration is required for supporting teachers and learning group setting up appropriate learning experiences.

The above mentioned issues have motivated research groups to step in with the provision of technological support. Above all, a working prototype for integration and remixing CBTs in learning activities is available under the title ‘Cloud Learning Activities Orchestration architecture (CLAO)’ (Hernández & Gütl, 2016). The CLAO infrastructure aims to manage the orchestration of learning activities using external tools in a cloud learning environment (CEE). With the purpose of addressing the interoperability of different cloud-based services within CEEs in view, it was established that there is a necessity to create an integration service that could act as a backend service to access the representational state transfer architecture (REST) based APIs of cloud-based services. The CLAO is a middleware responsible for handling all the logic of communication, authentication and integration with services and tools on the cloud as well as to provide an interface by which the various CEEs can use the service. The idea behind the CLAO middleware is to manage the bureaucratic work of orchestration and let the teacher devote full attention to the learners and activities.

As presented in Figure 1, a simplified architecture built for the CLAO architecture consists of the following components (Hernández & Gütl, 2016):

- Virtual learning environment: In practical terms, it represents the main interface for interaction between learners and teachers. The VLE manages the records, assignments, public documents and the access interface to the external cloud-based tools.
- Learning activities orchestration (LAO): This is a component that manages the orchestration of learning activities within the VLE using external CBTs.
- Template Layer: The different learning activities are defined based on functionality, with the purpose of focusing on the tasks rather than on the tools. The objective is to provide a common template infrastructure to the user and reduce the complexity to configure specific tools.
- Business layer: It is composed by the JavaScript-based controls, the business logic engine and JSON-LD processor and Hydra client. This layer provides the technical communication with the external tools with different top-class technologies, for more details refer to Hernández, Gütl and Amado-Salvatierra (2014b).
- Authentication: (OAuth 2.0): This layer manages the authentication phases with the external tools in order to provide transparent and usable interaction for the learners.
- Communication (JSON-LD and Hydra API): The component is appointed with the task to translate the messages between systems. (Hernández, Gütl & Amado-Salvatierra, 2014b)
- Protocol Wrapper (JSON or XML-based). This is a technical component that converts the messages between systems.
- Cloud-based tools: This group of applications and apps is available in Internet to be used and reused by teachers and learning groups to design new and innovative learning activities.

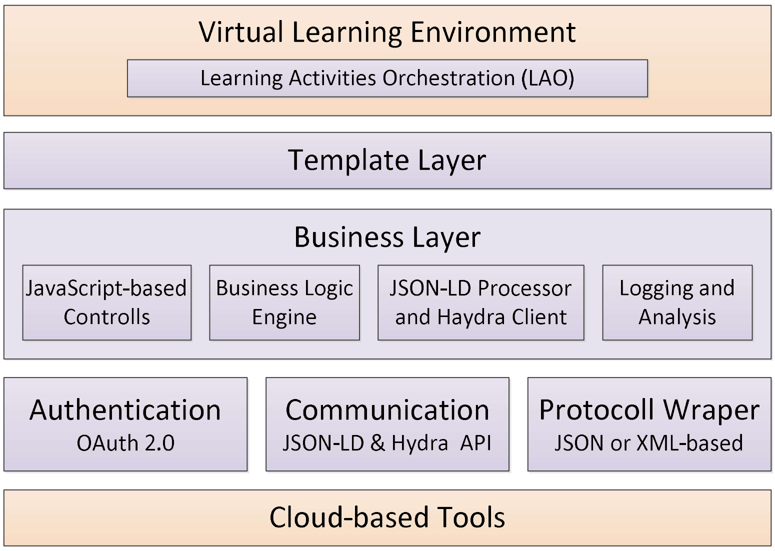

Figure 1. Simplified architecture of the CLAO: cloud learning activity orchestration proposal (based on Hernández & Gütl, 2016).

