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The Application of Cloud-Based Tools in MOOCs: Experiences and Findings

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ABSTRACT

This study provides information related to the use of cloud-based tools in online learning and MOOC settings. The main purpose is to get thorough information about how much and how effectively cloud-based tools are used in MOOCs during the last few years, what are the added values and advantages of using it besides the drawbacks and issues faced by its use, providing recommendations for better improvements in future. For that, cloud-based tools in online learning and MOOCs will be categorized and discussed in details with its benefits, learning objectives, and related examples. Cloud-based tools interoperability issue, which is one of the main issues faced by using CBTs in online learning and MOOCs, will be presented and discussed as well with the available solutions for it. Also to give some insight into the existing research work, initiatives and experiences of using cloud-based tools in MOOCs, a literature review has been conducted and will be presented with its findings. Furthermore, a survey with MOOCs creators and experts has been done to collect information about their opinion, needs and experiences of applying cloud-based tools in e-learning settings in general, and in MOOCs in particular, including its usefulness and drawbacks besides possible recommendations for a good use of it. The survey will be discussed and analysed in depth, and findings with recommendations will be presented. Finally, the report concludes with selected findings and recommendations for the use of cloud-based tools in MOOCs, derived from the literature and the conducted survey and classified on learners, teachers and tutors, and technical and organizational aspects.

Keywords

Massive Open Online Course, Online Collaboration, Online Learning, CBT, Cloud-Based Tool, Learning Activity, Gamification, Interoperability, Cloud-Based Tools Interoperability, CLAO, ROLE.

TABLE OF CONTENTS

I. INTRODUCTION

Motivation

Massive Open Online Courses (MOOCs) have become increasingly popular and interesting to students, educators, educational institutions, and researchers over the last years. MOOCs help to make learning available to huge number of learners any time and regardless of their location and their social and cultural background. It allows them to communicate, collaborate and learn autonomously according to their learning goals, prior knowledge, and common interests (Hernández, Gütl, & Chang, 2013). Hundreds of MOOCs are available now online, provided by well-known institutions and online education companies such as edX and Coursera, having hundreds of thousands of registrations.

Learning activities are an important part of MOOCs. It motivates learners to be actively engaged in the learning process and helps them to achieve the desired learning objectives. Since the cloud-based tools (CBTs) are constantly evolving and becoming more and more popular especially in the education domain, a wide range of useful CBTs can be used in MOOCs with a large potential and acceptance for both learners and teachers. CBTs have the potential to improve students' engagement and learning outcomes by providing them of a wide range of activities including interact, brainstorm solutions, elaborate reports, and create conceptual designs. It promotes the openness, sharing and reusability of learning resources on the web (Hernández, 2015). CBTs can interoperate also with other systems, offering the possibility to orchestrate services and create an ecosystem for a comprehensive and integrated learning experience (Chang, & Guetl, 2007).

This situation has motivated research and development of MOOCs making use of cloud-based learning tools for learners to collaborate, interact, and learn in a MOOC environment, and which will be also the focus of this work. An intensive literature survey has been conducted about the different types of cloud-based tools that can be used in MOOCs with its learning objectives and benefits, besides the existing research work and experiences of its use with its effectiveness and drawbacks. Furthermore, positive and negative findings and recommendations derived from literature and the survey conducted with MOOCs creators and experts are discussed in details from learners, tutors and teachers, and technical and organizational perspective.

Structure of the Report

The main chapters of this report can be described briefly as follows:

Chapter "II. BACKGROUND" provides a brief background information about the main concepts discussed in the report. A short description of the Massive Open Online Course history, platform and benefits is presented, followed by a short overview of using cloud computing in education with its advantages and challenges. Finally, the chapter ends with presenting the gamification concept, benefits and the main gamification strategies focusing on its use in online learning.

Chapter "III. CLOUD-BASED ONLINE LEARNING" describes shortly the cloud-based tools in online learning and MOOCs with its important role in improving students' learning and engagement, followed by a classification of the cloud-based tools according to its use and purposes with relevant examples. The importance of effective learning activities, in online learning and MOOCs, and its characteristics is discussed briefly then with its corresponding learning objectives and supported cloud-based tools and relevant examples. The end of this chapter focuses on the importance of cloud-based tools interoperability in online learning and MOOCs, discussing shortly few of the available standards and systems for learning tools interoperability, and finalizing the chapter with a brief presentation of the available middlewares for CBTs interoperability.

Chapter "IV. Cloud-Based Tools in MOOC Settings" presents an overview about existing research work, initiatives and experiences of using CBTs in MOOC learning settings, including some selected examples with the authors' findings about its effectiveness.

Chapter "V. BEST PRACTICES" summarizes the experiences and findings from literature regarding the effectiveness of using cloud-based tools in MOOCs, including the problems and issues faced with its use and related improvements and recommendations. The chapter describes also the survey that has been conducted with MOOC Maker partners of the consortium with an analysis for the results and reporting of the findings.

Chapter "VI. RECOMMENDATIONS AND FINDINGS" summarizes all findings and recommendations related to the use of cloud-based tools in MOOCs, derived from literature and MOOC Maker partners' survey and classified into three different aspects: learners, tutors and teachers, and technical and organizational aspects.

Chapter "VII. SUMMARY" briefly summarizes and concludes the report.

II. BACKGROUND

Massive Open Online Courses (MOOCs)

A Massive Open Online Course (MOOC) is an online, free of charge course aimed at large-scale interactive participation and open access via the web. MOOCs provide people from all over the world the opportunity to expand their education for free without any commitment or prior requirements (Barak, Watted, & Haick, 2016; Venkatesh, 2014). Given a computer and an Internet connection, learners around the world have open access to high-quality courses from the best schools and organizations. Rather than simply making resources or courseware freely available, MOOCs create the opportunity for learners to take part in learning activities, interact with other learners and connect with course instructors, albeit in a limited sense (Fauvel & Yu, 2015; Dara, Nicholas, & Bailey, 2014).

The Massive Open Online Course (MOOC) phenomenon started in 2008. The first MOOC was conducted by George Siemens, Stephen Downes and David Cormier. It was called Connectivism and Connective Knowledge 2008 (CCK08) MOOC. David Cormier was responsible for coining the term MOOC (Jain et al., 2014). MOOCs exploded into the academic consciousness in 2011, when a free artificial intelligence course offered by Stanford University in California attracted some 160,000 students from around the world, some 23,000 of whom finished it (Brito, 2013).

MOOCs provide real learning experiences to learners, from videos, readings, quizzes and activities; to opportunities to connect and collaborate with others through discussion, gamified forums and other Web 2.0 tools (Hernández, Morales, & Guetl, 2016). MOOCs can make learning accessible regardless of social and cultural background allowing participants to connect with a diverse learning group of learners enabling them to converse, collaborate and learn autonomously (Hernández, 2015).

MOOCs support self-regulated learning with a multitude of learning tools allowing participants to access, collaborate and contribute to the learning according to their learning goals, prior knowledge and skills, and common interests (Hernández, Gütl, & Chang, 2013). This type of learning compels student to learn in a self-regulated way and may choose tools of their choice. For institutions MOOCs might be a vehicle to reach a wider community and act as a strategic weapon for monetary advantages.

In general, MOOCs platforms include the following three components: course contents, community building tools, and platform tools. Course contents can be divided into informational assets and interactive assets. Informational assets include videos (by far the main content delivery strategy in MOOCs) and supporting learning materials (such as reading materials from textbooks or website, lecture slides, lecture notes, topic outline, etc.). Interactive assets include exercises, quizzes and exams for learners to complete as part of their assessment. Community building tools include asynchronous tools such as forums, as well as synchronous tools such as chat rooms and real-time group discussions. They may also include group work tools, and peer support tools. Platform tools include searching and recommendation features, as well as learner authentication. Most platforms also provide an interface for instructors to organise their course contents, and some basic statistics and data visualisation tools to support them in teaching. (Fauvel & Yu, 2015). This common structure for MOOC platform is summarised in Figure 1:

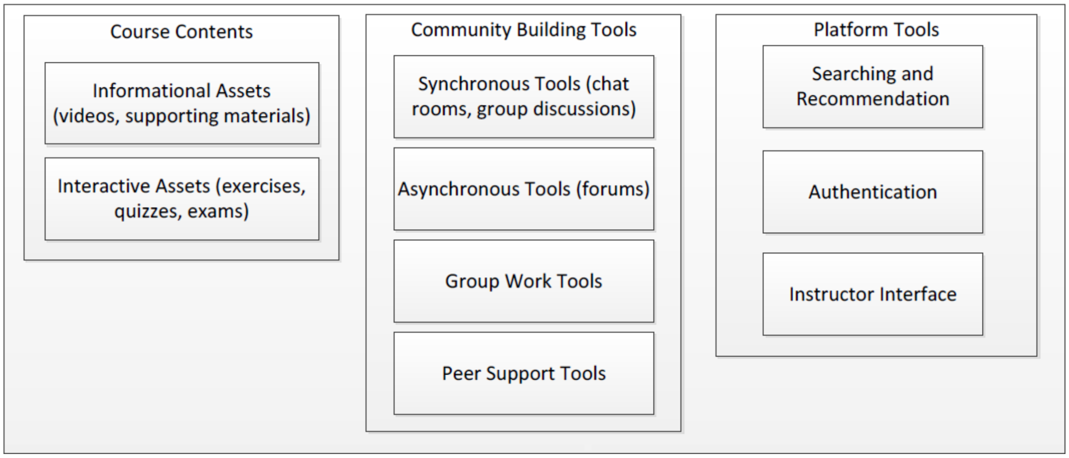

Figure1. The Current MOOC Ecosystem (replicated from Fauvel & Yu, 2015)

Over the last years, MOOCs have become increasingly interesting for students, educators, educational institutions, and researchers. Many well-known institutions have made considerable efforts to develop, promote and offer open online courses to the world. MIT, Harvard and Berkeley have all joined forces and founded edX. Other companies such as Udacity and Coursera have also emerged, and these online education companies offer hundreds of courses and having hundreds of thousands of registrations (Hernández, Guetl, & Amado-Salvatierra, 2014).

Cloud Computing and Education

Cloud computing, as defined by the National Institute of Standards and Technology (NIST), is (Mell & Grance, 2011):

> *"a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction"*.

The paradigm of cloud computing provides a set of virtual resources (hardware, development platforms or services) available on the network. These computational capabilities can be quickly delivered and removed to scale quickly according to demand.

Cloud computing services are typically categorized into three main types (González-Martínez, Bote-Lorenzo, Gómez-Sánchez, & Cano-Parra, 2014): Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). IaaS consists mainly of computational infrastructure available over the internet, such as processing, storage, networking, and other computing resources on-demand. PaaS is based on application development platforms that allow the use of external resources to create and host applications. Finally, SaaS is nowadays the best-known model, consisting of applications offered by the provider over the network, instead of being run on the user's computer.

In education, cloud computing caters for desirable properties to provide e-learning services, especially in scenarios where these services are computer-intensive (virtual worlds, simulations, video streaming, etc.), or are offered in a high-scale way, as in Massive Open Online Courses (MOOCs). The cloud can provide students and teachers with tools to deploy computing resources on-demand for lectures and labs according to their learning needs. It provides them with a great number and variety of online applications that can be employed to support a wide range of learning scenarios. These applications are usually web-based, accessible anywhere, anytime over the Internet, thus extending the exposure time to learning of students (González-Martínez et al., 2014).

Different cloud services and applications can often be mixed using their available Application Programming Interfaces (APIs) into completely customized learning environments suited to the needs and preferences of students, facilitating the creation of Personal Learning Environments (PLE).

Also the cloud can help to overcome the current limitations in mobile learning (m-learning) regarding the limited processing and storage capabilities of the devices, mainly through the affordances of availability of enough computing resources and scalability of the cloud. This way, learning applications can run on students' mobile devices while the heaviest computing tasks take place in the cloud. Students can also use their mobile phones to access, accumulate, share, and synchronize learning contents in the virtually unlimited storage resources that cloud computing provides. As a result, students can use m-learning services and applications that are rich and useful (multimedia, real-time, context-aware, etc.) with the adequate Quality of Service (QoS) and they can access them anywhere any time they need them, provided they have network connectivity (González-Martínez et al., 2014; Washington, & Sequera, 2015).

Cloud Computing has laid the ground for a new generation of educational environments, by providing scalable anytime and anywhere services simply accessed through the Web from multiple devices without worrying about how or where those services are installed, maintained or located (Tabaa, Ahansal, Elahrache, Lajjam, & Medouri, 2013).

Cloud computing delivers major benefits to both public and private organizations, including educational institutions and students such as (PDST Technology in Education, 2015; Yadav, 2014; Lewis, 2012; Cisco, 2011):

- **Personalized Learning**: Cloud computing offers opportunities for more flexibility in learning. Using an Internet-connected device, students can access a wide array of resources and software tools that suit their learning styles and interests.
- **Flexibility**: Cloud computing offers the flexibility to meet rapidly changing software requirements for today's and tomorrow's teachers and students. It offers

also increased flexibility for teachers, who can select from a wide range of cloud based applications that complement their curriculum and can be approached at any time.

- **Reduced Costs**: Cloud-based services can help institutes reduce costs and accelerate the use of new technologies to meet evolving educational needs.
- **Accessibility**: Users have access to data and applications from around the globe, using different devices (tablets, laptops, desktops, etc.) both inside and outside the local infrastructure.
- **Scalability**: Organizations have access to many resources that scale based on user demand.
- **Collaboration**: Organizations see the cloud as a way for members to work simultaneously on common data and information.
- **User Friendly**: easy to implement, easy to understand and easy to operate.
- **Elasticity of service**: In a single moment many students and teachers can store data. Organizations can request, use, and release as many resources as needed based on changing needs.
- **Increased efficiency**: The cloud model provides the ability to rapidly acquire, provision, and deploy new IT platforms, services, applications, and test environments. With cloud capabilities, months-long IT hardware procurement processes can be eliminated, reducing time spent on such tasks to a matter of hours or even minutes. The cloud model also helps ensure that university networks are available and secure, regardless of the circumstances. The result is a more agile and efficient organization that can swiftly respond to changing conditions and requirements.
- **Quality of service**: Service quality is the most important feature and in maximum cases where exact necessities have to be fulfilled by the outsourced resources and outsourced services.
- **Management of data**: A large amount of data is generated by each institution and thus to maintain them effectively and to use it appropriately when needed is the best feature of the education cloud.
- **Disaster recovery**: When companies/University starts relying on cloud-based services, they no longer need complex disaster recovery plans. Cloud computing providers take care of most issues, and they do it faster.
- **Automatic software updates**: Cloud computing suppliers do the server maintenance including security updates themselves, freeing up their customers' time and resources for other tasks.
- **Instructional and educational innovation**: In education, the primary purpose of technology should be to enable and inspire innovation in the classroom and lab.

> That means giving educators, administrators, and students both the applications and the freedom they need to do their work. With the agility of the cloud model, IT organizations can try out new applications with minimal commitment, pay for as much as they use and adjust as necessary.

But at the same time, there are challenges and risks that will constrain educational institutions' adoption of cloud computing such as (Lewis, 2012; Cisco, 2011; Yadav, 2014):

- **Security**: Security and data privacy implications are the foremost concern for many educational institutions; users do not have control or know where their data is being stored and the service provider can access the data that is on the cloud at any time. Solutions to privacy include policy and legislation as well as end users' choices for how data is stored. Users can encrypt data that is processed or stored within the cloud to prevent unauthorized access.
- **Interoperability**: a universal set of standards and/or interfaces have not yet been defined, resulting in a significant risk of vendor lock-in (being dependent on a vendor for products and services and unable to use another vendor without substantial switching costs).
- **Control**: the amount of control that the user has over the cloud environment varies greatly.
- **Latency**: All access to the cloud occurs through a network (or the internet in the case of public clouds), introducing latency into every communication between the user and the environment.

Gamification and Online Learning

Games are created to draw people in, to keep them playing, to keep them interested, entertained and involved. Game-players are often ready to invest significant efforts to challenge each other (and themselves) in achieving the highest possible scores and game mastery (Freire, Blanco, & Fernández-Manjón, 2014).

Games and game-like behaviour is a natural way to acquire knowledge and improve skills from early childhood on. The use of games for learning purposes has become increasingly popular over the last decades. Gee (2003) identified 36 learning principles that can be found in games. Games tend to increase learners' natural desire for competition, goal achievement, and genuine self-expression, while they also promote interactivity, have rules, a quantifiable outcome, and can be colourful, appealing, and extremely realistic (Pappas, 2014).

Gamification attempts to harness the motivational power of games and apply it to real-world problems. It is the use of game thinking and mechanics such as rewarding points, achievement badges, and leader boards in a non-game context, such as e-learning, to motivate learners to get engaged in the learning process, and to explore and learn as they move toward an end goal. (Legault, 2015; Corso, Humphreys, & Tolson, 2014)

Gamification typically makes use of the competition instinct possessed by many people to motivate and encourage ‘productive’ behaviours. Also gamification elements promote cooperativeness and sharing, and encourage learners to be willingly involved in a wider range of tasks.

Based on research conducted by educational institutions, what makes games mechanics effective for learning is the learners’ level of activity, motivation, interactivity and engagement (Pappas, 2014). Gamification increases learner’s participation in the learning process and increases his retention and knowledge absorption. It helps learners to remember the learning material, apply it to their real lives, and come back to learn more (Hughes, 2014).

Nowadays a large myriad of learning strategies is being implemented to improve MOOC learning experiences, learning outcome and retention. In this sense, gamification strategies have been proposed as a complement to learning approaches to provide a more powerful and motivational learning experience to the students.

Examples of gamification strategies commonly utilized in online learning and MOOCs include (Strmečki, Bernik, & Radošević, 2016; Nanney, 2016):

- **Badges, medals or rewards** provided upon successful completion of a goal. Achievements act as a way of providing positive feedback and rewards to a learner for performing the required tasks. It also acts as a means for a learner to keep track of what he has done and to show his accomplishments off to other learners.
- **Points**: one of the most traditional gamification mechanics. Points allow learners to feel a sense of progression through the learning process as a gradual pace based on their amount of action.
- **Leaderboards and ranking**: leaderboards are one of the most popular ways to encourage competition in the gaming world. Leaderboards rank players and their scores, and people love them because they like to get recognition for their skills and efforts. The same in online learning, leaderboards motivate learners for better achievements and help to foster a sense of community.
- **Progress bar**: progress helps learners understand that their actions, however small, relate to a larger whole or a grander accomplishment. Progress in gamification can be as simple as telling a user when they’ve completed a required action or as complex as moving through multiple stages of an extensive process.
- **Levels**: it helps to drive a desire to progress and improve.
- **Competition, between teams or individuals**. Competitions motivate learners for better accomplishments and engagement.

- **Time constraints**: Games use time constraints to create a sense of urgency, which pressures the gamer to think and act quickly. The same can be applied in online learning and MOOCs using timer on quizzes and activities.
- **Feedback**: immediate and positive feedback makes learner feel good about completing something and motivates him to do it again. Feedback system can be enabled in every trackable activity. Feedback for activities that need to be done, what is completed, what percentage of the whole course is achieved, how many points and what level is learner on, etc.
- **Customization**: learners have the ability to customize their avatar profile as well as their private information and position of system's elements. Some elements are possible to move around and make them visible on demand.
- **Social Recognition**: by integrating social media platforms with gamification apps, learners can share their experiences and show off their rewards. Incentives such as badges can be displayed on learners' profiles and news feeds. This allows the leaner to show off his accomplishments and motivates him for better ones.

These key gaming mechanics often provide learners with opportunities to solve problems and build confidence in learning content through interaction and trust building.

Summing up, gamification can enhance the motivation of participants and can influence the participation, commitment and loyalty of learners that may end in a greater number of proactive participants. It can help to make education more fun, compelling and engaging without undermining its credibility.

III. CLOUD-BASED ONLINE LEARNING

Cloud-Based Tools in Online Learning and MOOCs

Today's students are immersed in technology and perceive it as an essential tool for learning because they use a variety of techniques and strategies to collect and sort data and to communicate and collaborate with their peers (Washington & Sequera, 2015). The collaborative activities and new ways of representing knowledge, expressing ideas and sharing information have become part of today's educational environments on the Web (Hernandez & Gütl, 2015).

According to (Washington & Sequera, 2015), effective learning:

- Encourages reflection.
- Allows dialogue.
- Promotes collaboration.
- Applies the theory learned into practice.
- Creates a community of peers.
- Allows creativity.
- Motivates students.

Technology offers many ways in which these features can be supported and developed through interaction, using multimedia, communication and collaboration tools with colleagues. Therefore, as a result, technologies can be used to promote various pedagogical approaches and improve learning.

The cloud-based tools (CBTs), also known as Web 2.0 tools, are highly interactive tools with collaborative features that use cloud computing to scale to hundreds of thousands of users (Hernández & Gütl, 2016). These tools involve mechanisms for sharing, collaborating, networking, content media production, and others. In addition, it has begun to open their Web APIs, so clients can access the tools and its features programmatically and build and create their own experiences (Hernández, 2015).

The cloud-based tools offer a diversity of rich applications, features, and scenarios that can be used for education. These applications can be used to support, enhance and positively transform the learning experience in order to improve learning outcomes for pupils and students. Many applications are free and provide a diverse and evolving range of possibilities to enhance learning. Schools and universities nowadays are increasingly using a wide range of useful cloud based tools and applications to support teaching, learning and assessment (PDST Technology in Education, 2015).

The CBTs have the potential to engage students by allowing them to a wide range of activities including interact, brainstorm solutions, elaborate reports, and create conceptual designs. It promotes the openness, sharing and reusability of learning resources on the web (Hernández, 2015). From the learner's perspective, cloud-based tools are measured with respect to motivations, usability, usefulness, acceptance, cognitive learning strategies, and user behaviour analytics.

Student-centred learning can be supported in the cloud also because CBTs promotes collaboration among students and instructors through setting a place to meet, interact, and conduct online learning activities using shared resources and processes.

The CBTs can interoperate with other systems, offering the possibility to orchestrate services that previously were seen as standalone CBTs and thus to create an ecosystem for a comprehensive and integrated learning experience (Chang, & Guetl, 2007). This also changes the paradigm of education environments from a monolithic architectural approach to a flexible, distributed and heterogeneous architectural setting for the educational environment, which is the aim of cloud education environments. This also maximizes innovation possibilities, allowing interoperability of the best and most appropriate cloud services based on the learning needs. (Hernández, 2015)

The advent of open courses has demolished organizational restrictions and dramatically increased the number of participating students (Hernández et al., 2013). MOOCs have become increasingly popular. This situation has motivated research and development of MOOCs making use of cloud-based learning tools and online tools for learners to collaborate, interact, and learn in a MOOC environment.