Cloud-based tools in MOOC learning settings

Adoption of tools in MOOC settings

A wide range of useful cloud-based tools can be used in MOOCs with a high potential and acceptance for both learners and teachers. A literature survey and MOOC maker partners' experiences of using cloud-based tools in MOOC learning settings are researched thoroughly within the MOOC Maker Project (MOOCMAKER 2016). The most relevant findings in the context of the paper are outlined in the remainder of the paper, and further findings can be accessed in MOOCMAKER (2016).

MOOC maker partners have a range of experiences in using different types of cloud-based tools in MOOCs. The research (MOOCMAKER, 2016) indicates the most important tools they used and want to use in future as illustrated in Figure 2 and 3.

The partners stated their needs as being the use of CBTs in future to enrich and complement the learning activities of MOOCs and to have a higher quality of content, and hence increase the interactivity and engagement in the course, and enhance the ability to achieve the learning objectives, and to assess the learners' performance. The most important tools to use in future as seen by the partners are the gamification tools, authoring tools, collaboration tools, software development tools, content creation tools, assessment tools, and learning management tools. Compared to the current use of CBTs, there is more emphasis in applying particular gamification tools to increase motivation in MOOCs. By contrast, content creation tools become less important in future learning settings.

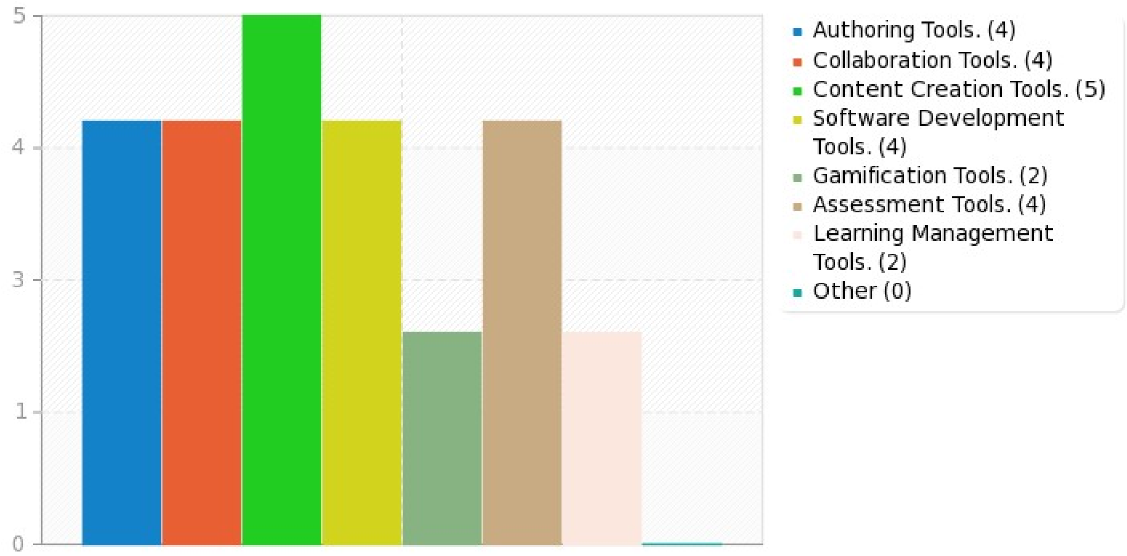

Figure 2. Types of CBTs in MOOC settings used by partners

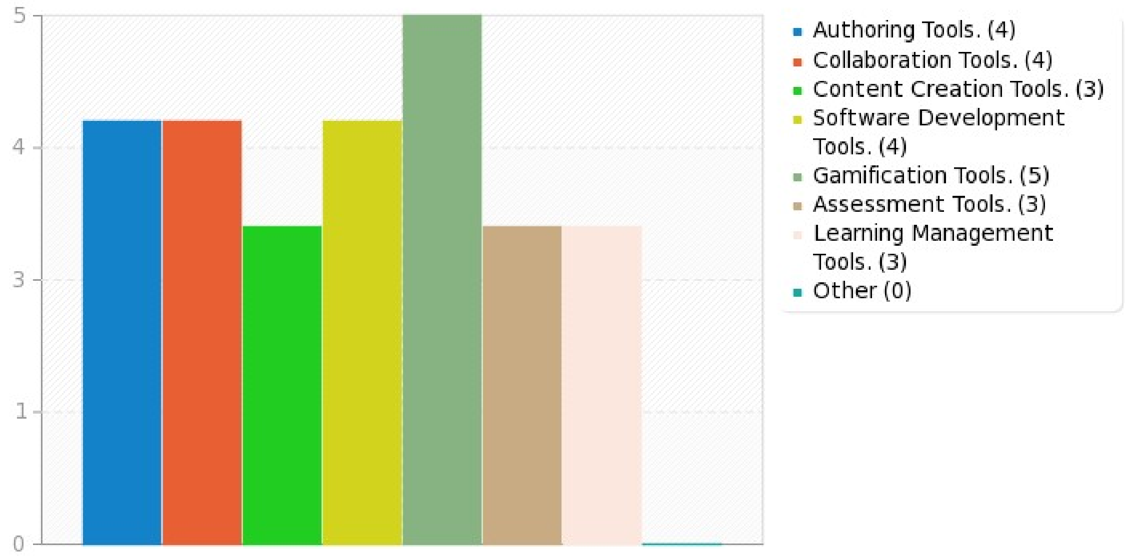

Figure 3. Types of CBTs partners want to use in future in MOOC settings

Analyzing existing literature reveals active research work, initiatives and experiences of using cloud-based tools in MOOCs in the last few years. In the following, we summarize the most important experiences with its findings, and further information can be accessed in MOOCMAKER (2016).

Alario-Hoyos, et al. (2016) presented their experience of the MOOC "Introduction to Programming with Java" that was deployed in edX and had more than 70,000 learners registered in it. Universidad Carlos III de Madrid (UC3M) designed this MOOC carefully to improve learner's interactivity with the learning contents by using wide range of activities supported by both edX built-in tools and other external tools. At the end of the MOOC, learners had the chance to answer a survey to give their opinion about the usefulness and quality of the interactive activities and the different tools supporting them. The results showed positive perception of learners about the usefulness of having a large number of interactive engagements in this MOOC and a very positive feedback about the selected tools, but at the same time the authors mentioned that there is a need to balance between the number of interactive exercises and the workload for teachers to create them.

Borras-Gene, Martinez-Nuñez, & Fidalgo-Blanco (2016) presented a gamification cooperative MOOC model (gcMOOC) that can be applied in a course design in the Engineering field at the Technical University of Madrid. They investigated the factors that affect motivation, collaboration and learning in gcMOOC, and suggested possible recommendations and tools to improve the motivation, learning level and completion rates. The results of this study showed that the use of virtual communities and gamification tools increases learners' motivation and improve their interest in the course. It helps to make the course more dynamic and interactive and improves learners' engagement and involvement in the course, increasing their motivation and consequently the completion rates in MOOCs. Furthermore, the virtual community of the gcMOOC has not only stimulated social interactions using gamification tools but has also helped to achieve the learning objectives. The survey results indicated that most of the students are positive about using gamification and social media in education and especially in MOOCs. As a limitation to this work, the authors found that the great amount of resources generated by the collaborative activities lead to information overload in the virtual community, and problems in filtering, classifying and selecting the accurate information.