Cloud-Based Tools Types in Online Learning and MOOCs

CBTs are constantly evolving and becoming more and more popular in the educational and professional domains. A wide range of innovative cloud-based tools can be used in online learning and MOOCs, with a large potential and acceptance for both learners and teachers. Based on an intensive literature survey, we suggest, depending on its purpose, the classification for the cloud-based tools elaborated in following subsections.

Authoring Tools

The course design stage is essential to ensure course effectiveness and learners' motivation and participation. Analysing learners' needs and learning content, and finding the appropriate mix of learning activities and technical solutions is crucial to creating an effective and engaging course (FAO, 2011). The authoring tools enable instructional designers, subject matter experts, and teachers to rapidly create engaging and interactive learning content.

Examples of these tools: UDUTU[1], EasyGenerator[2], Lectora Online[3], Elucidat[4],

[1] UDUTU (http://www.udutu.com/); [2] EasyGenerator (https://www.easygenerator.com/);
[3] Lectora (http://trivantis.com/products/lectora-online-authoring/); [4] Elucidat (https://www.elucidat.com/);

haikulearning[5], WizIQ[6] and QuickLessons[7] authoring tool.

Collaboration Tools

Online collaboration allows the collection of data for the comparison, discussion, analysis and feedback of knowledge among students (Washington & Sequera, 2015). Cloud-based collaboration tools enable online communication and collaboration among learners and teachers. It allows learners to engage problems as teams, to interact and brainstorm solutions easily, develop thinking and communication skills, and to craft reports and presentations (Hernández & Gütl, 2016). It varies from instant messaging to file and document management, from video conferencing to remote access, from collaborative mind-mapping to knowledge sharing (Rivera, 2014).

Examples of these tools: MindMeister[8], Bubbl.us[9], Cacoo[10], Wikispaces[11], Dropbox[12], OSQA[13], BOOMWRITER[14], MeetingWords[15], Mindomo[16], Stormboard[17], Vialogue[18], Remind[19], WizIQ[6], Flashcard Machine[20], Sync.in[21], Classpager[22], Eyejot[23], Wiggio[24], Edublogs[25], Voicethread[26], Voki[27], ProBoards[28], Google Hangouts[29], and Skype[30].

Among the collaboration tools there are also the social bookmarking tools, that serve as an organizational tool to collect, annotate, search and classify a variety of web resources (hyperlinks, documents, podcasts, video files, graphics, etc.) using tags/keywords with the ability to share the bookmarks with others and to see what others have bookmarked (MOBIVET2.0 Project, 2013). These tools enhance and improve the learning experience by encouraging group collaboration and making organizing, classifying and saving web resources faster and easier for students.

Examples of the social bookmarking tools: Diigo[31], Symbalooedu[32], Evernote[33], Delicious[34].

Collaboration tools may include also content sharing tools that enable learners and teachers to manage and share learning content, documents, ideas, notes, information, and resources with each other. It enhances collaboration with team members, for more flexibility and better protection of work.

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[5] haikulearning (https://www.haikulearning.com/); [6] WizIQ (https://www.wiziq.com/);
[7] QuickLessons (http://www.quicklessons.com/); [8] MindMeister (https://www.mindmeister.com/);
[9] Bubbl.us (https://bubbl.us/); [10] Cacoo (https://cacoo.com/); [11] Wikispaces (http://www.wikispaces.com/);
[12] Dropbox(https://www.dropbox.com/); [13] OSQA (www.osqa.net); [14] BOOMWRITER (http://www.boomwriter.com/);
[15] Meeting Words (http://meetingwords.com/); [16] Mindomo (https://www.mindomo.com/);
[17] Stormboard (https://www.stormboard.com/); [18] Vialogue (https://vialogues.com/);
[19] Remind (https://www.remind.com/); [20] Flashcard Machine (http://www.flashcardmachine.com/);
[21] Sync.in (http://sync.in/); [22] Classpager (https://www.classpager.com/); [23] Eyejot (http://corp.eyejot.com);
[24] Wiggio (https://wiggio.com/); [25] Edublogs (https://edublogs.org/); [26] Voicethread (https://voicethread.com/);
[27] Voki (http://www.voki.com/); [28] ProBoards (https://www.proboards.com/);
[29] Google Hangouts (https://hangouts.google.com/); [30] Skype (https://www.skype.com);
[31] Diigo (https://www.diigo.com/); [32] Symbalooedu (http://www.symbalooedu.com/);
[33] Evernote (https://evernote.com/); [34] Delicious (http://del.icio.us/);

Examples of cloud-based content sharing tools: DropBox[12], SlideShare[35], Google Drive[36], 4Shared[37], Quizlet[38], Notes.io[39], Flashcard Machine[20], MySchoolNotebook[40], WizIQ[6], CourseHero[41], and Evernote[33].

Content Creation Tools

Content creation tools enable learners and teachers to create something new such as presentations, videos, diagrams, charts, mind maps and documents, that can be seen and/or used by others. This class of tools might also overlap with authoring and collaborative tools stated above.

Examples of these tools: Office[42], Google Docs[43], Google Drive[36], gliffy[44], Creately[45], Visual.ly[46], Emaze[47], Cacoo[10], WizIQ[6], StudyBlue[48], Evernote[33] and GoAnimate[49].

Software Development Tools

Software development tools enable learners to deploy onto the cloud infrastructure applications created using programming and runtime environments supported by the provider.

Examples of these tools: Codeanywhere[50], iOS Software Development Kit (SDK)[51], Python Fiddle[52], Cloud9[53], Eclipse Cloud Development[54], and Macincloud[55].

Gamification Tools

Gamification is becoming more popular in different domains including education. Game mechanics and strategies are being employed in online learning and MOOCs in order to enhance learners' engagement, create extended periods of interaction and to reward engagement and achievements; and hence ensuring loyalty. Some of game mechanics that can be utilized in online learning and MOOCs are: points, badges, leaderboards, levels, competition, and feedback (See section II – Gamification and Online Learning). Gamification tools can enhance knowledge acquisition of learners. It helps teachers to bring a little interactive fun and excitement into their classrooms and motivates learners for better engagement and achievements.

Examples of these tools: GamEffective[56], Gametize[57], Kahoot[58], Quizlet[38], funbrain[59], MangaHigh[60], Academy LMS[61], and Blockly[62].

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35 SlideShare (http://www.slideshare.net/); 36 Google Drive (https://drive.google.com/);
37 4Shared (https://www.4shared.com); 38 Quizlet (https://quizlet.com/); 39 Notes.io (http://notes.io/);
40 MySchoolNotebook (http://www.myschoolnotebook.com/); 41 CourseHero (https://www.coursehero.com/);
42 Office (https://portal.office.com/); 43 Google Docs (https://docs.google.com/); 44 gliffy (https://www.gliffy.com/);
45 Creately (http://creately.com/); 46 Visual.ly (http://visual.ly/); 47 Emaze (https://www.emaze.com/);
48 StudyBlue (https://www.studyblue.com/); 49 GoAnimate (https://goanimate.com/);
50 Codeanywhere (https://codeanywhere.com/); 51 SDK (https://developer.apple.com/xcode/);
52 Python Fiddle (http://pythonfiddle.com/); 53 Cloud9 (https://c9.io/); 54 Eclipse (http://www.eclipse.org/ecd/);
55 Macincloud (www.macincloud.com); 56 GamEffective (http://gameffective.com/solutions/for-training/);
57 Gametize (https://gametize.com/); 58 Kahoot (https://getkahoot.com/); 59 funbrain (http://www.funbrain.com/);
60 MangaHigh (https://www.mangahigh.com); 61 Academy LMS (http://www.growthengineering.co.uk/academy-lms/);
62 Blockly (https://developers.google.com/blockly/);

Assessment Tools

Assessment and feedback are essential to student learning. It helps to develop students' ability to evaluate themselves, to make judgements about their own performance and to improve upon it. It is an integral part of instruction, as it determines whether or not the goals of education are being met.

There are different types and strategies for student assessment that need to be supported by the cloud-based tools such as, self-assessment, peer assessment, and assessments managed by teachers and tutors. There are also, on other dimensions, the computer-based assessment, semi-automatic and automatic assessment besides the summative and formative assessment, and the analytic assessment on the curricula base. Variety of tools can be used to assess student's performance, knowledge and achievement of learning objectives.

Assessment tools typically enable teachers and learners to create online quizzes using a range of question types (such as allowing users to create multiple choice, fill in the blank, matching, short answer, essay and true/false questions) with automatic grading and feedback as well as performance tracking.

Among the assessment tools, there are also the cloud plagiarism detection tools that help teachers to detect plagiarism in contents, assignments and projects and help learners to improve their paraphrasing.

Assessment tools include also the online assessment management tools that automate and optimize the whole assessment process to meet the academic goals of educational institutions and to improve students' learning, outcomes and performance. It enables institutions to manage data related to coursework, quizzes, tests, examinations, and generate reports to evaluate student performance.

Examples of cloud-based assessment tools: Educaplay[63], Easy Test Maker[64], ClassMarker[65], WizIQ[6], Quizlet[38], Flashcard Machine[20], Google Forms[66], SurveyPlanet[67], iRubric[68], StudyStack[69], ProProfs[70], PlagScan[71], PaperRater[72], PlagTracker[73], and Creatrix Campus[74].

Learning Management Tools

Learning management tools are an effective and responsive way for educational institutions to create, deliver, and manage their content, as well as to monitor participation and assess performance among learners. Learning management tools support assignments (labs, exercises, reading), rubrics (learning goals and expectations),

[60] MangaHigh (https://www.mangahigh.com); [61] Academy LMS (http://www.growthengineering.co.uk/academy-lms/);
[62] Blockly (https://developers.google.com/blockly/);
[63] Educaplay (https://www.educaplay.com); [64] Easy Test Maker (https://www.easytestmaker.com/);
[65] ClassMarker (https://www.classmarker.com/); [66] Google Forms (https://docs.google.com/forms/);
[67] SurveyPlanet (https://surveyplanet.com/); [68] iRubric (http://www.rcampus.com/);
[69] StudyStack (http://www.studystack.com/); [70] ProProfs (http://www.proprofs.com);
[71] PlagScan (http://www.plagscan.com/); [72] PaperRater (http://paperrater.com);
[73] PlagTracker(http://www.plagtracker.com/); [74] Creatrix Campus (http://www.creatrixcampus.com);

submissions (individual and group), feedback, news, calendars, and resources. Cloud-based learning management tools offer flexible, cost efficient and effective eLearning to students and employees with minimal start-up costs, automatic upgrades, quick deployment capabilities, and enhanced security (Kaplanis, 2014). MOOC environments are included in the learning management tools.

Examples of these tools: Milaulas[75], UDUTU[1], TalentLMS[76], Docebo[77], Edmodo[78], haikulearning[5], Litmos[79] LMS, edX[80], and Coursera[81].

Online Learning Activities

A learning activity is composed of set of tasks in order to achieve the desired learning outcomes through their completion. Learning is considered interactive when learners are actively engaged in a variety of learning activities, and along with their peers and teacher, they are co-constructors of knowledge. The learning environment provides a sense of a learning community in which participants collaborate with each other to negotiate and share knowledge and experiences. An important goal of education is helping students learn how to think more productively by combining creative thinking (to generate ideas) and critical thinking (to evaluate ideas). Learning activities vary widely, from the delivery of knowledge (learning content relevant for a lecture) to the development of student learning skills (problem solving) (Wasserman, Davis, Astrab et al., 2009).

Learning activities that require student's interaction and encourage sharing ideas, promote a deeper level of thought. Using CBTs within learning activities can promote higher-order thinking skills, such as analysing, evaluating, and creating. Another benefit of using CBTs is that many of them are managed over cloud computing, which is highly scalable in terms of computing to support thousands of active requests. All of this, in conjunction with the nature of a distributed environment for performing the learning experience, brings a highly scalable environment.

A student's learning process is enhanced through careful activity preparation on the side of the instructor or course designer. The goal is to create learning activities that will engage and challenge learners while expand their personal connections to their existing knowledge and will lead to the achievement of the course outcomes (CONRAD & Donaldson, 2004).

Characteristics of effective learning activities can be summarized in (Wasserman, Davis, Astrab et al., 2009):

- **Focusing on student learning**: The purpose of any learning activity is student learning so all components of the activity should focus on this goal.

[75] Milaulas (http://www.milaulas.com); [76] TalentLMS (http://www.talentlms.com);
[77] Docebo (https://www.docebo.com/); [78] Edmodo (https://www.edmodo.com/); [79] Litmos (http://www.litmos.com/);
[80] edX (https://open.edx.org/); [81] Coursera (https://www.coursera.org/)

- **Having a compelling purpose**: Activities cannot be successful if the students do not recognize their value and importance.
- **Having clear objectives**: Each activity has the potential to provide a combination of information, solution methodologies, and the opportunity to develop specific learning skills. These objectives need to be specifically identified.
- **Supporting the desired type of learning**: The learning activity must be appropriate for the type of learning called for in the learning objectives. Not all concepts, tools, processes, contexts, or rules are well served by the same types of learning activities.
- **Balancing content and skill development**: Learning objectives should specify the proper balance between content and skill development. When a learner is exposed to something for the first time, content will typically receive most of the attention. Later, the learner will want to focus on developing skills by applying this new content.
- **Supporting the needs of diverse learning styles**: Learners have a variety of preferences for how they learn new material. When constructing an activity, it is important to consider which types of activities will address the preferences of multiple learning styles. It is also critical to use a variety of learning activities in a single course to be inclusive of all learning styles.
- **Including assessment of student learning**: Student learning is the goal of an activity, then assessment of student learning should be integrated into the activity itself. Learning must therefore be assessed based on predetermined performance criteria.
- **Including evaluation of the activity**: Upon completion of an activity, learners should be able to evaluate the learning activity itself. The results of this evaluation should be used to strengthen the future development and application of the activity.
- **Aligning with course objectives**: Learning activities are designed to develop learning that supports course outcomes. The majority of learning outcomes should fall into the application, analysis, synthesis, or evaluation levels of thinking as described in Bloom’s taxonomy.

The learning objectives of the MOOC can be summarized as to acquire knowledge of e-learning theory and technology as well as to apply the knowledge to design and create online courses (Hernández, Gütl, Chang, & Morales, 2014).

Learning objectives and the corresponding learning activities with the selected cloud-based tools for it can be categorized based on the digital classification of Bloom’s taxonomy (Churches, 2008) as illustrated in Table 1.

Learning Objective after Bloom	Activities and Cloud-based tools
Content acquisition: acquiring learning information.	**Activities Keywords:** read, watch, check, browse, search, play, share, annotate, summarize, google. **Activities Examples**: Videos, Documents and Resources access. **CBTs Examples**: WizIQ, Dropbox, SlideShare, Youtube, Milaulas, UDUTU, StudyBlue, Google Drive.
Remembering: Retrieving, recognizing, and recalling knowledge from memory.	**Activities Keywords**: define, describe, identify, label, list, name, outline, recall, recognize, highlight, reproduce, select, state, retrieve, tell, google. **Activities Examples**: Flash cards, Online quizzes, Q&A discussion forums, Social bookmarking, searching for facts, Digital classification, Simple mind maps, Rote learning based on repetition, and Reading. **CBTs Examples**: ProProfs, ProBoards, OSQA, WizIQ, StudyBlue, Quizlet, Flashcard Machine, StudyStack, Evernote, StudyPlanet, Diigo, Symbalooedu, Google, Google Docs, Mindmeister, Stormboard, Visual.ly, Notes.io.
Understanding: Comprehending the meaning, interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining of ideas, concepts and problems. (Understanding of given information).	**Activities Keywords**: categorize, clarify, classify, compare, annotate, calculate, conclude, describe, distinguish, estimate, explain, extend, exemplify, interpret, explain, illustrate, predict, rewrite, summarize, translate, match, paraphrase, report, comment. **Activities Examples**: Mind mapping, Blogging, Discussion forums, using wikis for content authoring, collaborating online, taking notes, Storytelling, Flash cards, Internet search, and Summarize in a Word processor. **CBTs Examples**: Mindmeister, Cacoo, OSQA, ProBoards, Office, Google Docs, Google Drive, Quizlet, Evernote, Notes.io, Wikispaces, Edublogs, Flashcard Machine.
Applying: Using information, concepts and ideas in new ways or situations. Carrying out or using a procedure or process through executing or imple-	**Activities Keywords**: apply, implement, change, compute, construct, demonstrate, discover, manipulate, modify, operate, predict, prepare, produce, relate, show, solve,

menting. Applying what was learned in the classroom into novel situations in the work place.	use, practice, play, share, illustrate. **Activities Examples:** Editing wikis, Podcasting, Simulation, Presentations, Creating a process. **CBTs Examples:** MindMeister, Wikispaces, SDK, Cloud, gliffy, Cacoo, Voki, Sync.in, Office, Visual.ly, Codeanywhere, Voicethread, Emaze, Skype.
Analyzing: Breaking material or concepts into component parts so that its organizational structure may be understood. Determining how the parts relate to one another and to an overall structure or purpose through differentiating, organizing, and attributing. Distinguishing between facts and inferences.	**Activities Keywords**: analyze, break down, compare, contrast, deconstruct, differentiate, discriminate, distinguish, identify, illustrate, infer, outline, relate, select, separate, detect, test, parse, organize, formulate, integrate, structure. **Activities Examples:** Mind mapping, Surveying, Annotating, Presentations, Polling, Rubrics, Validating, Linking, Debating, Reverse engineering (deconstruction). **CBTs Examples:** MindMeister, Cacoo, Google Forms, Emaze, Evernote, Sync.in, gliffy, Emaze, iRubric, Visual.ly, Office.
Evaluating: Making judgments based on criteria and standards through checking and critiquing. Defending concepts and ideas.	**Activities Keywords**: appraise, compare, conclude, contrast, verify, critique, defend, describe, discriminate, evaluate, explain, interpret, justify, relate, summarize, support, coordinate, monitor, moderate, check, detect, experiment. **Activities Examples:** Survey, Blogging, debating in forums, collaborating online, Discussion boards, Moderating discussions, Using wikis, Web conferencing. **CBTs Examples:** Easy Test Maker, ProProfs, Educaplay, SurveyPlanet, Edublogs, Office, ProBoards, OSQA, Wikispaces, Google Hangouts, Stormboard, Quizlet, Creatrix Campus, WizIQ.
Creating: Building a structure or pattern from diverse elements. Putting parts together to form a coherent or functional whole, with emphasis on creating a new meaning or structure through generating, planning, or producing.	**Activities Keywords**: categorize, combine, compile, compose, create, devise, design, explain, generate, modify, organize, plan, rearrange, reconstruct, relate, reorganize, revise, rewrite, summarize, tell, write, improve, invent, hypothesize, publish, produce. **Activities Examples:** Blogging, using wikis,

	Programming, Podcasting, Presenting, leading forum discussions, creating a new model, Creating a Mind-map. **CBTs Examples:** MindMeister, Creatly, Visual.ly, Cacoo, Google Drive, gliffy, Emaze, Bubble.us, Sync.in, Wiggio, Office, Edublogs, Wikispaces, Voki, Codeanywhere.

Table 1. Learning objectives and selected learning activities and supporting cloud-based tools

Cloud-Based Tools Interoperability in Online Learning and MOOCs

Cloud-Based Tools are constantly evolving and a wide range of innovative cloud-based tools can be used in online learning and MOOCs, with a large potential and acceptance for both students and teachers. However, because of the distributed nature of the resources created in the CBTs, many challenges have been identified, such as ownership, management, adaption, and intervention. This is even more critical in open and massive education, where resources are usually publicly available with thousands of interested learners attracted to the materials for learning and re-purposing intent (Hernández, 2015).

Teachers, learners, and technology providers are faced with the need to incorporate and use cloud-based tools in education, so a flexible educational environment that is capable of enacting granular orchestrated learning activities is required. Learning Orchestration (LO) identifies the capacity to have a granular management over CBTs, with the ability to provide adaption, flexibility, intervention, assessment, and role management. The process of LO is based on teachers' functions, such as defining activities and evaluation rubrics, monitoring individual or group activities and adapting deadlines and workload (Hernández, 2015). This requires full administrative control over all the components of the educational experience. Learning Orchestration also requires interventions, adaptation of the learning paths, scaffolding knowledge and experiences from one activity performed in a CBT to the next one. Subsequently for educational purposes, it is not enough just to use in an educational setting new tools that are available on the cloud and through many devices, because that comes with obstacles which needs to be considered.

Using and combining several CBTs in learning settings might lead to the following issues (Hernández, 2015):

- Multiple login registrations.
- Difficulties for the teacher to follow up and verify learners' performance in the third-party tool.

- Inability to pre-set up the learning process as designed (e.g., create and prepopulate tool instances to be used by the learners), requiring the learner to first understand and discover how to administer the tool and then set up the tool instance as required, thus increasing the cognitive load in nonessential, nonrelated educational tasks.
- Group activities may require extra setup that cannot be easily deployed by the teacher.
- Multiple tools used in a given educational experience exponentially increase the setup and management problems.
- Utilization of results from one tool as an input for the activity to be done in another tool is not integrated.

Students, educators, and administrators expect seamless integration of different data or content sources, multiple software applications and tools, and enterprise IT systems (Walker, 2012). The usability of isolated data, content, and applications is rapidly diminishing. Educational agencies and institutions are seeking to strategically leverage their assets across a number of systems. Thus, interoperability has become a necessary capability for the systems that are emerging.

Broadly speaking, interoperability can be defined as a measure of the degree to which diverse systems or components can work together successfully. More formally, IEEE and ISO define interoperability as the "ability for two or more systems or applications to exchange information and mutually use the information that has been exchanged". To be more concrete, in the context of cloud computing, interoperability should be viewed as the capability of public clouds, private clouds, and other diverse systems within the enterprise to understand each other's application and service interfaces, configuration, forms of authentication and authorization, data formats etc. in order to cooperate and interoperate with each other (Baudoin, Dekel, & Edwards, 2014).

In educational settings, interoperability was defined as a "*condition that exists when the distinctions between information systems are not a barrier to accomplishing a task that spans multiple systems*" or as "*the capability of different systems to share functionalities or data.*" (Hernández, 2015)

Interoperability makes acquiring, maintaining and evolving the infrastructure that supports education and administration more affordable, flexible, and sustainable. Without interoperability, combining the many sources of content or data and the variety of software applications that must work together to support instruction, assessment, or various management and administrative functions would be impractical, if not impossible (Walker, 2012).

Perfect interoperability would make it possible to use any data, any digital content, and any software application on any system. Users could easily and continuously access, create, and share content or data from multiple sources on any device, using any platform to perform a variety of tasks (Classroomaid, 2014).

Current learners typically have multiple devices, use multiple apps through them, and experiment with different new scenarios. In this current reality, the standard monolithic environment approach for a Virtual Learning Environment (VLE) is still predominant in education. Thus, the challenge is a distributed, non-monolithic environment because is not possible to limit educational settings to just one environment. The aim is to create an educational environment based on a distributed set of services and contents available in the cloud of apps and devices (Hernández, 2015).

Enabling a Cloud Education Environment (CEE) that integrates CBTs is indeed necessary for new educational experiences. It is necessary to provide a simple yet powerful unified environment that includes CBTs while addressing challenges such as simplifying the adoption barriers for teachers, giving them best practices, allowing them full control over the educational experience, creating easy initial steps for the use of a new tool for the learner, providing support structures for both learners and teachers, and allowing institutional adoption. Thus, issues such as hierarchy and control problems, role definition and corresponding management of those roles, authority over resources created, integration with legacy systems such as VLEs, and lower literacy issues are created when using a new CBT for the first time. Such a unified environment that addresses the described challenges and issues can only be conceived if granular controls for interoperability are enabled between a central management system (such as a VLE) and the CBTs, increasing the quality of the experience as a whole and lowering the literacy issues because the CBTs' management process and setup can be done automatically (Hernández, 2015).

In order to enable interoperability between systems that are capable of performing operations, there is a need to design and develop customized interfaces for each tool that will be integrated in the Cloud-Based Learning Platform (CBLP). That is the current approach in most interoperability systems using traditional Web services technologies or others. Each new CBT planned to be incorporated in the Virtual Learning Environment (VLE) requires a custom API interface, which involves a significant amount of programming effort, as well as a maintenance effort with frequent changes and updates that take place in the CBT Web API as it is improved (Hernández & Gütl, 2016).

Standards and Systems for Learning Tools Interoperability

Lewis (2012) identified the important role of standards for the educational interoperability, and (Aroyo, Dolog, Houben, et al., 2006) listed some of the most used standards such as: learning object interoperability framework (LORI), content object repository discovery and resolution architecture (CORDRA), Edutella, and learning tools interoperability (IMS LTI) (As cited in Hernández at al., 2014).

There are many educational standards and specifications for interoperability. All of them help to create a flexible educational environment in which many pieces of the big puzzle of an educational environment can be used as plug and play components. Those standards and specifications can be organized according to Shepherd (2006) and Al-Smadi (2012) as follows (as cited in Hernández, 2015):

- **Authentication**: seamless single sign-on.
- **Content packaging**: providing sharable content and the transmission of it among systems.
- **Data definitions**: providing a kind of schema (in XML or any other format) that has the corresponding content structure.
- **Data transport**: to describe how data is transferred among systems.
- **Launch and track**: how content and tools can be launched and afterward tracked.
- **Metadata**: used for content description, search, and retrieval.

One of these standards as mentioned previously is the **"Learning Tools Interoperability (LTI)"** standard, created by IMS Global Learning Consortium for interoperability. LTI enables the integration of internet-based learning applications with online platforms offered by learning providers. It enables the use of new and specialized tools for the learning process in a single, unified, and seamless way. LTI handles automatic credential exchange and management, authentication, and authorization in a secure fashion, including the notion of context (e.g., a course) and respective user info and roles. It enables Tool Consumer (TC) and Tool Provider (TP) to exchange information, and defines a Tool Proxy that determines a negotiated interface contract between a particular TC and TP. The primary drawback of the current LTI is that it does not offer the concept of basic CRUD operations (create, read, update, delete) over the resources, nor does it offer support for any other type of operation over a resource. Thus, it limits itself to the exchange of information between the TC and TP, launching the tool from the TC, and providing context (a group, a classroom) to that tool without the ability to execute explicit operations that might be available on public API by the TP. (Hernández et al., 2014)

There are several architectures as well that support the integration with external tools including CBTs. A good example is the **Group Learning Uniform Environment (GLUE!)**, an architecture for the integration of external tools in a Virtual learning environment (VLE). It's capable of creating, configuring, and assigning external tool instances and, finally, deleting these instances. There is a GLUE! core that handles all communication between the VLE and the external tool and processes the integration contracts. Those contracts are represented and materialized as adapters for both the VLE and the external tools. Manual development and maintenance of the adapters is required, which involves custom programming. Also GLUE! does not support operations (e.g., CRUD), nor does it have the notion of resources and related properties. Thus it limits itself to launch and basic communication between the TP and TC. (Hernández et al., 2014)

Another example, **Learning Activities Management Systems (LAMS)**, is capable of designing, managing, and delivering online collaborative Learning Activities while providing teachers with an intuitive and interactive authoring environment for creating sequences of Learning Activities. For connecting and integrating with external tools, LAMS has defined what is called Tool Adapters, which use LAMS Tool Contract for management issues such as authorization and authentication. The adapters are also known as Wrappers and can integrate CBTs. (Hernández et al., 2014)

Current specifications and systems for educational interoperability lack the ability to clearly define for each CBT the objects and their corresponding operations and properties, so management controls over CBTs are limited. From a pedagogical point of view, granular controls over CBTs are required (Hernández, 2015). Furthermore, those specifications and systems do not use current semantic technologies that are capable of enabling machine-processable definitions of Web APIs, which simplify interoperability efforts (Hernández, 2015). How to create such a definition of a tool that can be interpreted at run time and avoid custom program interfaces for each new tool? A semantic approach leads to the discovery and identification of the available objects, operations and properties a tool has all at run time, and all machine-processable. This clears the hurdles of custom interface programming for each tool and improves the scalability of building, extending and maintaining tools (Hernández, 2015).

Middlewares for Cloud-Based Tools Interoperability

Pedagogical research identified barriers for the adoption of CBTs, such as authority, computer literacy, effectiveness of use, and technological cohesion with current VLEs. Thus, it has become clear that a flexible Web interoperability is required between the VLEs and CBTs that addresses the aforementioned issues. Thereby, Web interoperability technologies are examined in terms of simplifying the integration and maintenance of Web interoperability with CBTs. The results are that Semantic Web technologies present the best approach due to the ability to have self-described Web APIs that allow automatic machine-processes (Hernández, 2015).

Cloud Learning Activity Orchestration system (CLAO)

This subsection is based on the following references: (Hernandez & Gütl, 2016; Hernández, 2015; Hernández et al., 2014)

CLAO is an infrastructure that is capable of orchestrating learning activities through Web interoperability with CBTs. This interoperability is achieved using an advanced Semantic Web technology, Hydra. This technology allows for the controlling of every single operation and all resources available from a CBT API; furthermore, it does the interoperability automatically, without involving CBT-specific code. It only requires defining the CBT API at a higher level, and then it can be automatically processed.

CLAO is designed to handle all the logic of communication, authentication, and integration with services and tools on the cloud and to provide a friendly user interface through a unified workspace environment. It enables teachers and students to interact with CBT used for learning activities. The architecture built for the CLAO consists of three main layers: Learning Activities Orchestrator (LAO), Learning Environment Connector (LEC), and Cloud Interoperability System (CIS).

- **Learning Activities Orchestrator (LAO)**: this component constitutes the user interaction layer of the CLAO architecture (interface and interaction). It presents the “one-stop shop” for students with a description of the LA and an entry point to the CBT (e.g. Mindmeister, Google Drive). LAO user interface creates a visual interface that is connected to the cloud tool, including features allowed by tool public API (e.g. in Google Drive, the online document editor embedded into the LAO and main controls such as ‘create a document’).

- **Learning Environment Connector (LEC)**: this component is used to integrate the CLAO architecture and the monolithic learning management system, providing a single user authentication. Examples of interaction between systems are user authentication (single sign-on), session management and assignments. LEC provides an API to create custom integration within the CLAO and a VLE. This includes two main services: (1) a single sign on service between the CLAO and the VLE. (2) The assignments management, to link grade results, from a Learning Activity performed in CBT, to the VLE assignments management tool.
- **Cloud Interoperability System (CIS)**: this framework is the core component of the architecture. It is the middleware that integrates; reuses and personalizes each of the CBTs or services that will be added to CLAO. It achieves this interoperability through a definition of services and through definition of a common interface of communication. The CIS component is divided into four layers: (a) the communication layer; (b) the authentication layer; (c) the analytic layer; and (d) the business layer. The communication layer (a) in CIS identifies each CBT that can be used for learning, and for each of these tools prepares a custom integrated service communication bundle. Within this layer, tracking data are sent to be stored and used by the analytics layer. This layer performs all the API requests between the CIS and the CBT public API. The CLAO architecture has an authentication layer (b) that handles the required tokens exchange for application authentication, as well as the correspondent learner authentication towards the CBT. The analytics layer (c) records user behaviour and interaction data from the CBT, and sends these data to cloud-based storage (Google Fusion Tables) for further analytics processing. The business layer (d) plays every CRUD operation upon the activity type (e.g. creation of a document).

The authors did an evaluation for the architecture and examined its effectiveness for the use of learning activities in the cloud for MOOCs experiences. CLAO architecture has been used in a good amount of MOOC courses taught through the Telescope platform (a Latin America initiative similar to Coursera or edX) at Galileo University. The authors wanted to gain insights in how learners used the CBTs enabled in CLAO for the MOOCs, identifying usage and failure patterns in the learning activity and how effectively these tools were used. Their experience was well accepted among the learners and proved that CLAO architecture is a robust environment for deploying cloud-based learning activities. Results revealed a satisfactory usability where learners evolved after doing several learning activities, to a more elaborated and meaningful use of the cloud-based tools.

Responsive Open Learning Environments (ROLE):

This subsection is based on the following references: (Hernández, 2015; European Commission, 2009-2016; Hernández et al., 2013; Govaerts et al., 2011)

ROLE is a European project that aims to exploit web-based tools and technologies to empower learners to construct their own personal learning environments (PLEs). PLEs allow individual learners to access, aggregate, configure and manipulate assets of their own current educational experiences, it has a learner-centric orientation where learners are provided with the facilities to incorporate the use of new services and tools in a simple manner while at the same time having the control over the environment. They are opposed to monolithic approaches of integrating all services into a single architecture.

ROLE framework provides a common technical infrastructure to assemble widgets and services in PLEs. ROLE technology is centred on the concept of self-regulated learning, aiming at creating autonomous learners that are able to plan their learning process, search for suitable resources independently, and learn and then reflect on their learning process and progress.

The vision of ROLE is to empower the learner to build his/her own responsive learning environment. Responsiveness is defined as the ability to react to the learner needs through recommendations, adaptation or visual analytics services that support the learner to be aware of and reflect upon his/her own learning process.

ROLE aims to include any type of content and tools with the possibility of the learner using a simple process to construct a learning environment; it exploits all existing and developing open educational sources including all popular cloud-based resources. The inclusion of those contents and tools is through a widget-based approach. ROLE consists of the following main components:

- **The Widget Container**: the core of the infrastructure is the widget container that enables the assembly of various widgets. It is an environment for widget rendering as well as management of and communication between widgets. It also provides a user-friendly way to organize widgets visually, set preferences, navigate to the widget store for choosing additional widgets, etc.
- **The Widget Store**: Learners and teachers use the Widget Store to select learning widgets. It provides a learning tool catalogue. The ROLE Widget Store allows learners to search for fitting learning tools and rate them. Found widgets can be included in existing learning environments.
- **Inter-Widget Communication (IWC)**: this component enables event-based communication between widgets. It enables more responsive, collaborative environments with real-time notifications and richer user experience.
  Widgets can communicate locally in the PLE or remotely to widgets in other PLEs to foster collaboration.

- **Contextualised Attention Metadata (CAM) Tracking Service**: User activities are tracked using the Contextualised Attention Metadata (CAM) format. CAM describes the interactions of the users with their learning environment, which resources are used within which applications and in which contexts. These data can be used for analysis and computing of personal, social and contextual information about users and applications. CAM can be exploited to provide personalised recommendations and thus serves as a basis for enabling responsiveness in ROLE. A second important goal of tracking such data is to enable the evaluation of ROLE services based on user activities that have been captured in real-world settings.
- **The Authentication and Authorisation Service**: the central identity provider allows single sign-on for the whole infrastructure.

So ROLE PLE is a bundle of interoperating widgets often realised as cloud-based services, used for teaching and learning. Hernández et al. (2013) decided to select two different widget bundles in order to create a comprehensive learning experience for learners: the first widget bundle consisted of the following six widgets: ObjectSpot, Binocs Media Search, MediaList, EtherdPad, MindMeister Mind Map and Facebook. The second widget bundle included three widgets, namely Google Drive, MindMeister Mind Map and Facebook. The two different bundles have been evaluated in two web-based courses at Galileo University, Guatemala, with participants from three different Latin-American countries. The authors measured emotional aspects, motivation, usability and attitudes towards the environment. The results demonstrated the readiness of cloud-based education solutions, and that the technologies provided by the ROLE project enable the development of a truly cloud-based PLE.

IV. Cloud-Based Tools in MOOC Settings

Today's students are immersed in technology and see it as an essential tool for learning because they use a variety of strategies to collect and sort data and to communicate and collaborate with their peers. The development of web technologies has also increased the depth and scope of learning activities that can be accessed online and that can be used in MOOCs for better motivation and engagement of learners. In this section we present existing research work, initiatives and experiences for using CBTs in MOOC learning settings, including some selected and repetitive examples with authors' findings about its effectiveness.

ALARIO-HOYOS, KLOOS, ESTÉVEZ-AYRES, et al. (2016) MOOC Experience:

The authors presented their experience of the MOOC "Introduction to Programming with Java – Part 1: Starting to Programming in Java" in their paper. This five-week MOOC was deployed in edX and ran from April to June 2015. More than 70,000 learners registered for this course from more than 190 countries, and had no prerequisites on programming skills. This MOOC was carefully designed by Universidad Carlos III de Madrid (UC3M) to enhance learner's interactivity with the learning contents through numerous formative activities supported by both edX built-in tools (multiple choice questions, multiple response questions, text input questions, drop-down list questions, drag and drop exercises and peer-review activities) and other external tools (such as Blockly, Codeboard[1], Greenfoot[2] and some additional JavaScript ad-hoc developed activities) aimed at helping to learn programming gradually. Table 2 shows the used tools and the distribution of exercises of each kind in the MOOC, and figure 2 shows an example of using Blockly activity in this MOOC. The authors described the MOOC from the interactive perspective, detailing the activities and the tools used in this course and presented the results of learners' opinions about their usefulness for learning.

As the authors described, this MOOC follows a similar structure during its five weeks. Each week includes four main subsections with videos presenting the theoretical concepts and a number of formative activities for reinforcing these concepts. In addition, there are from five to six complementary subsections: a laboratory subsection to keep practicing the main concepts using mazes and games in a fun way to increase learners' engagement; a recap subsection to summarize the main concepts of the week and provide solutions to the most challenging formative activities; one or two subsections with the graded exams (summative activities); a subsection with additional formative exercises for those who want to learn more; and a subsection with videos collecting learners' view about that week. The summative evaluation system is based on two types of activities: exams and peer review activities.

[1] Codeboard (https://codeboard.io/); [2] Greenfoot (http://www.greenfoot.org/);

Type of tool	*Number of exercises*
edX - Multiple choice questions	150
edX - Multiple response questions	49
edX - Text input questions	182
edX - Drop-down list questions	98
edX - Drag and drop exercises	15
edX - Peer-review activities	2
Blockly activities	15
Codeboard activities	38
Greenfoot activities	19
JavaScript ad-hoc developed activities	10
TOTAL	**578**

Table 2. Distribution of exercises of each kind in the MOOC
(Replicated from ALARIO-HOYOS, KLOOS, ESTÉVEZ-AYRES, et al., 2016)

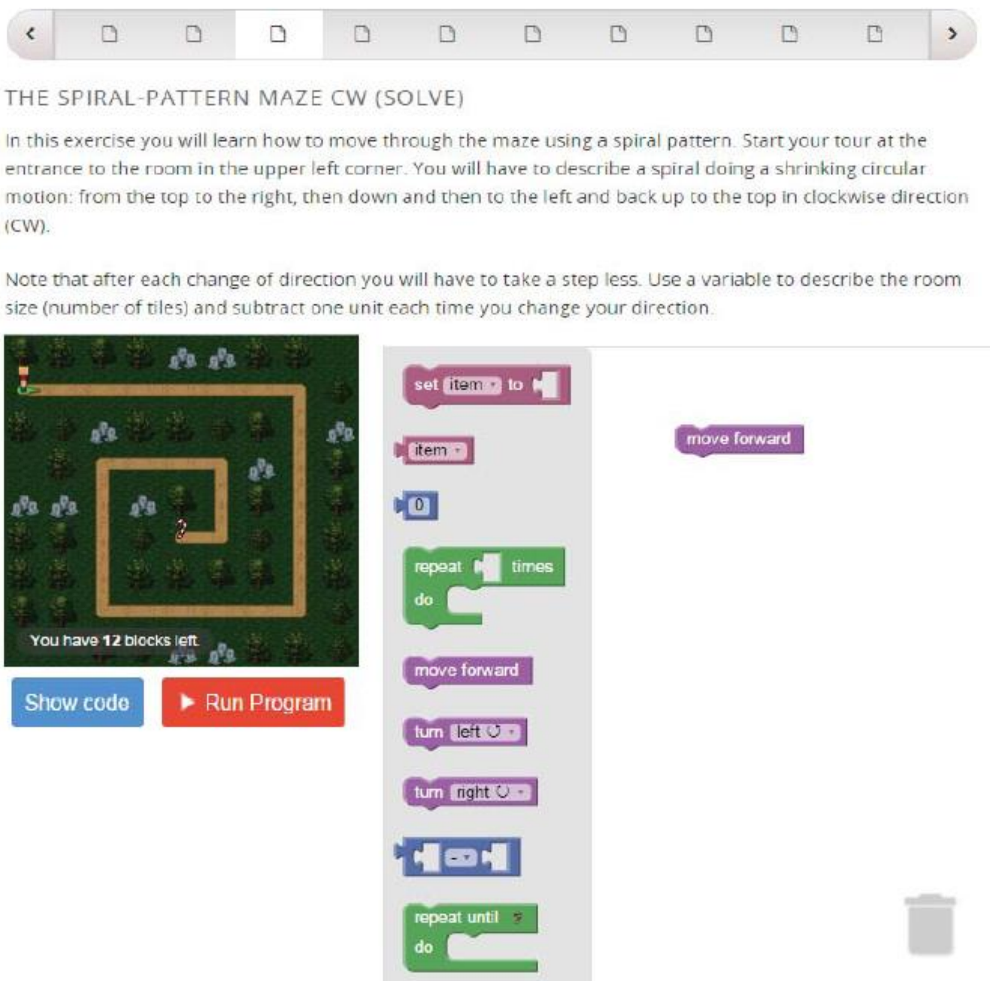

Figure 2. Screenshot of the MOOC in edX integrating a Blockly activity
(Replicated from ALARIO-HOYOS, KLOOS, ESTÉVEZ-AYRES, et al., 2016)

Learners had the opportunity to answer an optional survey at the end of the MOOC to express their opinion about various aspects of the course, including interactive activities and the different tools supporting them. Learners were asked, in general, about the usefulness of the interactive activities for learning in this MOOC, and also about their quality. Then, they were asked about the usefulness for learning of each type of activity and their difficulty. Figure 3 presents an overview of the results.

Figure 3. Summary of learners' view of interactive activities
(Replicated from ALARIO-HOYOS, KLOOS, ESTÉVEZ-AYRES, et al., 2016)

The results of this study showed, as mentioned by the authors, learners' positive perception about the usefulness of having a large number of interactive engagements in this MOOC and a very positive feedback of the selection of tools included. Regarding the difficulty of the activities, the authors found that Blockly activities were perceived as easier than the others, as they were used to introduce novice learners in the programming world; while Codeboard, Greenfoot and the peer-review activities were added in advanced stages of the course. The authors ended their paper by mentioning that these positive results need to be balanced with the trade-off between the number of interactive exercises and the workload for teachers of creating them.

Borras-Gene, Martinez-Nuñez, & Fidalgo-Blanco (2016) MOOC Experience:

The authors presented a gamification cooperative MOOC model (gcMOOC) that can be applied in the design of a course in the field of Engineering Education at the Technical University of Madrid on the MOOC platform MiríadaX[1]. They investigated the factors that influence motivation, collaboration and learning in gcMOOC, and suggested a set of practical recommendations and tools to improve the motivation, learning level and completion rate of participants in MOOC course in Engineering Education when the gcMOOC model is implemented. The gcMOOC model includes 4 proposals involving the motivation of the student and meeting the needs of relationships, autonomy and competence.

The course consists of four modules divided into lessons; each module has a multiple choice test that students must pass along with a final activity. This final activity should deliver a document with the scheme of a learning community using social networking that is evaluated by peers within the platform. Teachers create virtual communities for their classrooms and manage them. This is the learning part of the initial content contributed by the teaching staff. It consists principally in video format accompanied by additional information (links, summaries and exercises) associated with each video in text format, and relies on the cooperation of its participants to generate content. Group interactions are centralized in the MOOC using Google+ throughout the course as a means for feedback and contributions, apart from the regular used to indicate students those most interesting publications and raise comments on these. A contest on Instagram was proposed as a voluntary activity, and during the course two live streamings via Google Hangout were offered and later stored on a YouTube channel. Students were able to listen or submit a project related to a course theme. The platform in which the course is taught, offers the possibility to the students to obtain a certificate of participation or overrun by the degree of completion (75% or 100%). These certificates can also be exported like badges inside the frame of the project Mozilla Open Badges. The winner of Instagram's contest and the 16 offers presented in the two hangouts were all delivered their badges also.