Hernández, Gütl, & Chang (2013) described a MOOC experience using cloud-based and online tools for collaboration, interaction, and learning in the MOOC environment, focusing on peer-assessment and online collaboration using discussion forums with a gamification approach. The results showed that using CBTs helps students to meet the instructional objectives, and the tools showed a great scalability. Another cloud-based learning experience was presented by Hernández, Amado-Salvatierra, & Gütl (2013) where selected cloud-based tools were used for different learning activities including collaboration, knowledge representation, storytelling activities and social networking. The results showed that the tools were easily used by students who showed interest in the learning activities highlighting the interaction, flexibility and creativity. In both papers, the authors emphasized that future research should focus on incentives for motivating participation and on providing systems with high usability, accessibility and interoperability aiming to create a cloud education environment that are capable of doing learning orchestration. In (Hernández, Gütl, Chang, & Morales, 2014), the authors presented another cloud-based learning experience in MOOC settings, where proper cloud-based tools were selected based on the learning and instructional objectives. The authors found that participants' attitudes of motivational and emotional aspects were highly ranked. Participants showed high motivation and perceived low anger and sadness with significantly higher happiness while doing learning activities using the CBTs. They also indicated positive learning outcomes using the CBTs but at the same time, the MOOC course reported a high dropout rate.

Best practices

An online survey with MOOC maker partners has been conducted within the MOOC Maker Project (MOOCMAKER 2016). The aim was to collect information about partners' experiences of applying cloud-based tools in e-learning settings in general, and in MOOCs in particular. Special interest was focused on the added values and advantages of using cloud-based tools as well as the drawbacks and issues faced by its use, and thus, providing recommendations for improvements and appropriate application and adoption in the future.

The survey was sent to the nine MOOC Maker Project partners, six of them successfully completed the survey and five out of the six have experiences in creating MOOCs and using cloud-based tools. The most important findings of the survey are summarized in Table 2, and further findings and details can be accessed in MOOCMAKER (2016).

Table 2: The most important findings of the MOOC Maker partners' survey.

<table>
<tr><th>Advantages</th><th>Issues</th></tr>
<tr><td rowspan="3">▪ Increased fun and interest in the topic and hence, improved motivation to learn and complete the course.
▪ Improved knowledge sharing and acquisition.
▪ Improved learning skills (problem solving skills, deeper thinking skills, etc.).
▪ Increased social interaction, collaboration and interactivity in the course.
▪ Better performance and achievements of learners.
▪ Wider variety of activities and tools that can be used.
▪ Improved assessment and evaluation of learners' performance.
▪ Enhanced learning process.
▪ Better ways of delivering information and knowledge to learners.
▪ Higher scalability and wider accessibility.
▪ Automatic updates of the tools.
▪ Engaging activities for less cost or for free.</td><td>▪ Selecting proper tools out of the myriad of existing ones.
▪ Time needed by learners and teachers to get familiar with the tools.
▪ Security and privacy issues.
▪ CBTs integration and interoperability issues.
▪ Limited control over tools (features, availability).
▪ Some tools are not free (cost of licenses).</td></tr>
<tr><td>Recommendations</td></tr>
<tr><td>▪ Finding proper tools and guide learners to use them (e.g. with a brief video or document).
▪ Helping teachers to find the appropriate tools for each course.
▪ Providing tutorials to help using the tools.
▪ Improving the connection between the tools and the evaluation system in the MOOC platform.</td></tr>
</table>

Furthermore, in order to survey and analyze the state-of-the-art in research and experiences of using cloud-based tools in MOOCs, a comprehensive literature survey has been conducted based on more than 50 papers. The collected information is mainly about to what extent and how effectively CBTs have been used in MOOCs during the past few years, the benefits and drawbacks of its use together with recommendations for possible improvements in future.

The most important findings of the literature survey can be synthesized by the following papers (Alario-Hoyos, et al., 2016; Borras-Gene, Martinez-Nuñez, & Fidalgo-

Blanco, 2016; Miguel, Hernandez, & Barchino Plata, 2015; Hernández, Gütl, Chang, & Morales, 2014; Freire, Blanco, & Fernández-Manjón, 2014; Hernández, Guetl, & Amado-Salvatierra, 2014a; Hernández, Gütl, & Chang, 2013; Hernández, Amado-Salvatierra, & Gütl, 2013; Hérnandez, Amado-Salvatierra, Guetl & Smadi, 2012; Mak, Williams, & Mackness, 2010), and is summarized in Table 3, while further information can be accessed in MOOCMAKER (2016).