The results of this study stated that the incorporation of virtual communities and gamification methodologies (contests and obtaining additional badges) increase participant learning motivation in engineering MOOC courses and improve their interest

[1] MiríadaX (https://miriadax.net);

in the course. It helps to make the course more dynamic and interactive and improves learners' engagement. Additionally, these gamification tools aid students to deepen their learning and involve them in the course, increasing their motivation and the completion rates in MOOCs; and the virtual community of the gcMOOC has not only stimulated social interactions using gamification elements but have also contributed to achieve the learning objectives. The survey results indicated that most of the students are positive about gamification and social media use in education and especially in MOOCs. Table 3 shows results related to learners' attitudes towards motivation in gcMOOC, and table4 shows results related to the used tools and gamification in gcMOOC.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Mean	SD
(6) My interest has increased during the course	0.61	1.69	9.12	31.36	57.22	4.43	0.77
(7) I found the course stimulating	0.70	2.10	12.80	33.20	51.20	4.32	0.83
(8) The course was dynamic and active	0.90	3.00	17.00	36.60	42.50	4.17	0.88
(9) The layout of the modules could hold my attention	1.90	4.00	17.40	35.70	40.90	4.10	0.95
(10) Participate steadily and work actively in the course	2.00	8.50	26.70	36.40	26.40	3.77	0.99
(11) Students were encouraged to participate in the Virtual Community	1.40	4.30	17.80	32.30	44.20	4.14	0.95
(12) Students were encouraged to identify and share resources	1.50	3.20	18.00	36.30	41.00	4.12	0.91
(13) Students were encouraged to comment on peers' resources	1.60	3.40	20.60	36.00	38.40	4.06	0.93

Table 3. Percentages of participant responses regarding their attitudes towards motivation in gcMOOC
(Replicated from Borras-Gene, Martinez-Nuñez, & Fidalgo-Blanco ,2016)

Gamificatin resource	Question	Yes	No
Google +	Do you think that the elements of Google + are motivating to take part?	97%	3%
	Have you checked any publication or comments with +1?	62%	38%
	Have you proposed some debate?	20%	80%
	Do you have proved interesting contributions from other partners?	85%	15%
	Have you helped input from your peers to better understand some of the concepts proposed in the MOOC?	83%	17%
	Think you from community content can say that there are new course content?	83%	17%
Hangouts	Have you participated in any of the hangouts?	30%	70%
Instagram contest	Did you like helpful?	80%	20%
	Have you voted for a proposal?	30%	70%
	Have you participated with any proposal?	13%	87%
Certificate and badges	Did you get motivated by the fact trying to get a badge?	77%	33%
	Did you get any badge?	40%	60%
	Have you obtained the certificate?	40%	60%
	You have motivated the fact of getting the certificate for completing the course?	75%	25%

Table 4. Results from survey interviews about tools and gamification
(Replicated from Borras-Gene, Martinez-Nuñez, & Fidalgo-Blanco ,2016)

As limitations 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. Along with the factor of low digital literacy, both two factors result in a massive duplication of contents, and problems or difficulties for members in filtering, classifying and selecting the accurate information.

Morales Chan, Hernández, Barchino Plata, & Amelio Medina (2015) MOOC Experience:

The authors described the motivational and cognitive learning strategies used by students of a large-scale MOOC titled "Cloud-based Tools for Learning" that focuses on using free cloud-based tools for learning. The main objective of the course is to present the opportunities provided by the cloud to create effective learning experiences and to innovate through tools that offer many possibilities to backup data, share information and create multimedia content.

The MOOC was given by the Telescope project, which is an initiative for Latin American Region with similar objective as Coursera or EdX. The Telescope project is carried out by the Galileo Educational System (GES) Department at Galileo University in Guatemala, which is in charge of Educational Technology R&D at the University.

Special focus was given to online collaboration through discussion forums using OSQA and peer assessment. For the peer assessment activities, a new tool was created and integrated into the learning management system (LMS) they use and which is based on LRN LMS. This assessment module included a rubric-based feature whereby instructors could create rubrics for the assessment activities.

Other cloud based tools were used also such as: Google Docs for essay writing, Google presentations for displaying the content, and a podcast and short videos representing the main resources of the learning content. Prezi for designing presentations, Dipity and Cacoo for development of a personal biography through a timeline and integration of a business card, Educaplay for quiz creation, and other tools for multimedia presentations and development of animated online videos. Table 5 shows the MOOC learning topics and learning objectives with the selected cloud-based tools

The cloud-based learning activities were organized and deployed using the CLAO, an interoperability system and environment engineered at GES from Galileo University, which is a pluggable environment in the MOOC infrastructure where professors can organize learning activities and orchestrate multiple cloud-based tools from a pedagogical perspective. CLAO provides a seamless interoperability with cloud-based tools and the MOOC environment and has an analytics engine to obtain data from learners when they are using the cloud based tools within the learning activities.

This study is based on a survey of 230 students who answered the motivated strategies for learning questionnaire (MSLQ). The MSLQ has questions about motivation and cognitive learning strategies used by students in the course.

The results showed that students present high motivations in the MOOC, they showed a high confidence to accomplish and master the tasks and had their own intrinsic motivations (challenge, curiosity, mastery) and beliefs that their learning efforts would have a positive outcome, probably in the current profession and work. Students see each learning activity as relevant to their own contexts, and they see themselves as intrinsically motivated and as having capabilities to perform well in the course.

Learning Topic	Instructional Objectives	Activities and Cloud-based Tools	Assessment type
Unit # 1 Cloud-based Learning Concept, characteristics and opportunities of cloud-based learning	Identify the benefits of creating cloud-based learning experiences. Determine how the cloud can be used in learning environments. Collaborate in the recognition of cloud-based learning tools that can be used in learning environments.	Creating a PLE's diagram and the integration of a personal avatar Faceyourmanga[1]	Auto-grading
		Developing an essay about cloud-based learning in Google Docs[2]	Peer assessment
Unit # 2 Presentation and Documentation of Cloud-based Learning Tools Characteristics, use, and application of the tools	Create educative resources through presentation and documentation of cloud-based learning tools and apply them within learning environments appropriate to their educational needs.	Designing a Prezi[3] presentation	Peer assessment
		Development of a personal biography through a timeline and integration of a business card Dipity and Cacoo[4]	Peer assessment
Unit # 3 Communication and Collaborative Cloud-based Learning tools Characteristics, use and application of the tools	Create educative resources through communication and collaborative cloud-based learning tools and apply them within learning environments appropriate to their educational needs.	Design an interactive wall that integrates multimedia resources such as images, articles, and a podcast. Padlet and Soundcloud[5]	Peer assessment
		Multimedia presentation to show a project and multimedia resources such as mental map, images, and more. Google Viewer, Mindmeister, Skype[6]	Peer assessment
Unit # 4 Interactive and Multimedia Cloud-based Learning Tools Characteristics, use and application of the tools	Create educative resources through interactive and multimedia cloud-based learning tools and apply them within learning environments appropriate to their educational needs.	Create a learning game like a crossword puzzle or a quiz on all topics of the course. Educaplay[7]	Peer assessment
		Develop an animated online video to present a topic Goanimate[8]	Peer assessment

[1] Faceyourmanga, http://www.faceyourmanga.com/
[2] Googledocs, http://www.google.com
[3] Prezi, http://prezi.com/
[4] Dipity and Cacoo; http://www.dipity.com/ & https://cacoo.com/lang/es/
[5] Padlet and Soundcloud, http://padlet.com/ & https://soundcloud.com/
[6] Google Viewer, Mindmeister, Skype, http://www.google.com
[7] Educaplay, http://www.educaplay.com/
[8] GO animate, http://goanimate.com/

Table 5. MOOC learning topics, instructional objectives, and selected cloud-based tools (Replicated from Morales Chan, Hernández, Barchino Plata, & Amelio Medina ,2015)

Hernández, Gütl, Chang, & Morales (2014) MOOC Experience:

The authors presented a MOOC learning experience with cloud-based tools for deployment of learning activities at Galileo University in Guatemala. The MOOC learning experience was designed to restrict the learning setting to a number of pre-selected tools and cloud services rather than the option of allowing students to choose from a variety of tools. The authors made this decision because of earlier experiences where learners had asked for seamless and integrated learning among their groups and that the use of different tools had impeded their learning.

The central access point for the MOOC was a learning management system (LMS) developed at and for Galileo University and is based on .LRN[1] LMS. The MOOC was designed with four learning topics; each topic had a set of learning activities and assignments supported by a selection of cloud-based tools. Appropriate cloud-based tools were selected based on the learning and instructional objectives. Each of the cloud-based tools used for learning activities required their own credentials; no interoperability or look and feel adaptations were implemented in this study. Examples of the cloud-based tools used in this MOOC are: Mindmeister, Cacoo, Bubble.us, Slideshare, Educaplay, OSQA, Office, and Milaulas; and for the peer assessment activities, a new tool was created and integrated into the LMS. This assessment module included a rubric-based feature, where the instructors can create rubrics for the assessment activities. Participants collaborated through the use of online forums and to motivate active participation, a gamification approach was added where medals were awarded for student contributions and achievements.

This study evaluated the MOOC experience considering emotional, motivational and usability aspects and at the same time reviewing the use of cloud-based tools for the learning activities. The authors found that participants' attitudes of motivational and emotional aspects were highly ranked. Participants showed high motivation and perceived low anger and sadness as well as significantly higher happiness while performing learning activities using the cloud-based tools. They also indicated positive learning outcomes using the cloud-based tools but at the same time, the MOOC course reported a high dropout rate.

Table 6 shows the motivational attitude with learning a new set of tools, utilizing the tools to finish the learning tasks and reflecting the knowledge gained from completing the learning activities, and table 7 shows the emotional attitude toward using the new tools.

Intrinsic Motivation	Completing learning activities using cloud-based tools	Learn to use new tools (which are cloud-based)	Reflect knowledge using the cloud-based tools
Absolutely Unmotivated	0.70%	0.00%	0.00%
Unmotivated	2.10%	0.00%	3.50%
Motivated	29.37%	18.18%	25.87%
Very Motivated	67.83%	81.82%	70.63%

Table 6. Intrinsic motivation regarding aspects of cloud-based tools (Replicated from Hernández, Gütl, Chang, & Morales ,2014)

[1] .LRN (http://www.dotlrn.org/);

Emotion	Explanation	Value
Happiness	When I used the tool, I felt satisfied/excited/curious?	2.27
Sadness	When I used the tool, I felt disheartened/dispirited?	0.52
Anxiety	When I used the tool, I felt anxious/insecure/helpless/nervous?	0.83
Anger	When I used the tool, I felt irritable/frustrated/angry?	0.53

Table 7. MOOC Computer Emotions Scale with 4-point Likert scale
(Replicated from Hernández, Gütl, Chang, & Morales ,2014)

Freire, Blanco, & Fernández-Manjón (2014) MOOC Experience:

The authors explored the integration of serious games as a new type of MOOC activity, specifically integrating EADVENTURE[1] serious games (SG) into edX. The eAdventure platform is a research project aiming to facilitate the integration of educational games and game-like simulations in educational processes in general and Virtual Learning Environments (VLE) in particular. It is being developed by the author's research group at the Universidad Complutense de Madrid, providing highly interactive content, increased engagement and a valuable source of learning analytics. According to the authors, the inclusion of serious games into MOOCs adds significant value for both courses and games, providing highly interactive content that can engage students and them to assess and apply their knowledge in an immersive scenario.

The authors analysed some of the issues that must be addressed in order to achieve this integration, attempting to chart this territory for future systems; and described a preliminary version of the EADVENTURE module, highlighting the authoring, assessment and gamification strategies included; and developed proof-of-concept modules test content integration, and have surveyed the current analytics capabilities of edX.

EADVENTURE module includes a fully-featured game editor, intended to allow non-technical users to create and modify their own SGs. At any time, authors can export their games for particular platforms and content packages. For instance, the same game can be exported as a stand-alone desktop application or as web-hosted Java applet in standardized format (e.g. SCORM) or platform-dependent format (e.g. LAMS), intended to be run from a conventional LMS (e.g. MOODLE), providing different alternatives at the time of integrating the games. Integrating EADVENTURE SGs as edX activities can be performed at several levels of granularity:

- **Minimal integration**: An EADVENTURE game can take the place of a traditional exercise, reporting back degree of completion, degree of correctness (or score), and the total time spent.
- **Multi-level integration**: An EADVENTURE game can be decomposed into a series of scenes or chapters, each of which can be considered a sub-activity. Results (completion, score, time spent) can then be reported for each.

[1] EADVENTURE (http://e-adventure.e-ucm.es/);

- **Low-level integration**: At the lowest level, individual actions within the game are reported as a constant stream of events.

According to the authors, the EADVENTURE module works correctly within the test environment, but has not yet been deployed into an actual MOOC. Figure 4 shows an example of heat map for an EADVENTURE game.

Figure 4. Example heat map for an EADVENTURE game
(Replicated from Freire, Blanco, & Fernández-Manjón, 2014)

Hernández, Guetl, & Amado-Salvatierra (2014) MOOC Experience:

The authors presented an approach to using cloud-based tools for MOOCs applying a new version of their architecture of 'cloud learning activities orchestration' (CLAO). They presented the CLAO, and examined its effectiveness for the use of learning activities in the cloud for MOOC experiences, presenting their results and findings.

This experiment has been done at Galileo University in three MOOC courses with different topics (Medical Urgencies, Introduction to E-Learning and Cloud Tool for Learning Activities) using their initiative project "Telescope" for hosting the MOOCs. These courses had more than 6,000 enrolled students and drew learners from more than 15 countries.

The authors described their architecture CLAO to deploy and orchestrate innovative learning activities using cloud-based tools (See section "Middlewares for Cloud-Based

Tools Interoperability" for more details about the architecture). The selected cloud-based tools in this experience are Google Drive document editor and MindMeister mind maps editor, used within the proposed CLAO architecture to complete the activity. The overall goal of this experience was to gain insights in how learners used the CBTs enabled in CLAO for the 3 MOOCs, identifying usage and failure patterns in the learning activity and how effectively these tools were used.

Figure 5 shows the interface of the Learning Activities Orchestrator (LAO) of the CLAO for learners, linking with learning activities.

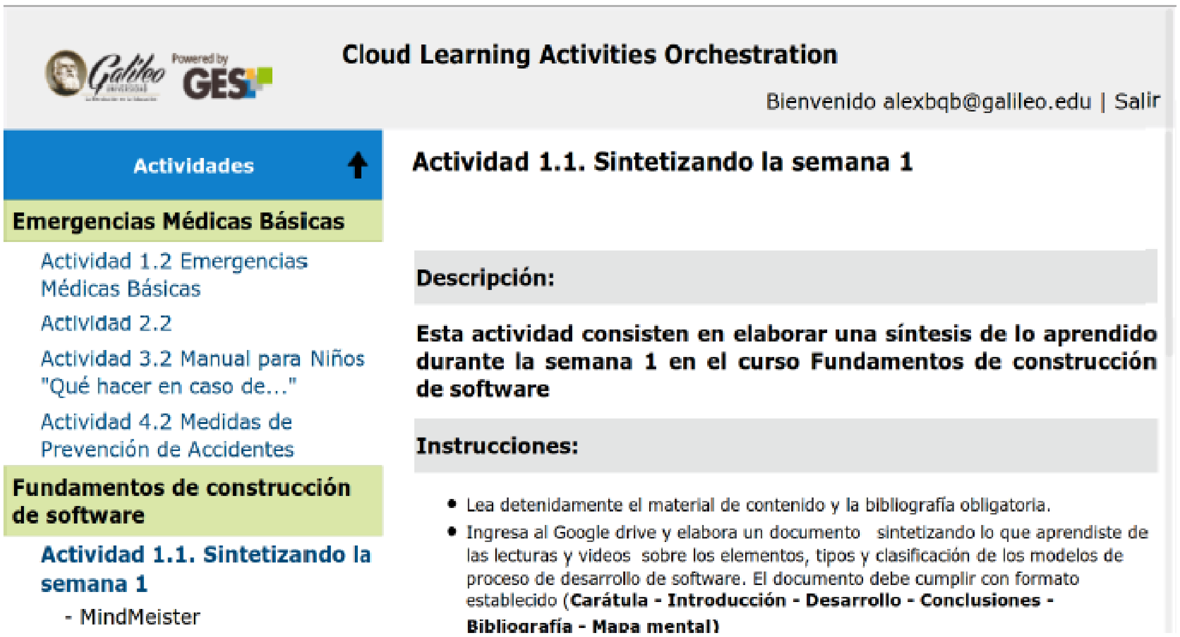

Figure 5. Learning Activities Orchestrator's Interface for students linking with Learning Activities (Replicated from Hernández, Guetl, & Amado-Salvatierra, 2014)

The results show how learners evolved, after doing several learning activities, to a more elaborated and meaningful use of the cloud-based tools. Authors concluded the following from the experiences in terms of CBTs effectiveness:

- When using cloud-based tools, the user needs to be conducted and guided by the system with the corresponding instructions on the usage of the tool.
- If a tool is somewhat detached from the learning environment, even if its use is required, it will not be used as expected, or even at all.
- Learners are willing and enjoy using cloud-based tools.
- Some sort of summative evaluations and grades have to be embedded into the learning activity to ensure full exploitation of the learning experience as it was conceived by the teacher.

- If a learning activity uses more than one cloud-based tool, the system must require the use of all of them: if not, the learner will tend to use just the tool presented for the final work.

Hernández, Gütl, & Chang (2013) MOOC Experience:

The authors described a MOOC experience which was set up specifically to support a group of Spanish speaking learners with little or no English literacy, using cloud-based learning tools and online tools for collaboration, interaction, and learning in the MOOC environment. The authors focused on two MOOCs offered by Galileo University to Spanish speaking learning community. Both MOOCs were built on the .LRN learning management system and utilized different cloud-based learning tools. Each MOOC was organized with a set of learning units, including learning content and assignments as well as peer discussion and assessment activities. Both MOOCs require the use of software or learning tools in the cloud, a set of tutorial videos and written instructions were created to support students to complete their assignments. Figure 6 shows the homepage of one MOOC, and figure 7 shows a video example in the other MOOC.

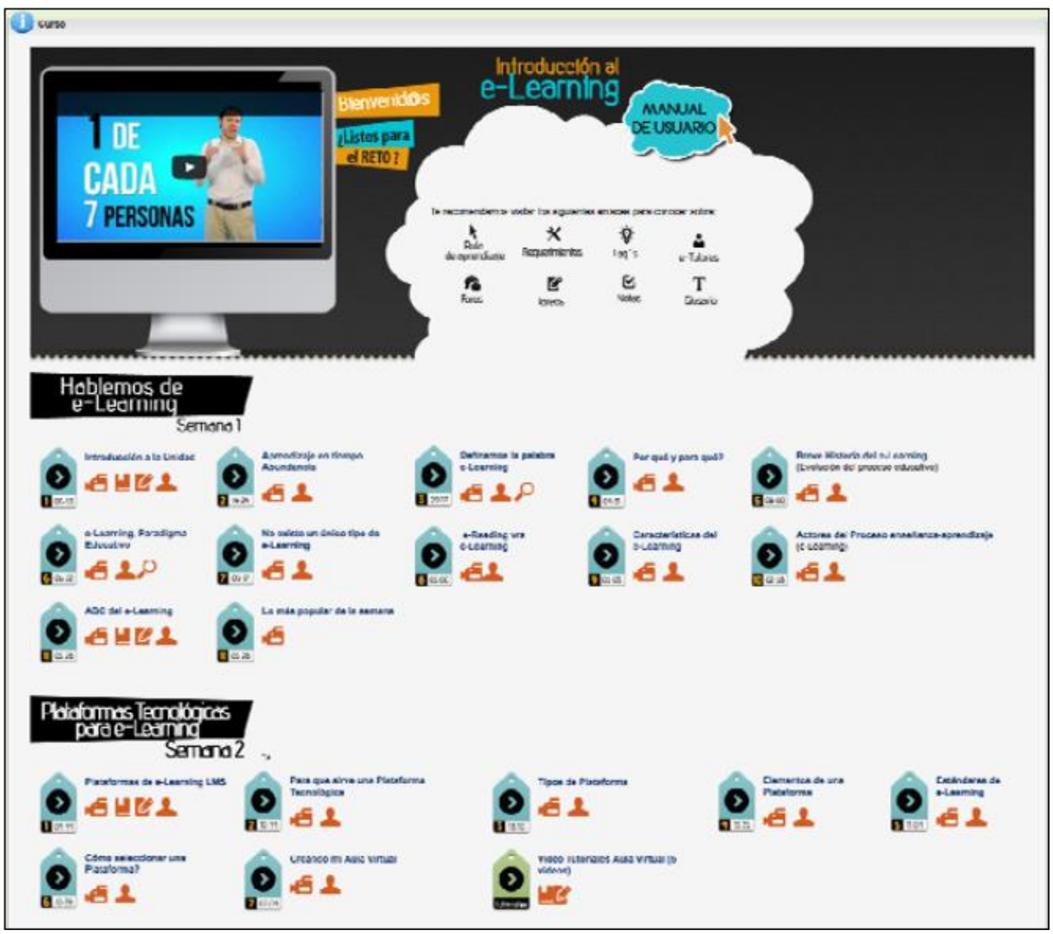

Figure 6. Homepage of the 'Introduction to E-Learning' MOOC
(Replicated from Hernández, Gütl, & Chang, 2013)

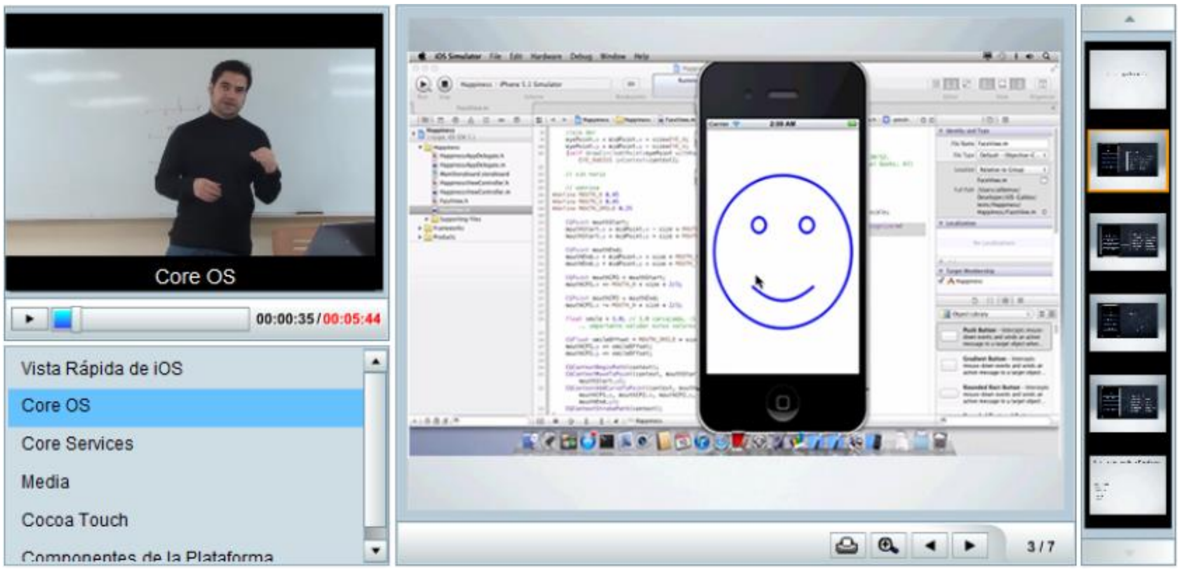

Figure 7. A class video of 'iPhone Development' MOOC
(Replicated from Hernández, Gütl, & Chang, 2013)

The selection of cloud-based tools was based on the digital classification of Bloom's taxonomy which described a mapping from different thinking skills orders to digital tools. Special focus was given to peer-assessment and online collaboration through discussion forums using a gamification approach. A rubric was created for each learning activity and students used the rubric to assess their peers. Examples of the cloud-based tools used in the MOOCs are: Mindmeister, Cacoo, Bubble.us, Slideshare, Office, Educaplay, OSQA, Milaulas, Macincloud, XCode4 and iOS SDK. The selected cloud-based tools also were not integrated in the .LRN LMS and the interfaces were not adapted, as such, the tools require their own login management.

The authors found that students were not only able to use the cloud-based tools, but they were also capable of meeting the instructional objectives. They mentioned that the tools have shown great scalability in particular with the new and innovative features. However, interoperability, orchestration and analytics of the tools remain another research area for this educational setting.

Hernández, Amado-Salvatierra, & Gütl (2013) Experience:

The authors described a cloud-based learning experience in Latin-American countries. They presented the design, deployment and evaluation of learning activities using cloud-based applications and services. The experiences presented are from Galileo University in Guatemala with students from three different countries in Central America and Spain, most of them are university professors.

Selected cloud-based tools were used for different learning activities in various application domains and in three courses: Introduction to e-Learning, e-Moderation and Online activities design. The courses are designed in learning units that usually last for one week; each unit has a diversity of online material such as video, audio, animations, interactive content, forums, assignments and a wide diversity of learning activities especially designed for enhancing learning acquisition. The used learning platform for the courses is .LRN LMS and some module are alternative provided in Moodle LMS.

The learning activities include collaboration, knowledge representation, storytelling activities and social networking. Students were assigned to the cloud-based learning activities for the first time, most of them were not very familiar with related technologies, but they had a preliminary course that introduced them into the use of the institutional LMS and related technologies. They were asked to perform the learning activities individually and in groups using the different type of Cloud-based tools.

The used cloud-based tools in this experience are: Google Docs, WikiSpaces, Office, Dipity, Timetoast[1], MindMeister, Cacoo, Issuu[2], GoAnimate, Xtranormal[3], Pixton[4], Facebook, Delicious bookmarking and Gloster[5].

Figure 8, 9, and 10 show examples for some of the used tools.

Figure 8. Screenshot of Timetoast time-line example
(Replicated from Hernández, Amado-Salvatierra, & Gütl, 2013)

[1] Timetoast (https://www.timetoast.com/); [2] Issuu (https://issuu.com/);
[3] Xtranormal (http://www.xtranormal.com/); [4] Pixton (https://www.pixton.com/);
[5] Gloster (https://www.gloster.com/);

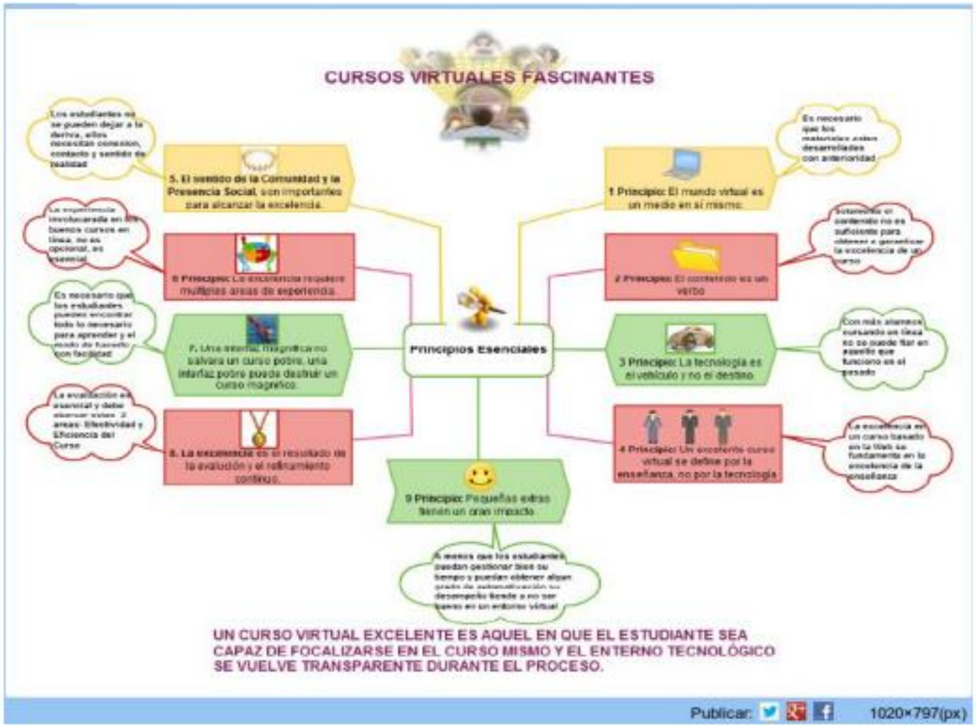

Figure 9. Screenshot of Cacoo mind map example
(Replicated from Hernández, Amado-Salvatierra, & Gütl, 2013)

Figure 10. Screenshot of Go-Animate storytelling example
(Replicated from Hernández, Amado-Salvatierra, & Gütl, 2013)

The study reports findings from motivational attitudes, emotional aspects and usability perception. From a total of 66 students, 45 of the students participated in the study by filling out at least one out of the two presented questionnaires. Some of the main results were:

- 95% of the participants liked the idea to use innovative learning online tools to represent new knowledge.
- 35% of the participants think that it was difficult to complete the learning activities
- 50% of the participants think that they would need more information and instructions to complete the learning activities.
- Only 10% of the participants expressed the learning activities were boring.
- 70% of the participants considered that the time for the activity was appropriate.
- 80% of the participants were positive about the expression that sharing results within groups and comments about other participants helps to learn new concepts related to the activity.

The results obtained appear to demonstrate that students are eager to use and have new and more interactive ways of learning, which challenge their creativity and group organization skills. It indicates evidence of the interest in learning activities highlighting the interaction, innovation, flexibility and creativity, capabilities that these cloud-based tools seem to be easily used by the participants.

Analysis from professor's perspective suggest that while doing and planning learning activities, professors have a growing interest on using new tools and resources that are easy to use, mix and reuse.

The authors mentioned that future research should focus on incentives for motivating participation as well as on providing systems with high usability, accessibility and interoperability with the aim to create a Cloud Education Environment that are capable of doing learning orchestration.

Mak, Williams, & Mackness (2010) MOOC Experience:

The authors presented their research and findings regarding the use of blogs and forums as communication and learning tools in the "Connectivism and Connective Knowledge" MOOC, run by the University of Manitoba and led by George Siemens and Stephen Downes. The instructors designed the course to encourage learners to develop personal learning networks in which they would use tools of their choice. The research explored how the use of blogs and aggregated blogs, an open choice of media (including discussion forums), and encouragement for learners to exercise autonomy in creating their own learning networks was experienced by participants in a MOOC.

In the MOOC's forums (Moodle forums) and blogs provided established affordances, of rapid public interaction, and quieter, personal ('protected') reflection, respectively.

However, they also provided innovative, different affordances. The forums were structured largely by the learners, with minimal or no ‘facilitation’. The initial survey showed, as illustrated by the authors, that in general terms, learners predominantly used three modes of interaction: blogs, forums, or both, and developed and consolidated the mode of interaction that best suited them in the context of the MOOC, and when asked about their preferred mode of interaction, however, learners did settle out into distinct groups: bloggers, forum users, and a substantial third group who used both media.

The authors’ findings point to a maturing of e-learning users, who are creating both personal learning networks and affordances, rather than just being consumers or even ‘content creators’. They found also an emerging and growing practice across the learners, once they realise the potential of the new affordances, to develop those affordances in innovative ways, with little regard to the ‘capabilities’ required or limitations of the particular media. They also point to a maturing of social networking among learners, as a network of affordances, rather than an aggregation of discrete and particular media.

V. BEST PRACTICES

Survey with MOOC Maker Partners

An online survey with MOOC Maker partners of the consortium has been conducted. Its purpose is to collect information about their experiences of applying cloud-based tools in e-learning settings in general, and in MOOCs in particular; including its usefulness and drawbacks besides their needs, expectations and possible recommendations for improvements and a good use of it. The survey was sent to nine different partners. Six of them successfully completed the survey.

The survey was divided into the following groups of questions that cover its purpose (The main questions of the survey are listed in APPENDIX 1):

- Declaration of consent.
- General questions about the lab or institution.
- General questions about experiences in creating MOOCs.

  This group is directed only for partners with experiences in creating MOOCs.
- General questions about the offered MOOCs.

  This group is directed only for partners with experiences in creating/offering MOOCs.
- Questions about experiences of applying CBTs in MOOCs and e-learning settings.
- Questions about experiences and best practices of applying CBTs in MOOCs, including application scenarios, benefits, issues, improvements and recommendations.

  This group is directed only for partners with experiences in using CBTs in MOOCs.
- Closing.

  This group is the last group in the survey and is directed only for partners with experiences in using CBTs in MOOCs. It includes two simple questions about their desire to get informed about the survey results and their willing to provide additional information concerning experiences related to using CBTs in MOOCs.

Regarding the general experiences in creating MOOCs for the six partners out of the nine (66.66%), who completed the survey, two partners stated that they have lots of experiences in creating MOOCs, two others have medium experiences, one partner has few experiences and the last one has no experiences at all as shown in figure 11.

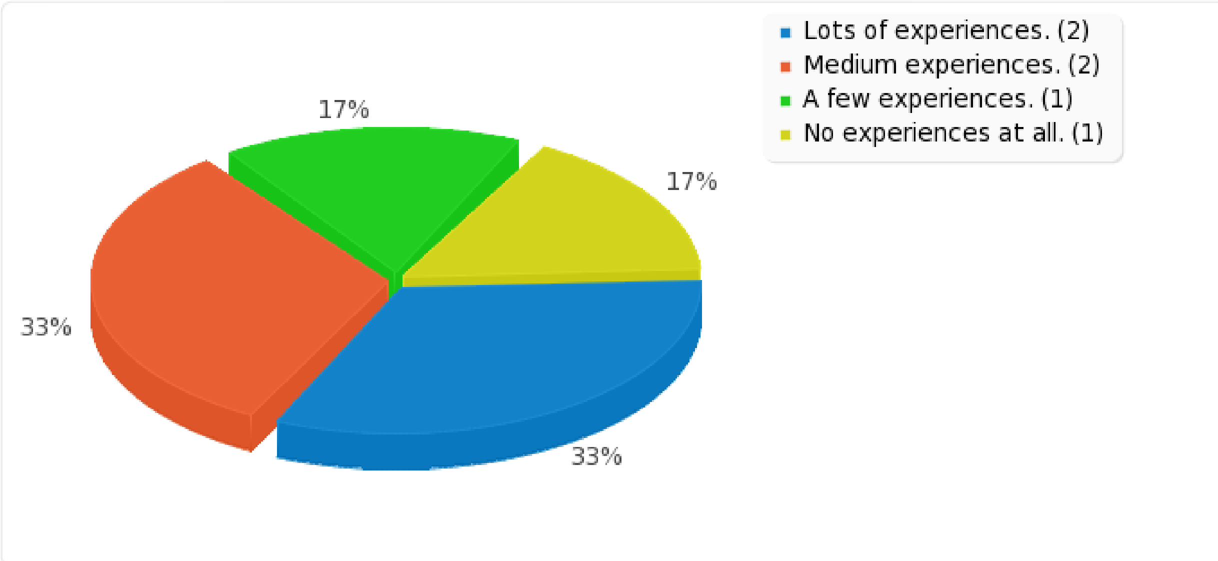

Figure 11. Partners' experiences in creating MOOCs

Two institutions are currently not actively offering or teaching MOOCs but will do in future while the others do and will continue as displayed in figure 12.

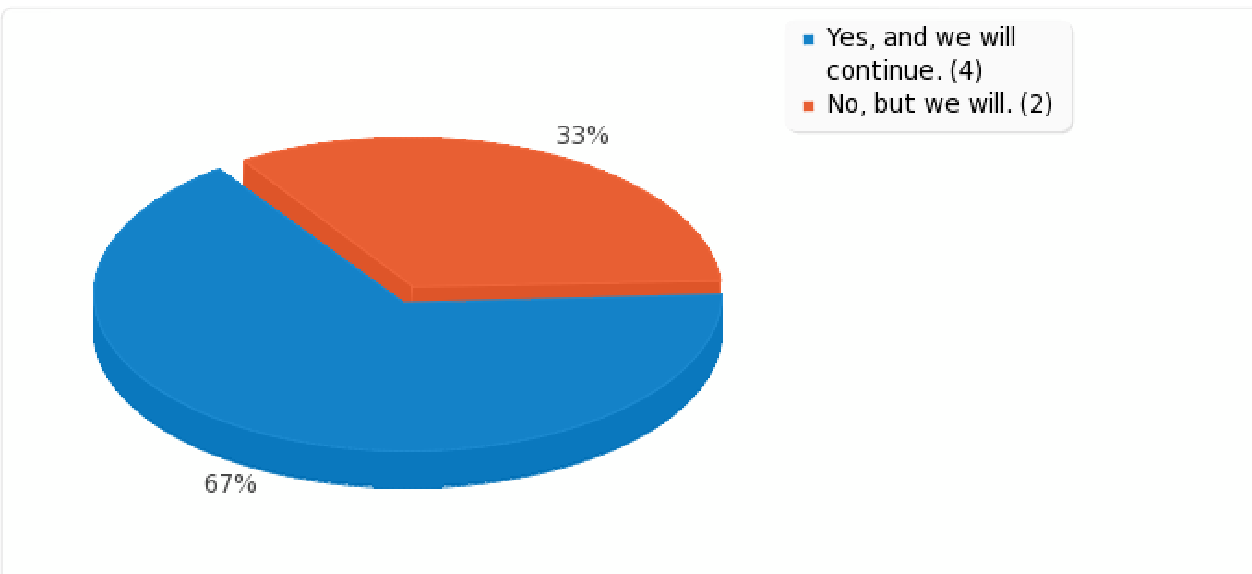

Figure 12. Is your institution or lab currently actively offering/teaching MOOCs?

The five partners out of the six (83.33%), who have experiences in creating MOOCs, created between 2 and 20 MOOCs in a time interval between 1 and 3 years, that differ depending on the partner's experience as illustrated in table 8.

Question	Partners				
	1	2	3	4	5
What are your lab's or institutions estimated experiences in creating MOOCs?	Lots of experience	Medium experience	Lots of experience	Few experience	Medium experience
For how long does your lab or institution create and offer MOOCs (in years)?	3	2	2	1	2
How many MOOCs in total has your lab or institution created?	20	15	16	2	6

Table 8. Partners' experiences in creating MOOCs

The used MOOCs platforms by the five experienced partners are: edX[1], OPENedX[2], Coursera[3], MiríadaX[4], and OpenEducation[5] as displayed in the figure bellow.

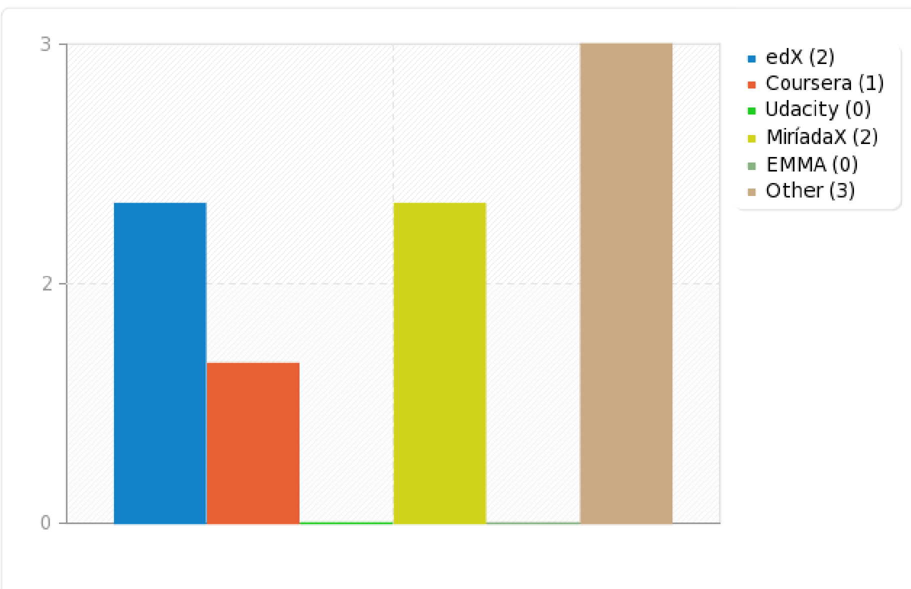

Figure 13. Used MOOCs Platforms by Partners

[1] edX (https://www.edx.org/); [2] OPENedX (https://open.edx.org/); [3] Coursera (https://www.coursera.org/); [4] MiríadaX (https://miriadax.net); [5] OpenEducation (http://www.openuped.eu);

Those five experienced partners included different types of learning activities in the offered MOOCs such as video content, presentations, simulations, mind maps, quizzes, and development and programming activities; and four of them utilized gamification strategies like badges, points, and leaderboards.

Results related to the experiences of applying CBTs in e-learning and MOOCs settings:

1. Experiences of using CBTs in general:

Five out of the six (83.33%) partners stated that they have experiences in using CBTs in general and will continue using it, while one partner has no experiences at all but needs to use it in future as shown in figure 14.

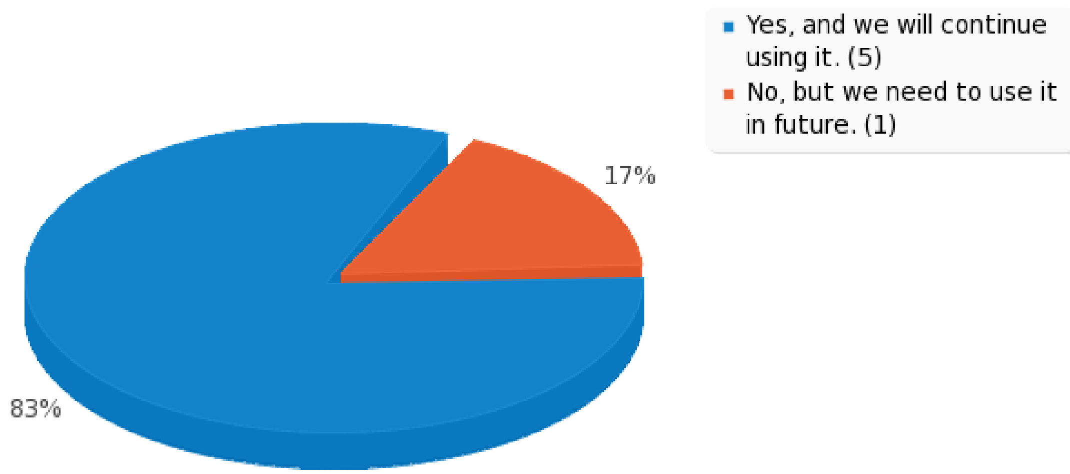

Figure 14. Partners' experiences with CBTs

The five experienced partners described shortly the scenarios and application domains of the used CBTs as follows:

- *"Programming MOOCs using IMS LTI-integrated programming environments, such as Blockly or Codeboard, and collaboration tools for sharing documents and synchronous editing."*
- *"Storage, management of activities, collaborative work, and virtual platform."*
- *"Github for example for allowing students to upload their code for assignments."*
- *"Digital literacy (high and medium education)."*
- *"Virtual Education."*

2. Experiences of using CBTs in e-learning settings:

Five out of the six (83.33%) partners stated that they have experiences in using CBTs in e-learning settings and will continue using it, while one partner hasn't used it yet but will do in future.

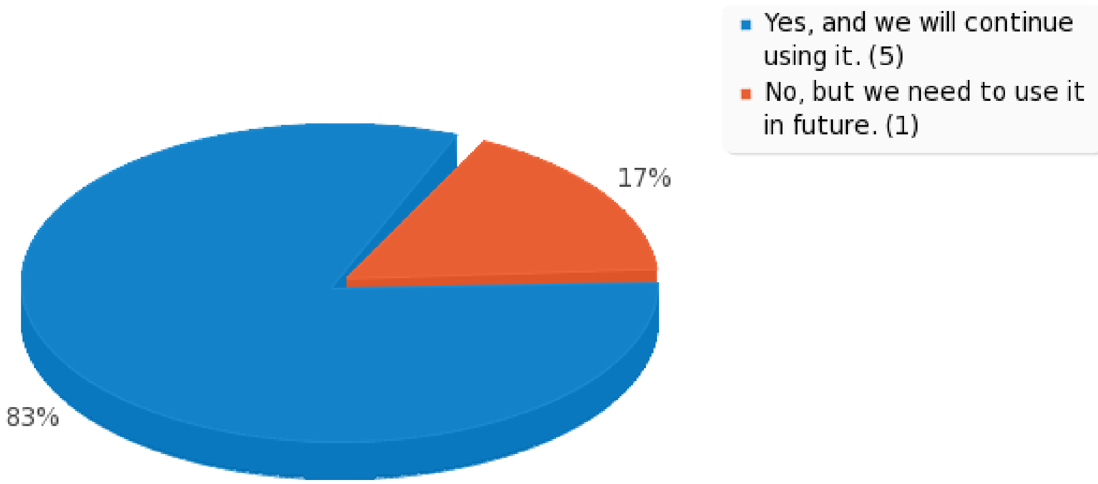

Figure 15. Partners' experiences with CBTs in e-learning settings

Three partners stated their needs to use CBTs in e-learning settings in future as follows:

- *"Platforms sometimes do not provide all the tools needed for a certain learning activity, and there is where CBTs can help close the loop. CBTs can be typically embedded in the platform as IFrames, or integrated with interoperability standards such IMS LTI."*
- *"There is a need of external tools that are not available directly in MOOCs."*
- *"MOOCs and SPOCs."*

Those 5 partners used all types of cloud-based tools mentioned in the literature, as displayed in figure 16, and all partners will make use of all types as well in future, as displayed in figure 17. They listed the tools they used as follows: Codeboard and Blockly, Google Drive, BlackBoard, One Drive, Creative Cloud Adobe, LMS .LRN, and LMS Blackboard.