Table 3: The most important findings of the literature survey.

Advantages	Issues
▪ Positive learning outcomes. ▪ More engagement and involvement in the course. ▪ Increased motivation to learn. ▪ Increased fun and interest in the learning activities. ▪ Enhanced social interactions. ▪ Highly interactive, dynamic, and stimulating course. ▪ Increased learner collaboration. ▪ Improved communication skills. ▪ Enhanced knowledge creation, sharing and acquisition. ▪ Ease of use. ▪ Increased flexibility to select from a wide variety of CBTs that suit the learning objectives. ▪ Improved assessment and tracking of the learner's performance. ▪ High scalability and accessibility. ▪ Many tools are free to use. ▪ The gamification tools may help to increase the completion rates of the MOOCs.	▪ Teachers and tutors need help to select the appropriate CBTs for the course. ▪ Learners, teachers and tutors need time to know the tools and how to use it. ▪ Dropout rate in MOOCs is still high in spite of using CBTs. ▪ Training, tutorial videos, or written instructions are needed to teach learners how to use the CBTs. ▪ CBTs integration, interoperability and orchestration issues. ▪ Security and privacy issues. ▪ Some tools include advertisements. ▪ Not all tools are free. ▪ Some tools cannot be used on all operating systems. ▪ Limited control over some tools. ▪ The workload of creating cloud-based learning activities may increase. ▪ The time needed for teaching and following the course may increase. ▪ Allowing learners to choose from a variety of CBTs may impede their learning.
Recommendations	
▪ Restricting the learning setting to a number of pre-selected CBTs other than letting learners choose from a variety of CBTs which may impede their learning. ▪ Providing training, tutorial videos or written instructions to teach learners how to use the tools. ▪ Using gamification tools to reduce the dropout rate in MOOCs. ▪ Balancing between the number of interactive learning activities and the workload for tutors and teachers to create it. ▪ Building CLAO (Cloud Learning Activity Orchestration) system to overcome CBTs integration and interoperability issue. ▪ Designing and developing activities carefully to achieve a good level of quality. ▪ Helping tutors and teachers to choose the right cloud-based tools for the course.	

Summary and future perspectives

Open source and content have paved the way to open education, and consequently MOOCS have been emerged and become a major trend in several application domains. The development of Web technologies has resulted in cloud technologies and social media, which also have become an important aspect in learning settings, in particular to please the new generation of learners. Research approaches and practical experiences in the context of the integration of cloud-based tools and social media in MOOC learning experiences have revealed advantages, such as the more engagement and involvement by more interactive and dynamic course, high scalability and accessibility, and a greater variety of learning activities. On the down side, the integration of several tools requires the management of multiple accounts and an advances rights management, increased effort in familiarization of multiple tools by the learning communities, as well as greater challenges of privacy and security aspects. First frameworks and middle ware approaches have emerged to support the learning community in combining cloud-based tools and the integration in MOOC environments.

On the technological dimension, there is still a great deal of room for research and development to provide the learning community with a middleware to seamlessly integrate various cloud-based tools, provide a unified interface and enable control of the tools on a micro-level in terms of features and access. Narrowing the field down to the didactics and pedagogical dimensions, open research questions remain concerning insights and models for mapping learning goals and activities in specific subject domains with the most appropriate learning tools, and how to automatically suggest proper tools and their combination for specific learning activities. Concluding with a short term future perspective, physical presence learning will increasingly and seamlessly merge with online learning, and cloud-based tools will take on an important - if not even the dominant - roll in modern learning settings for the next generation of learners.

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