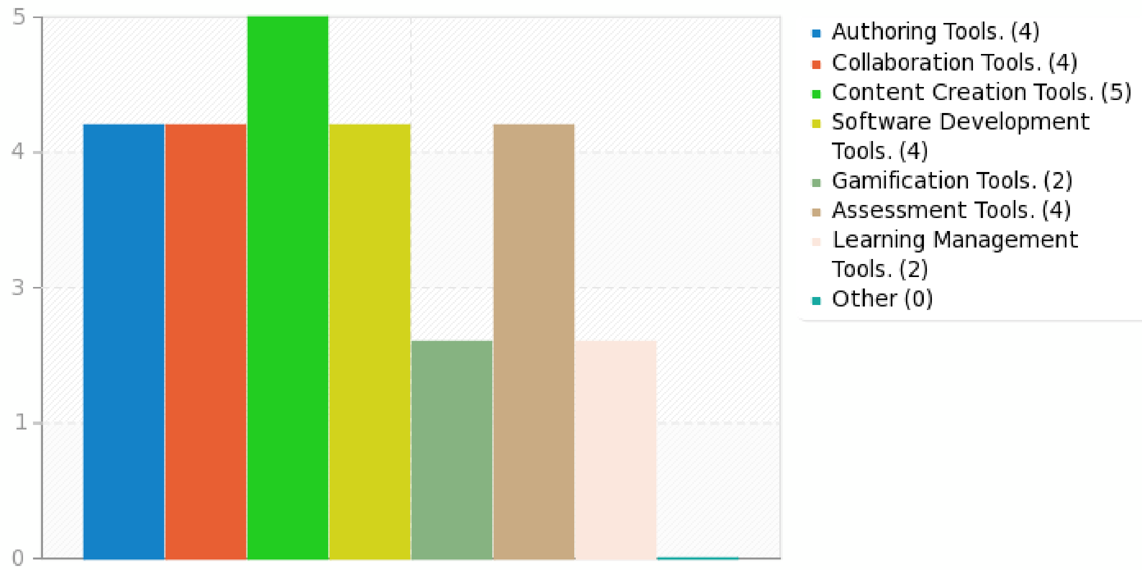

Figure 16. Types of Used CBTs in e-learning settings by Partners

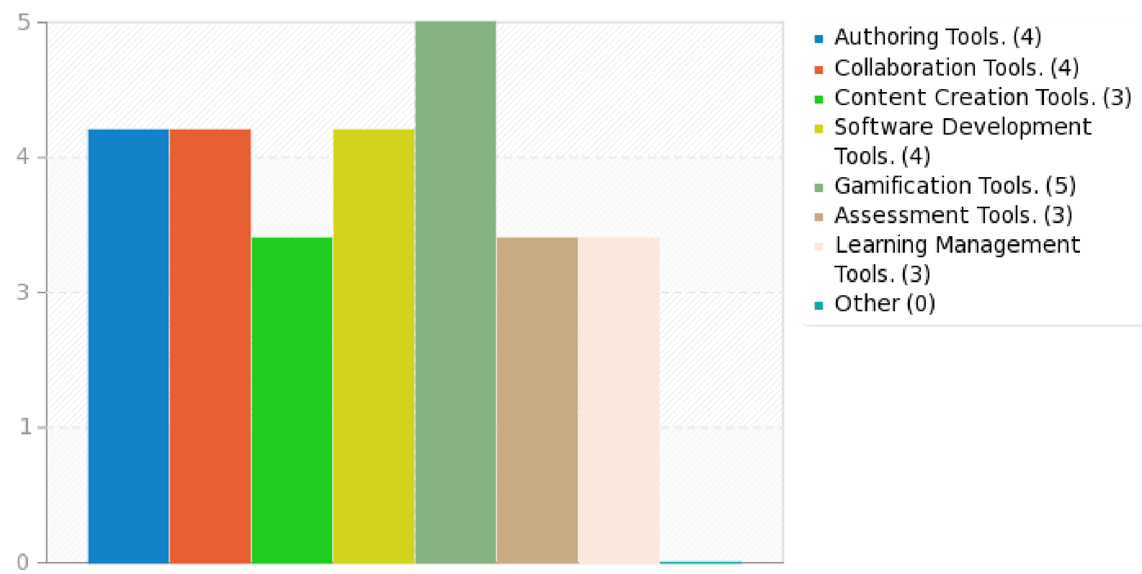

Figure 17. Types of CBTs partners want to use in future in e-learning settings

3. Experiences of using CBTs in MOOCs:

Two out of the six partners (33.33%) stated that they have experiences in using CBTs in MOOCs settings and will continue using it, while four partners haven't used it in MOOCs yet but will do in future as shown in figure 18.

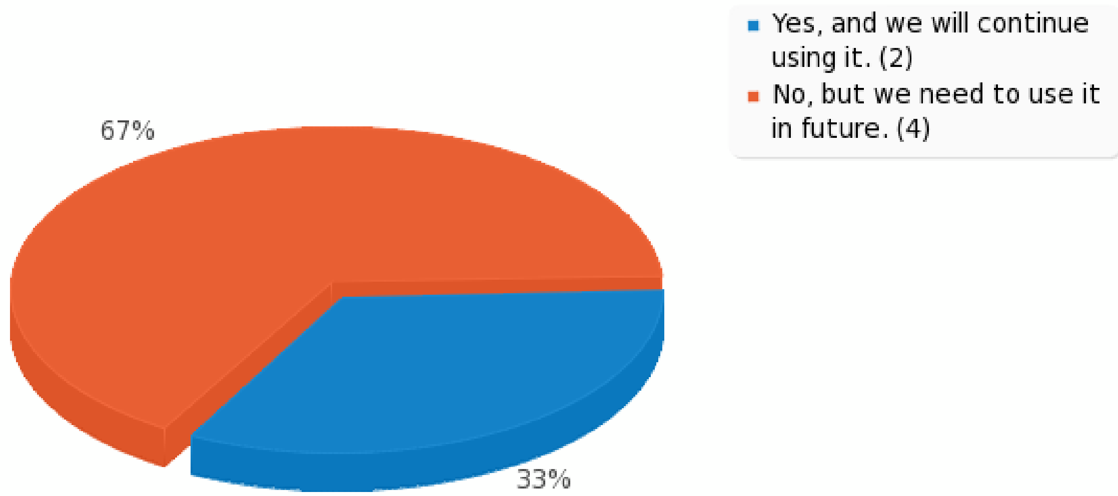

Figure 18. Partners' experiences with CBTs in MOOCs settings

Five partners stated their needs to use CBTs in MOOCs settings in future as follows:

- *"It is important that CBTs can scale up and support hundreds and thousands of learning working on the tool at the same time. That means additional servers on the tool side."*
- *"It is noteworthy that typical collaboration tools, such as Google Drive, do not support massive numbers of users working at the same time in the same instance (e.g., document)."*
- *"The use of gamification as part of the evaluation MOOCs."*
- *"Multimedia content and storage resources."*
- *"Tools for facilitating the process of video revision and evaluation of the MOOCs content."*
- *"They can complement the learning activities of the MOOCs."*
- *"Content Creation Tools, Assessment Tools."*

Those 2 partners used all types of cloud-based tools mentioned in the literature (authoring tools, collaboration tools, content creation tools, software development tools, gamification tools, assessment tools, and learning management tools), as displayed in figure 19, and all partners will make use of all types in future as displayed in figure 20.

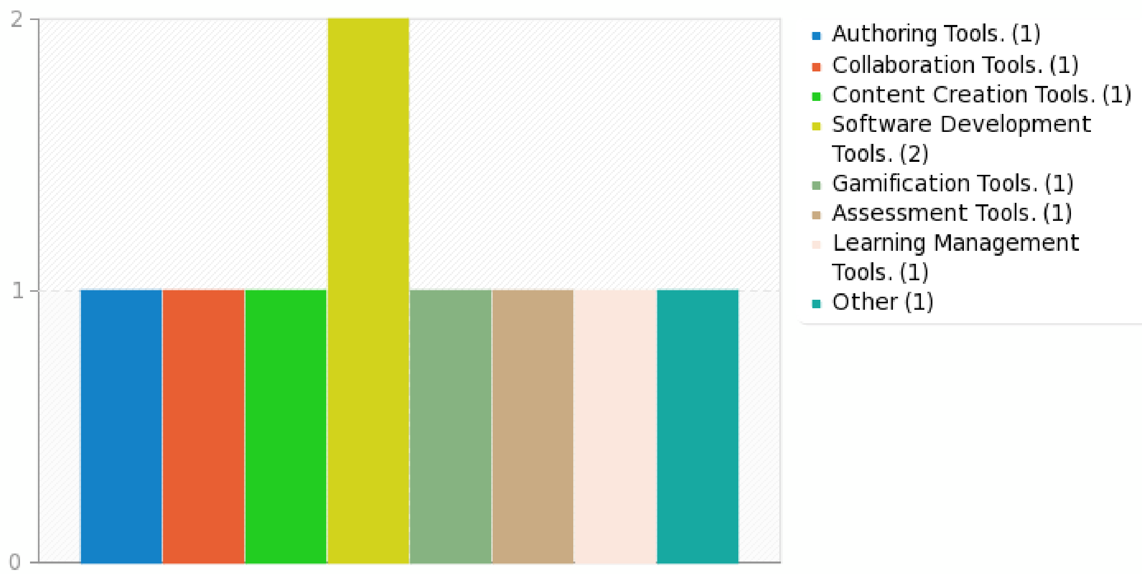

Figure 19. Types of Used CBTs in MOOCs settings by Partners

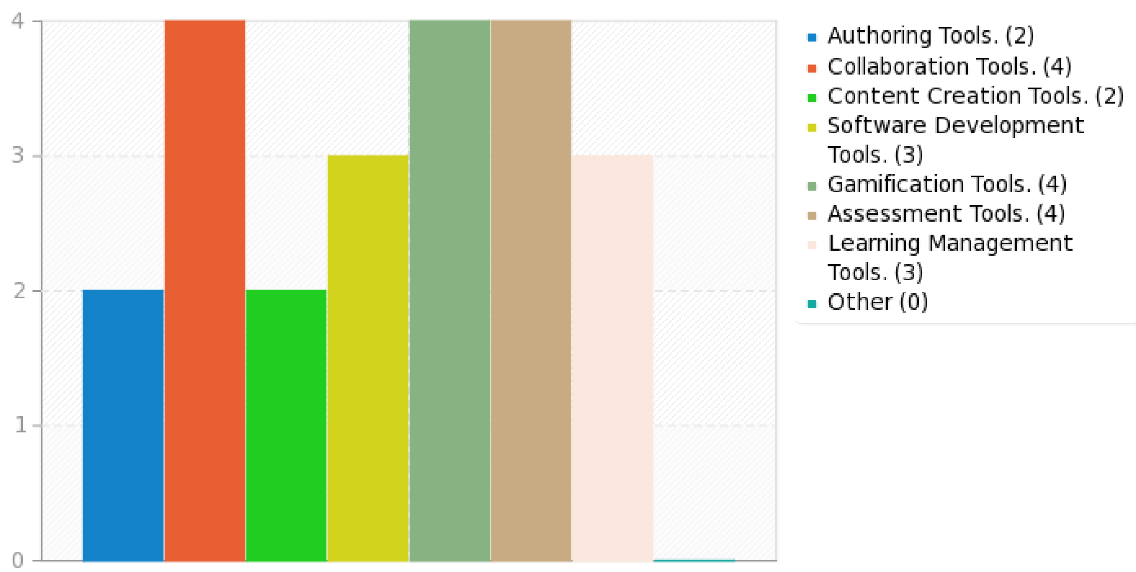

Figure 20. Types of CBTs partners want to use in future in MOOC settings

The following tables show the results of the survey for the six partners, who completed the survey, relating the benefits and issues of using cloud-based tools in MOOCs and e-learning settings for learners, teachers and tutors, and from technical and organizational perspective, with the related percentage of partners' agreement (check APPENDIX 2 for more statistical details):

Benefits for learners	Agreement %
Improved motivation to learn.	83.33%
Improved engagement.	100%
Improved knowledge sharing.	83.34%
Improved knowledge acquisition.	83.34%
Improved knowledge retention.	33.33%
Increased fun and interest in the topic.	50%
Improved collaboration.	83.34%
Improved communication skills.	50%
Improved learning skills (problem solving skills, deeper thinking skills, etc.)	83.33%
Improved achievement of learning objectives.	66.67%
Reduced time and effort for learning.	33.34%
Benefits for teachers and tutors	**Agreement %**
Better ways of delivering information and knowledge to learners.	100%
Increased interactivity in the course.	100%
Increased variety of activities that can be used.	100%
Improved assessment and evaluation of learners' performance.	100%
Decreased time and effort of preparing learning activities.	50%
Decreased time and effort of teaching.	33.33%
Increased completion rates of MOOCs.	50%
Enhanced learning process.	83.33%
Benefits from technical and organizational perspective	**Agreement %**
Reduced development, deployment, maintenance and upgrade time, effort and cost.	66.67%

Improved scalability.	66.66%
Enhanced security and privacy.	33.33%
Improved accessibility.	33.33%
Automatic upgrade.	66.67%
More storage space.	83.33%
Other benefits from partners' point of view	
"I think the benefits and drawbacks of using CBTs highly depend on the particular CBT that is integrated in the course. In general, they bring new opportunities to the teachers to better plan their courses, and become a powerful alternative to built-in activities, but this does not necessarily mean that the cognitive load for students and teachers decreases, or that the integration is a simple process."	
"Professorial training."	
"Improves and strengthens the skills of students in their careers."	
How should CBTs be used depending on partners' opinion	
"To support interaction, experimentation and group work."	
"Encourage the use within the activities of the courses."	
"Work must be articulated from the processes involved in teaching and learning."	

Table 9. Benefits of using cloud-based tools in MOOCs and e-learning settings

Problems and Issues for learners	Agreement %
Difficulty of use.	33.33%
Increased effort for learning.	16.67%
Increased time for learning.	16.67%
Decreased motivation to learn.	0%
Decreased engagement.	16.67%
Difficulty in using different CBTs in the course.	33.34%

Problems and Issues for teachers and tutors	Agreement %
Difficulty of use.	50%
Increased time for training learners on using the CBTs.	66.66%
Difficulty in choosing proper CBTs for the course.	66.67%
Less completion rates of MOOCs.	0%
Problems and Issues from technical and organizational perspective	Agreement %
CBTs Integration issues.	50%
CBTs interoperability problem.	66.67%
Security and privacy issues.	83.34%
Limited control over the CBTs.	50%
Other Problems and Issues from partners' point of view	
"Again, the problems depend on the particular CBTs. One of the most important one is the limitation to include activities that are implemented on CBTs as part of the evaluation of students' learning, as most activities do not provide a communication channel back to the platform where the course is taking place."	
"Cost of licenses".	
Partners negative experiences	
"At the beginning some students and teachers don´t understand the use of tools."	

Table 10. Problems and issues of using cloud-based tools in MOOCs and e-learning settings

Results related to experiences and best practices of applying CBTs in MOOCs:

Only two partners out of six (33.33%) have experiences related to the use of CBTs in MOOCs as mentioned previously. They used edX and OpenEducation MOOCs platforms and utilized different types of cloud-based tools. The following table shows the information collected from those two partners related to their experiences.

Question	Answer
CBTs application scenario(s):	Starting to program (first steps) using a visual environment and without the need of installing anything in the learners' laptop.
	Virtual Education.
Benefits of using CBTs in this experience(s) for learners:	Easy to use, interactive, seamless use of the tool.
	New educational alternative. Educational content according to the needs of students. Increased motivation and interaction.
Benefits of using CBTs in this experience(s) for teachers and tutors:	New possibilities for hands-on activities.
	Higher Quality of content. Allows greater collaboration and learning. Reach more students.
Benefits of using CBTs in this experience(s) from technical and organizational perspective:	Easy to integrate through the IMS LTI standard.
	Comprehensiveness. Improved provisioning. It requires less technical infrastructure requirements.
Drawbacks and problems faced in using CBTs in this experience(s) for learners:	In our experience, we didn't have problems.
Drawbacks and problems faced in using CBTs in this experience(s) for teachers and tutors:	In In our experience, we didn't have problems.
Drawbacks and problems faced in using CBTs in this experience(s) from technical and organizational perspective:	In In our experience, we didn't have problems.
What could be improved for further applications, from learners' aspect?	None at the moment, we are in the initial phase of expansion of the service.

What could be improved for further applications, from teachers and tutors' aspect?	None at the moment, we are in the initial phase of expansion of the service.
What could be improved for further applications, from technical and organizational aspect?	Connection between the tool and the evaluation system in the platform.
	None at the moment, we are in the initial phase of expansion of the service.
What recommendations can you summarize for other groups using CBTs in MOOCs, from learners' aspect?	None at the moment, we are in the initial phase of expansion of the service.
What recommendations can you summarize for other groups using CBT in MOOCs, from teachers and tutors aspect?	Finding appropriate tools and informing learners how to use them, maybe with a brief video or document.
	None at the moment, we are in the initial phase of expansion of the service.
What recommendations can you summarize for other groups using CBT in MOOCs, from technical and organizational aspect?	Helping teachers to find the appropriate tools for each course.
	None at the moment, we are in the initial phase of expansion of the service.

Table 11. Experiences and best practices of applying CBTs in MOOCs

Findings from Literature

This literature has been done in order to survey and analyse the state-of-the-art in MOOCs research and experiences related to the use of CBTs in MOOCs. The main purpose is to get thorough information about how much and how effectively CBTs are used in MOOCs during the last few years, what are the added values and advantages of using it besides the drawbacks and issues faced by its use, providing recommendations for better improvements in future. The literature survey has been conducted depending on more than 50 papers to cover the most important and related topics, including:

- The available cloud-based tools that can be used in MOOCs, with examples and its learning objectives.
- The CBTs interoperability issue, which is one of the main issues faced by using CBTs in MOOCs and online learning, with the available solutions.

- The existing research work, initiatives and experiences of using CBTs in MOOCs, including some examples and findings.

The selection of the papers depended on how much it's related to the research topics and on its recency. Among the selected papers, 9 papers were used for the related research work, initiatives and experiences of using CBTs in MOOC learning settings, including the related work of our MOOC-Maker partners. The authors in those papers presented their experiences and findings concerning the usefulness of cloud-based tools in MOOCs for learning. Information about those papers with its related experience contribution can be summarized in the following table:

Authors	Title	Year	Published In
ALARIO-HOYOS, Carlos; KLOOS, Carlos DELGADO; ESTÉVEZ-AYRES, Iria; FERNÁNDEZ-PANADERO, Carmen; BLASCO, Jorge; PASTRANA, Sergio; SUÁREZ-TANGIL, Guillero; VILLENA-ROMÁN, Julio.	Interactive activities: the key to learning programming with MOOCs.	2016	The European stakeholder summit on experiences and best practices in and around MOOCs (EMOOCS 2016).
Contribution: The authors presented their experience of using CBTs in one MOOC deployed in edX at Universidad Carlos III de Madrid. The MOOC was designed to enhance learner's interactivity with the learning contents through different activities using cloud-based tools. They presented their experience results from learners' perspective regarding the usefulness of CBTs for learning in MOOCs.			
Borras-Gene, Oriol; Martinez-Nuñez, Margarita; Fidalgo-Blanco, Ángel.	New Challenges for the Motivation and Learning in Engineering Education Using Gamification in MOOC.	2016	The International Journal of Engineering Education.
Contribution: The authors presented a gamification cooperative MOOC model (gcMOOC) that can be applied in Engineering courses at the Technical University of Madrid on the MOOC platform MiríadaX. The model incorporates virtual communities and gamification methodologies (contests and obtaining additional badges) using cloud-based tools and applications to increase learners motivation and collaboration. They investigated the factors that influence motivation, collaboration, learning and completion rates in gcMOOC, and suggested a set of practical recommendations and tools for improvements.			
Morales Chan, Miguel; Hernandez Rizzardini, Rocael; Barchino Plata, Roberto;	MOOC Using Cloud-based Tools: A Study of Motivation and Learning Strategies in Latin	2015	International Journal of Engineering Education.

Amelio Medina, Jose.	America.		
Contribution: The authors described the motivational and cognitive learning strategies used by students in one MOOC deployed by their Telescope project at Galileo University in Guatemala, using a variety of free cloud-based tools for learning. They presented their experience results about the effectiveness of using CBTs in MOOCs.			
Rizzardini, Rocael Hernández; Gütl, Christian; Chang, Vanessa; Morales, Miguel.	MOOC in Latin America: Implementation and Lessons Learned.	2014	The 2nd International Workshop on Learning Technology for Education in Cloud,
Contribution: The authors presented a MOOC learning experience with cloud-based tools for deployment of learning activities at Galileo University in Guatemala. The central access point for the MOOC was an LMS developed at and for Galileo University depending on .LRN LMS. They evaluated the MOOC experience considering emotional, motivational and usability aspects.			
Freire, Manuel; Blanco, Ángel del; Fernández-Manjón, Baltasar.	Serious games as edX MOOC activities.	2014	IEEE Global Engineering Education Conference, EDUCON.
Contribution: The authors explored the integration of serious games as a new type of MOOC activity, specifically integrating EADVENTURE serious games into edX. They analyzed some of the issues that must be addressed in order to achieve this integration, and evaluated the experience but in a test environment not in an actual MOOC.			
Hernández, Rocael; Guetl, Christian; Amado-Salvatierra, Hector R.	Cloud Learning Activities Orchestration for MOOC Environments.	2014	Learning Technology for Education in Cloud. MOOC and Big Data: Third International Workshop.
Contribution: The authors presented an approach to using cloud-based tools for MOOCs applying a new version of their architecture of 'cloud learning activities orchestration' (CLAO). They presented their results about CLAO effectiveness for the use of learning activities in the cloud for MOOC experiences.			
Rizzardini, Rocal Hernandez; Gütl, Christian; Chang, Vanessa;	MOOCs Concept and Design using Cloud-based Tools: Spanish MOOCs Learning Experi-	2013	The Sixth International Conference of MIT's Learning International Networks Consortium

	ences.		(LINC).
Contribution: The authors described two MOOCs experiences at Galileo University, using cloud-based learning tools and online tools for collaboration, interaction, and learning in the MOOC environment. Both MOOCs were built on the .LRN LMS and utilized different CBTs. They presented their experience results regarding the usefulness of CBTs in MOOCs.			
Rizzardini, Rocael Hernández; Amado-salvatierra, Hector; Guetl, Christian;	Cloud-based Learning Environments: Investigating Learning Activities Experiences from Motivation, Usability and Emotional Perspective.	2013	The 5th International Conference on Computer Supported Education.
Contribution: The authors described a cloud-based learning experience in Latin-American countries. They presented the design, deployment and evaluation of learning activities using CBTs. The experiences presented are from Galileo University in Guatemala using .LRN and Moodle LMS for the MOOCs. The authors reported findings from motivational attitudes, emotional aspects and usability perception.			
Mak, Sui Fai John; Williams, Roy; Mackness, Jenny;	Blogs and forums as communication and learning tools in a MOOC.	2010	The 7th International Conference on Networked Learning.
Contribution: The authors presented their research and findings regarding the use of blogs and forums as communication and learning tools in a MOOC at University of Manitoba.			

Table 12. Used papers for the related research work and experiences of using CBTs in MOOC learning settings

Based on the selected literature, the used MOOC Platforms in these experiences were edX[1], MiríadaX[2], .LRN LMS[3], Moodle LMS[4], and the Telescope project[5]. The authors used a variety of CBTs from all types mentioned in this literature survey, such as:
Blocky[6], Codeboard[7], Greenfoot[8], Google+[9], Instagram[10], Google Hangout[11], YouTube[12], Mozilla Open Badges[13], OSQA Discussion Forum[14], Google Docs[15], Google Presentations[16],

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1 edX (https://www.edx.org/); 2 MiríadaX (https://miriadax.net/); 3 .LRN LMS (http://dotlrn.org/);
4 Moodle LMS (https://moodle.com/cloud/); 5 Telescope Project (http://telescopio.galileo.edu/);
6 Blocky (https://developers.google.com/blockly/); 7 Codeboard (https://codeboard.io);
8 Greenfoot (http://www.greenfoot.org); 9 Google+(https://plus.google.com/);
10 Instagram (https://www.instagram.com); 11 Hangout (https://hangouts.google.com/);
12 YouTube (https://www.youtube.com/); 13 Mozilla Open Badges (http://openbadges.org/);
14 OSQA (www.osqa.net); 15 Google Docs (https://docs.google.com);

Podcast[17], Prezi[18], Dipity[19], Cacoo[20], Educaplay[21], Mindmeister[22], Bubble.us[23], Slideshare[24], Office[25], Milaulas[26], eAdventure[27], Macincloud[28], iOS SDK[29], WikiSpaces[30], Timetoast[31], Issuu[32], GoAnimate[33], Xtranormal[34], Pixton[35], Facebook[36], Delicious bookmarking[37] and Gloster[38].

Findings from the previously mentioned experiences can be summarized as follows (see section IV – Cloud-Based Tools in MOOC Settings for more details):

Advantages and Effectiveness of Using CBTs in MOOCs:

1. For learners:

- Learners have positive perception about the usefulness of having a large number of interactive learning activities for learning in MOOCs, for certain topics like programming, and a very positive feedback of the selection of included CBTs.
- Learners see each learning activity in the MOOC as relevant to their own contexts, and they see themselves as intrinsically motivated and as having capabilities to perform well in the course.
- Learners believe that their efforts in the MOOC will bring them positive outcomes, that they will study more strategically and effectively, and that this will lead them to success and mastery in the course.
- Learners' attitudes towards using CBTs in MOOCs, from motivational and emotional aspects, are highly ranked.
- Learners are not only able to use the cloud-based tools, but they are also capable of meeting the instructional objectives.
- Learners indicated positive learning outcomes using CBTs.
- Learners show more engagement in the course.
- Most learners are positive about gamification and social media use in education and especially in MOOCs.

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[16] Google Presentations (https://www.google.com/slides);
[17] Podcast (http://www.apple.com/itunes/podcasts/); [18] Prezi (https://prezi.com/);
[19] Dipity (http://www.dipity.com/); [20] Cacoo (https://cacoo.com/);
[21] Educaplay (https://www.educaplay.com/); [22] Mindmeister (https://www.mindmeister.com/);
[23] Bubble.us (https://bubbl.us/); [24] Slideshare (http://www.slideshare.net/);
[25] Office (https://portal.office.com/); [26] Milaulas (https://www.milaulas.com/);
[27] eAdventure (http://e-adventure.e-ucm.es/); [28] Macincloud (http://www.macincloud.com/);
[29] iOS SDK (https://developer.apple.com/xcode/); [30] WikiSpaces (https://www.wikispaces.com/);
[31] Timetoast (https://www.timetoast.com/); [32] Issuu (https://issuu.com/);
[33] GoAnimate (https://goanimate.com/); [34] Xtranormal (http://www.xtranormal.com/);
[35] Pixton (https://www.pixton.com/); [36] Facebook (https://www.facebook.com/);
[37] Delicious bookmarking (http://del.icio.us/); [38] Gloster (https://www.gloster.com/);

- Gamification tools aid learners to deepen their learning and involve them in the course, increasing their motivation to learn.
- Using virtual community in MOOCs with gamification elements (contests and obtaining additional badges) not only stimulates social interactions between learners but also increases learners' motivation to learn and contributes to achieve the learning objectives.
- The inclusion of serious games into MOOCs adds significant value for both courses and games, providing highly interactive content that can engage students and them to assess and apply their knowledge in an immersive scenario.
- Learners are eager to use and have new and more interactive ways of learning, which challenge their creativity and group organization skills.
- Learners interest in the learning activities increases, including the interaction, innovation, flexibility and creativity.
- Increased learner collaboration.
- Improved communication skills.
- Enhanced knowledge sharing and acquisition.
- Most of the tools are easy to use.

2. **<u>For teachers and tutors:</u>**

- Most of the tools are easy to use.
- Increased flexibility for teachers and tutors to select from a wide range of cloud based tools that suit the learning objectives and can be reached at any time.
- Using CBTs help to make the course more dynamic, interactive and stimulating.
- Using cloud-based learning activities help to foster the learners' interaction with the learning contents.
- Using cloud-based learning activities increases the fun and interest in the course and improves knowledge sharing.
- Activities with CBTs can be very interactive and innovative.
- Cloud-based learning activities promote meaningful learning, learning by doing, allowing flexibility in learning.
- Teachers and tutors have a growing interest in using new tools and resources that are easy to use, mix and reuse.
- Different types of assessment tools that tutors and teachers can choose from to assess and track learners' performance.

- CBTs facilitate authoring flexibility, content creation, and the generation of new knowledge.
- Improved learners' engagement in the course.
- Gamification tools may help to increase the completion rates of the MOOCs.
- Gamification could have great potential in MOOCs learning process.

3. From technical and organizational perspective:

- CBTs show high scalability.
- CBTs are accessible anytime and from anywhere.
- Many tools are free to use.

Issues and Problems of Using CBTs in MOOCs:

1. For learners:

- Some learners need time to get to know the tools and how to use it.
- Some learners think that it's difficult to complete the learning activities.
- Allowing learners to choose from a variety of CBTs may impede their learning.
- The great amount of resources generated by the collaborative activities leads to information overload in the virtual community, and results in a massive duplication of contents, and problems or difficulties for learners in filtering, classifying and selecting the accurate information.

2. For teachers and tutors:

- Dropout rate in MOOCs is still high in spite of using CBTs.
- Teachers and tutors need to learn how to use the CBTs to create learning activities.
- The workload may increase for creating cloud-based learning activities.
- Training/tutorial videos/written instructions are needed to teach learners how to use the CBTs.
- The time needed for teaching and following the course may increase.

3. From technical and organizational perspective:

- If a tool is somewhat detached from the learning environment, even if its use is required, it will not be used as expected or even not used at all.

- Issues related to integration, interoperability and orchestration of CBTs.
- Not all tools are free to use and some tools include Ads.
- Some of the tools are not accessible and can't be used in all operating systems.

Improvements:

Improvements applied by authors to overcome some issues related to using CBTs in MOOCs can be summarized as follows:

- 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 problem.

Recommendations:

Authors' recommendations in terms of using CBTs in MOOCs can be summarized as follows:

- When using cloud-based tools, the user needs to be conducted and guided by the system with the corresponding instructions on the usage of the tool.
- Some sort of summative evaluations and grades have to be embedded into the learning activity to ensure full exploitation of the learning experience as it was conceived by the teacher.
- If a learning activity uses more than one cloud-based tool, the system must require the use of all of them: if not, the learner will tend to use just the tool presented for the final work.
- Some cloud-based learning activities were perceived by learners as easier than others so some CBTs have to be used in advanced stages of the MOOC.
- There should be a balance between the number of interactive learning activities and the workload for tutors/teachers to create it.
- Activities should be carefully designed and developed to achieve a satisfactory level of quality.

- Restrict learners to a number of pre-selected CBTs because leaving the choice for them to choose from a variety of CBTs may impede their learning.
- Tutors and teachers need help to choose the right cloud-based tools for the course.

VI. RECOMMENDATIONS AND FINDINGS

Many required tools for creating interactive learning activities and learning contents are not directly provided by MOOCs platforms, as derived from literature and MOOCs creators and experts, and which highly motivates making use of cloud-based tools to support the creation of more dynamic, interactive and stimulating course. The presented literature has shown that a wide variety of innovative cloud-based tools can be used in MOOCs with a large potential and acceptance for both learners and teachers. It was shown that using cloud-based tools in MOOCs and online learning has a valuable impact on improving the learning process with a wide range of advantages and benefits on different aspects. Results from related experiences presented in the literature showed that cloud-based tools have a great impact on improving learners' motivation to learn and complete the course, and help to reduce the drop-out rates in MOOCs. It has a big potential to improve learners' engagement and learning outcomes, and learners show better performance and better achievements using cloud-based learning activities.

Findings and recommendations derived from the conducted literature and the achieved survey with MOOC Maker partners can be summarized in the following tables and classified on three aspects: learners (Table 13), tutors and teachers (Table 14), and technical and organizational (Table 15) aspects. Each table contains summarized information related to the effectiveness and advantages, and issues and drawbacks of using cloud-based tools in MOOCs on one aspect with the related recommendations for an efficient use of it.

Findings and Recommendations From Learners' Aspect	
Benefits	
1	Positive attitudes towards using CBTs in MOOCs.
2	Excitement to use and have new and more interactive ways of learning, which challenge learners' creativity and group organization skills.
3	Improved motivation to learn, study and complete the course.
4	Better performance in the course.
5	More positive learning outcomes.
6	Improved achievement of the learning objectives.
7	Improved involvement and engagement in the course.
8	Improved social interactions between learners.
9	Increased fun and interest in the learning activities, including the interaction,

	innovation, flexibility and creativity.	
10	Improved collaboration.	
11	Improved communication skills.	
12	Improved knowledge sharing.	
13	Improved knowledge acquisition.	
14	Improved learning skills such as problem solving skills.	
15	Improved higher-order thinking skills, such as analyzing, evaluating, and creating.	
16	Increased interactivity in the course.	
17	Improved group work skills.	
18	Ease of collaborative work and interaction.	
19	Improved and strengthened skills for career.	
20	Improved sharing and reusability of learning resources on the web.	
21	Ease of use of most tools.	
22	Less software and hardware requirements for using the tools.	
Issues and Drawbacks		**Recommendations**
1	The time needed to get to know the tools and how to use it.	▪ Provide training, clear tutorial videos or written instructions to teach learners how to use the tools as quickly as possible. ▪ Conduct and guide the learner while using the cloud-based tools with corresponding clear instructions on how to use it.
2	Difficulty in completing the learning activities as conceived by some learners.	▪ Use the CBT in a proper stage of the MOOC depending on its difficulty. Some cloud-based learning activities were perceived by learners as more difficult than others so some CBTs have to be used in advanced stages of the MOOC. ▪ Design and develop activities carefully to achieve a satisfactory level of quality and difficulty.

3	Allowing learners to choose from a variety of CBTs may impede their learning.	Restrict learners to a number of pre-selected CBTs.
4	Difficulties in filtering, classifying and selecting the accurate information in virtual communities because of the great amount of resources generated by the collaborative activities, which leads to information overload and massive duplication of contents.	Restrict communication to only one tool/one virtual community to ensure a simple way of communication that can be controlled and followed more easily.

Table 13. Findings and recommendations of using CBTs in MOOCs from learners' aspect

Findings and Recommendations From Tutors and Teachers' Aspect	
Benefits	
1	Powerful alternative to built-in activities especially that many required tools for learning activities are not provided directly by MOOCs platforms.
2	Better ways of delivering information and knowledge to learners.
3	Increased flexibility to select from a wide range of CBTs that suit the learning objectives and can be reached at any time.
4	Increased variety of activities that can be created and used in MOOCs.
5	New opportunities for tutors and teachers to better plan their courses.
6	Increased interest in using new tools and resources that are easy to use, mix and reuse.
7	More dynamic, interactive and stimulating course.
8	More interactive and innovative learning activities.
9	Higher quality of content.
10	Enhanced learner's interaction with the learning content.
11	Improved assessment and evaluation of learners' performance.
12	Higher flexibility in learning, learning by doing.
13	Increased fun and interest in the course.

14	Improved knowledge sharing.
15	Improved authoring flexibility, content creation, and generation of new knowledge.
16	Rapid creation of engaging and interactive learning content.
17	Improved learners' engagement in the course.
18	Ease of collaborative work and interaction.
19	Enhanced completion rates of MOOCs.
20	Enhanced learning process.
21	Improved virtual learning environments.
22	Ease of use of most tools.
23	Less software and hardware requirements for using the tools.

Issues and Drawbacks		**Recommendations**
1	Dropout rate in MOOCs is still high.	▪ Make use of gamification tools to reduce the dropout rate in MOOCs. ▪ Embed summative evaluations and grades into the learning activity to ensure full exploitation of the learning experience and to motivate learners to finish the activities.
2	The time needed to learn how to use the CBTs to create learning activities.	Provide training, tutorial videos or written instructions to help teachers and tutors to use the CBTs as quick as possible.
3	Difficulty in using some tools.	Provide help and guidance for teachers and tutors to use the tools, either by training, tutorial videos or written instructions.
4	The workload may increase for creating cloud-based learning activities.	▪ Balance between the number of interactive learning activities and the workload of creating it. ▪ Restrict learners to a number of preselected CBTs.
5	Training, tutorial videos or written instructions are needed to teach	▪ Provide training, tutorial videos or written instructions to teach learners how

	learners how to use the CBTs.	to use the tools. ▪ Conduct and guide the learner while using the cloud-based tools with corresponding instructions on how to use it.
6	Increased time for training learners on using the CBTs.	Provide tutorial videos or written instructions to teach learners how to use the tools, this would save tutors and teachers' time especially that it's re-usable.
7	The time needed for teaching and following the course and learners may increase.	Balance between the number of interactive learning activities and the workload it requires.
8	Difficulty in choosing proper CBTs for each course.	Provide help and guidance for tutors and teachers to choose appropriate cloud-based tools for each course.
9	Limitation on including cloud-based activities as part of the evaluation of students' learning, as most activities do not provide a communication channel back to the platform where the course is taking place.	▪ Make a connection between the tool and the evaluation system in the platform for better learners' assessment. ▪ Improve the communication between platforms and CBTs for a richer and holistic learning experience.
10	Some collaboration tools, such as Google Drive, do not support massive numbers of users working at the same time in the same instance (e.g., document).	Choose appropriate tools that suit the learning objectives. When there's no possibility for massive collaboration, smaller group work would be feasible.

Table 14. Findings and recommendations of using CBTs in MOOCs from tutors and teachers' aspect

Findings and Recommendations From Technical and Organizational Aspect	
Benefits	
1	High scalability.
2	Accessibility anytime anywhere.
3	Many tools are free to use.
4	Most tools are easy to use.

5	Reduced development, deployment, maintenance and upgrade time, effort and cost.	
6	Automatic upgrade.	
7	More storage space.	
8	Less software and hardware requirements for using the tools.	
9	Easy of integrate through the IMS LTI standard.	
Issues and Drawbacks		**Recommendations**
1	CBTs interoperability and integration issues.	Use the available interoperability standards or systems for CBTs integration and interoperability, like IMS LTI standard.
3	If a tool is somewhat detached from the learning environment, even if its use is required, it will not be used as expected or even not used at all.	Integrate the tool into the learning environment.
	If a learning activity uses more than one cloud-based tool, the learner might tend to use just the tool presented for the final work.	The system must require the use of all the tools.
4	Security and privacy issues.	Assure data protection, secure authentication, authorization, and other identity and access management functions.
5	Limited control over the CBTs.	Achieving CBTs interoperability enhances the control over CBTs.
6	Not all tools are free to use – Cost of license for some tools.	There's a huge variety of CBTs that can be used for learning activities with lots of alternatives for each one, so choose properly the right tools for your goals.
7	Some tools include Ads.	
8	Some tools don't work on all operating systems.	

Table 15. Findings and recommendations of using CBTs in MOOCs from technical and organizational aspect

VII. SUMMARY

Massive Open Online Courses (MOOCs) have expanded rapidly and gained significant popularity with a broad acceptance among students, educators and educational institutions over the last years. MOOCs offer new learning opportunities in a wide range of topics to a huge number of learners from a wide variety of backgrounds, without cultural or financial restrictions and with a global access anytime anywhere. Those factors make MOOCs increasingly popular and interesting for learners from all over the world. Many well-known universities and institutions nowadays are offering a large number of MOOCs and having hundreds of thousands of registrations.

Learning activities are an important part of MOOCs. It motivates learners to be actively engaged in the learning process and helps them to achieve the desired learning objectives. Learning activities in MOOCs can be video contents, presentations, simulations, mind maps, quizzes, and any other type of activities that could help to improve learners' knowledge acquisition, motivation and achievements. Many required tools for creating learning activities in MOOCs are not provided directly by MOOCs platforms, which make the cloud-based tools (CBTs) a powerful alternative and complementary to the built-in activities especially with its wide range of possibilities and advantages. A variety of useful CBTs can be used in MOOCs with a large potential and acceptance for both learners and teachers.

This literature survey provides comprehensive information about how much and how effectively cloud-based tools are and can be used in MOOCs, what are the added values and advantages of using it besides the drawbacks and issues faced by its use, providing recommendations for better improvements in future.

The report starts with brief background information about the main discussed concepts in the literature including MOOCs concept and benefits, Cloud Computing in Education with its advantages and challenges, and the gamification concept with its strategies and benefits for learning. Then a detailed classification of cloud-based tools' types has been presented according to its use and purposes, based on an intensive literature survey, where benefits and examples for each type has been displayed with the learning objectives that it can be used for.

A little focus has been given to the cloud-based tools interoperability issue since it is one of the main issues faced by using CBTs in online learning and MOOCs. It has been discussed briefly with the available solutions for it.

To give some insight into the existing research work, initiatives and experiences of using cloud-based tools in MOOC learning settings, a literature review has been conducted and presented, showing some selected examples with findings related to the effectiveness and usefulness of CBTs in MOOCs. And to get more profound information that supports the goal of the report, a survey with MOOCs creators and experts has been conducted and presented in details with a deep analysis of the results and a discussion of the findings with recommendations.

Finally, some selected findings, derived from the conducted literature and the achieved survey, regarding the benefits of using cloud-based tools in MOOCs with the problems and issues faced by its use, supported by related improvements and recommendations, are presented and classified on three aspects: learners, teachers and tutors, and technical and organizational aspects.

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APPENDIX 1

Survey with MOOC Maker Partners

In the following, the main questions of the conduced survey with MOOC Maker partners with the title "The Application of Cloud-Based Tools (CBTs) in MOOCs", are listed:

1. General Information

- Name of the institution
- Name of the department or lab
- Country of the institution
- City
- What are your lab's or institutions estimated experiences in creating MOOCs?
- Is your institution or lab currently actively offering/teaching MOOCs?

2. Experiences of creating MOOCs

"This section is only for who has any experiences in creating MOOCs"

- Which platforms have you used for the MOOCs?
- For how long does your lab or institution create and offer MOOCs?
- How many MOOCs in total has your lab or institution created?

3. Information about the offered MOOCs

"This section is only for who has any experiences in creating/offering MOOCs"

- In which languages are the MOOCs offered?
- What are the fields / subjects of the offered MOOCs (e.g. Mathematics, Chemistry, Physics, Biology, Life Science, ...)
- How sophisticated are the offered MOOCs?
- What types of learning activities offered in the MOOCs?
- What types of gamification strategies used in the MOOCs? (If there's any)

4. Experiences of Applying CBTs in MOOCS and e-learning settings

- Has your institution any experiences with CBTs?

- In case your institution has an experience, list the scenarios and application domains:
- Have you used CBTs in any e-learning settings?
- In case you don't want to use CBTs in future in e-learning settings, what are the reasons?
- In case you want to use CBTs in future in e-learning settings, what are your needs?
- What types of CBTs have you used in e-learning settings? (If there's any)
- Please name the CBTs you have used in e-learning settings (if there's any).
- What types of CBTs would you like to use in future in e-learning settings? (If there's any)
- Have you used CBTs in MOOCs settings?
- In case you don't want to use CBTs in future in MOOCs settings, what are the reasons?
- In case you want to use CBTs in future in MOOCs settings, what are your needs?
- What types of CBTs have you used in MOOCs settings? (If there's any)
- Please name the CBTs you have used in MOOCs settings (if there's any).
- What types of CBTs would you like to use in future in MOOCs settings? (If there's any)
- What do you think are the benefits of using CBTs in MOOCs and e-learning settings for learners?

  (Likert scale: Strongly Disagree (1), Disagree, Neutral, Agree, Strongly Agree (5))

  - Improved motivation to learn.
  - Improved engagement.
  - Improved knowledge sharing.
  - Improved knowledge acquisition.
  - Improved knowledge retention.
  - Increased fun and interest in the topic.
  - Improved collaboration.
  - Improved communication skills.
  - Improved learning skills (problem solving skills, deeper thinking skills, etc.)

- Improved achievement of learning objectives.
- Reduced time and effort for learning.

▪ What do you think are the benefits of using CBTs in MOOCs and e-learning settings for teachers and tutors?

(Likert scale: Strongly Disagree (1), Disagree, Neutral, Agree, Strongly Agree (5))

- Better ways of delivering information and knowledge to learners.
- Increased interactivity in the course.
- Increased variety of activities that can be used.
- Improved assessment and evaluation of learners' performance.
- Decreased time and effort of preparing learning activities.
- Decreased time and effort of teaching.
- Increased completion rates of MOOCs.
- Enhanced learning process.

▪ What do you think are the benefits of using CBTs in MOOCs and e-learning settings from technical and organizational perspective?

(Likert scale: Strongly Disagree (1), Disagree, Neutral, Agree, Strongly Agree (5))

- Reduced development, deployment, maintenance and upgrade time, effort and cost.
- Improved scalability.
- Enhanced security and privacy.
- Improved accessibility.
- Automatic upgrade.
- More storage space.

▪ What other benefits of using CBTs in MOOCs and e-learning settings, depending on your experiences and in your opinion?

▪ What do you think are the problems and issues of using CBTs in MOOCs and e-learning settings for learners?

(Likert scale: Strongly Disagree (1), Disagree, Neutral, Agree, Strongly Agree (5))

- Difficulty of use.

- Increased effort for learning.
- Increased time for learning.
- Decreased motivation to learn.
- Decreased engagement.
- Difficulty in using different CBTs in the course.

▪ What do you think are the problems and issues of using CBTs in MOOCs and e-learning settings for teachers and tutors?

(Likert scale: Strongly Disagree (1), Disagree, Neutral, Agree, Strongly Agree (5))

- Difficulty of use.
- Increased time for training learners on using the CBTs.
- Difficulty in choosing proper CBTs for the course.
- Less completion rates of MOOCs.

▪ What do you think are the problems and issues of using CBTs in MOOCs and e-learning settings from technical and organizational perspective?

(Likert scale: Strongly Disagree (1), Disagree, Neutral, Agree, Strongly Agree (5))

- CBTs Integration issues.
- CBTs interoperability problem.
- Security and privacy issues.
- Limited control over the CBTs.

▪ What other problems/issues for using CBTs in MOOCs and e-learning, depending on your experiences and in your opinion?

▪ What improvements could be done in future?

▪ What are your positive experiences related to using CBTs in MOOCs and e-learning settings?

▪ Are there any negative experiences related to using CBTs in MOOCs and e-learning settings?

▪ How should CBTs be used in MOOCs and e-learning settings, depending on your experiences and in your opinion?

5. Experience(s) and best Practice of Using CBTs in MOOCs

"This section is only for who has any experiences in using CBTs in MOOCs settings"

Please give more details about your experience(s) in using CBTs in MOOCs

- The used MOOC platform(s)
- CBTs Types
- CBTs List (please name the used CBTs in this experience(s))
- CBTs Application Scenario(s) (please list your application scenarios here)
- Benefits of using CBTs in this experience(s) for learners
- Benefits of using CBTs in this experience(s) for teachers and tutors
- Benefits of using CBTs in this experience(s) from technical and organizational perspective
- Drawbacks and problems faced in using CBTs in this experience(s) for learners
- Drawbacks and problems faced in using CBTs in this experience(s) for teachers and tutors
- Drawbacks and problems faced in using CBTs in this experience(s) from technical and organizational perspective
- What could be improved for further applications, from learners' aspect?
- What could be improved for further applications, from teachers and tutors' aspect?
- What could be improved for further applications, from technical and organizational aspect?
- What recommendations can you summarize for other groups using CBTs in MOOCs, from learners' aspect?
- What recommendations can you summarize for other groups using CBT in MOOCs, from teachers and tutors aspect?
- What recommendations can you summarize for other groups using CBT in MOOCs, from technical and organizational aspect?

APPENDIX 2

Statistical results for some questions of the survey are displayed bellow:

Benefits of using CBTs in MOOCs and e-learning settings for learners:

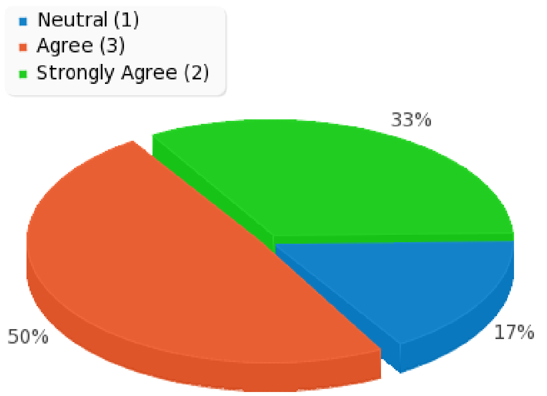

Figure 21. Improved motivation to learn

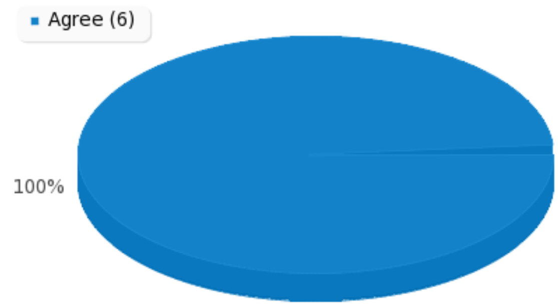

Figure 22. Improved engagement

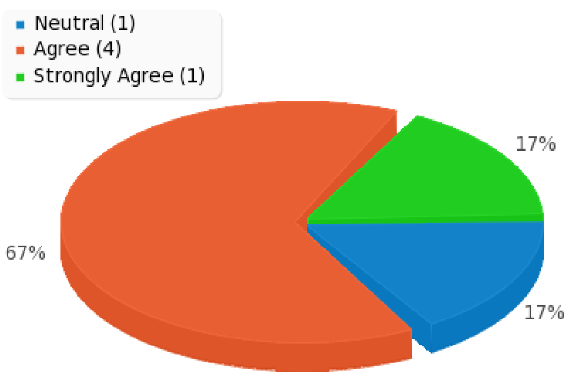

Figure 23. Improved knowledge sharing

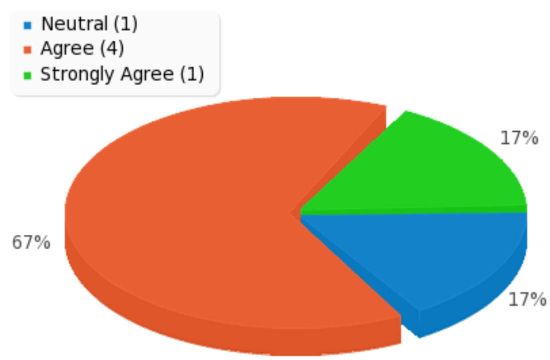

Figure 24. Improved knowledge acquisition

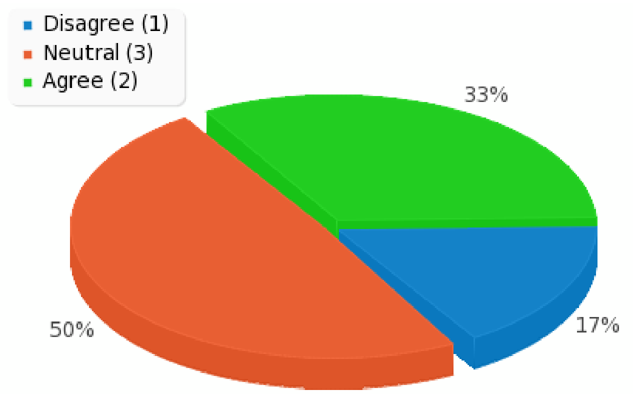

Figure 25. Improved knowledge retention

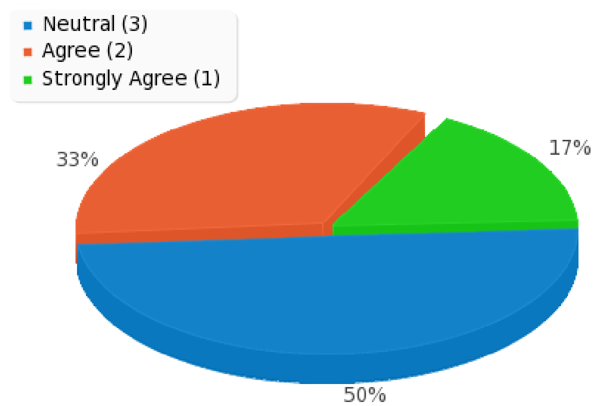

Figure 26. Increased fun and interest in the topic

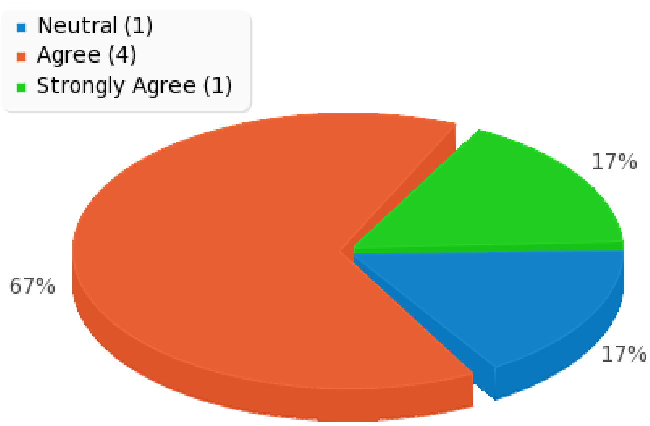

Figure 27. Improved collaboration

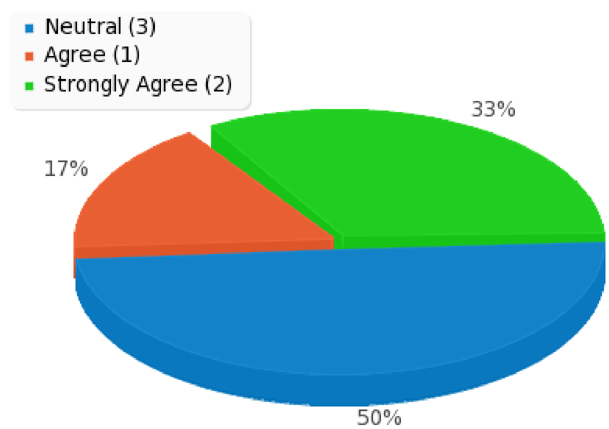

Figure 28. Improved communication skills

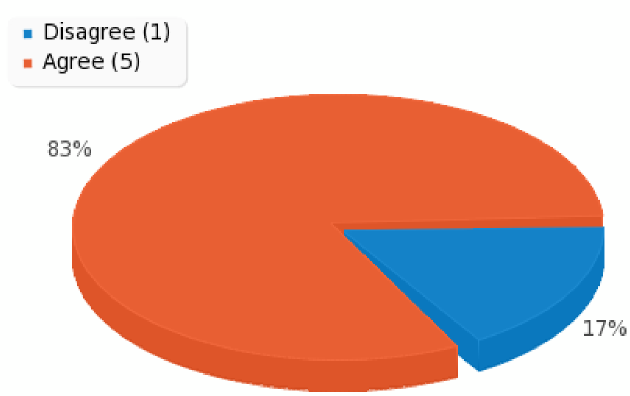

Figure 29. Improved learning skills

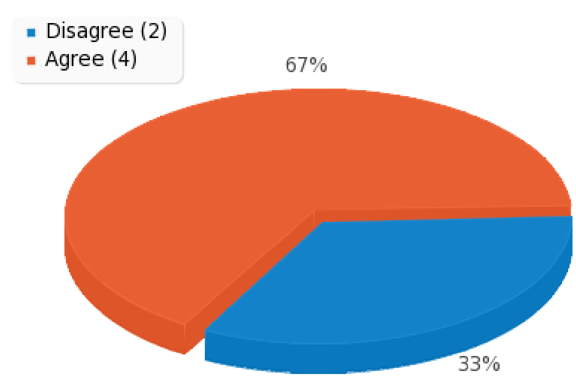

Figure 30. Improved achievement of learning objectives

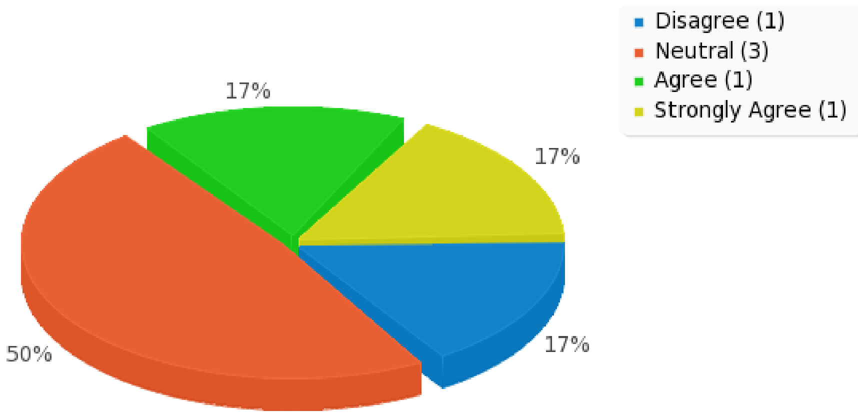

Figure 31. Reduced time and effort for learning

Benefits of using CBTs in MOOCs and e-learning settings for teachers and tutors:

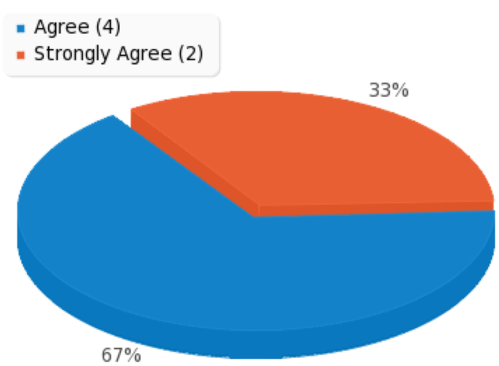

Figure 32. Better ways of delivering information and knowledge to learners.

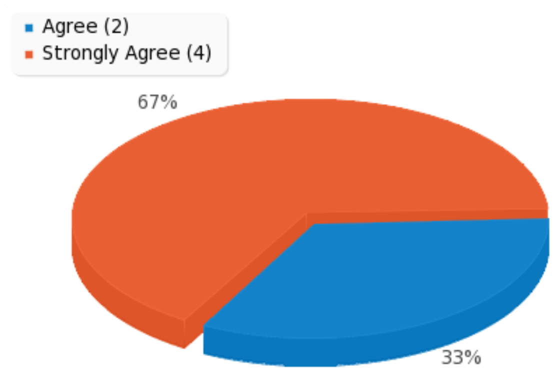

Figure 33. Increased interactivity in the course.

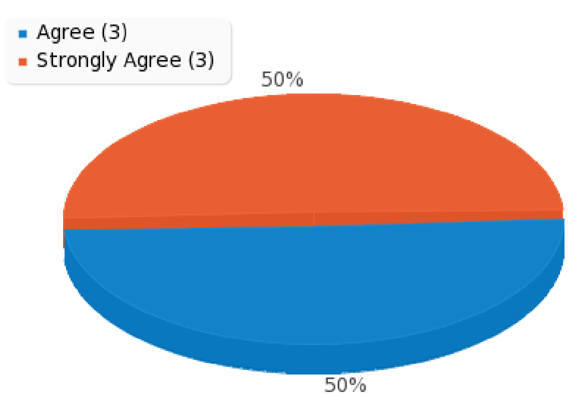

Figure 34. Increased variety of activities that can be used.

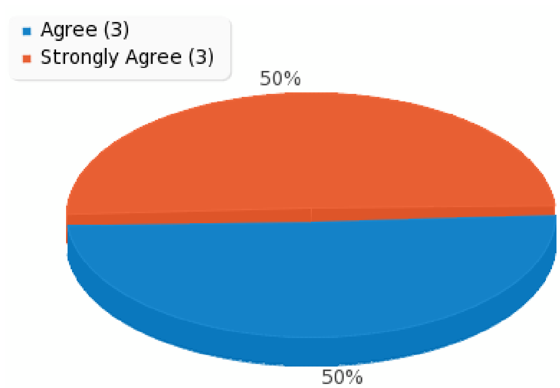

Figure 35. Improved assessment and evaluation of learners' performance.

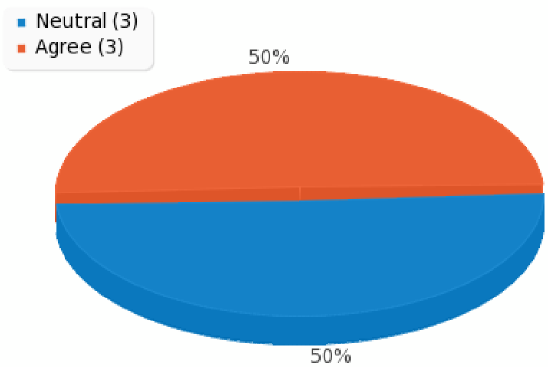

Figure 36. Decreased time and effort of preparing learning activities.

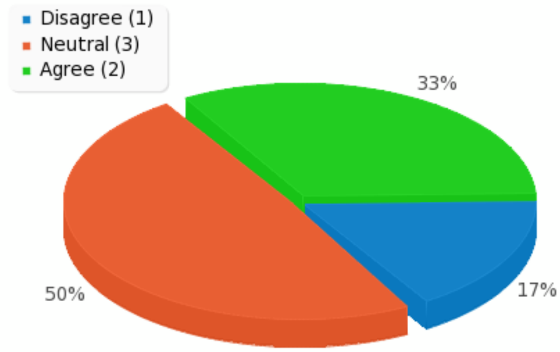

Figure 37. Decreased time and effort of teaching.

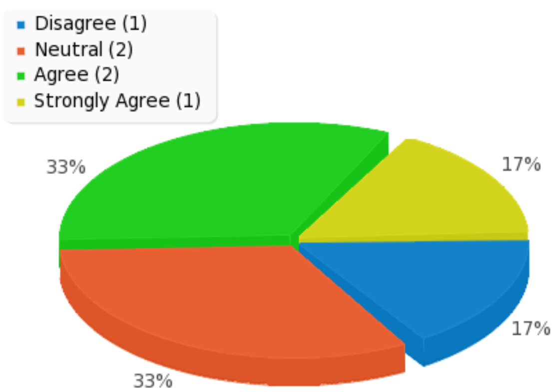

Figure 38. Increased completion rates of MOOCs.

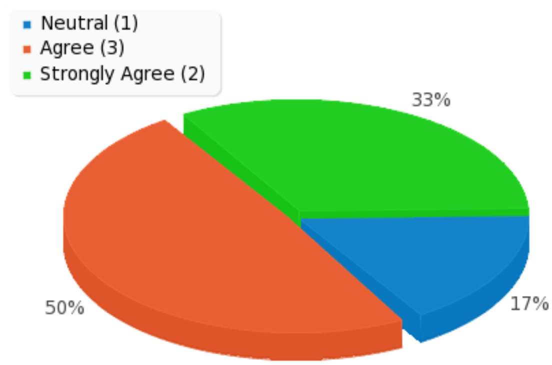

Figure 39. Enhanced learning process.

Benefits of using CBTs in MOOCs and e-learning settings from technical and organizational perspective:

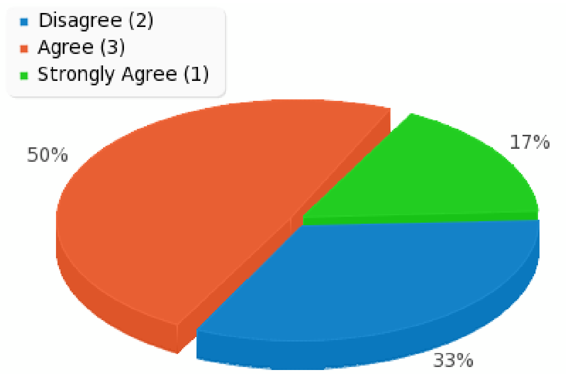

Figure 40. Reduced development, deployment, maintenance and upgrade time, effort and cost.

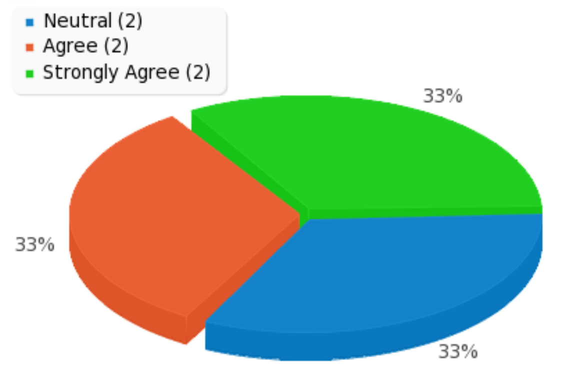

Figure 41. Improved scalability.

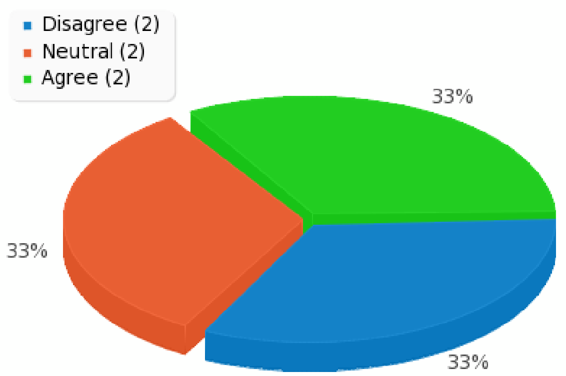

Figure 42. Enhanced security and privacy.

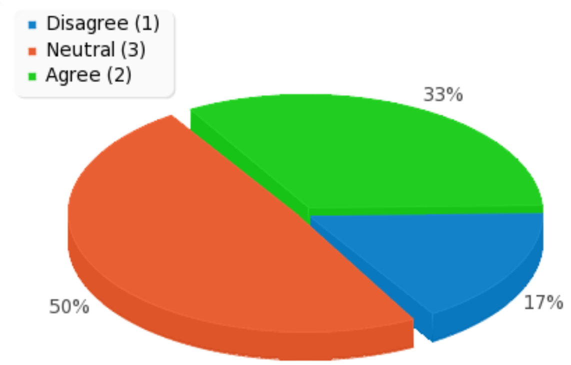

Figure 43. Improved accessibility.

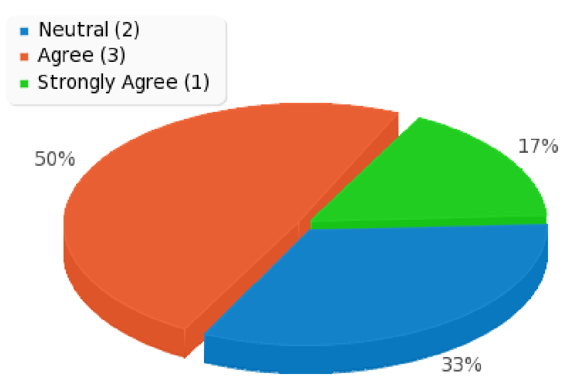

Figure 44. Automatic upgrade.

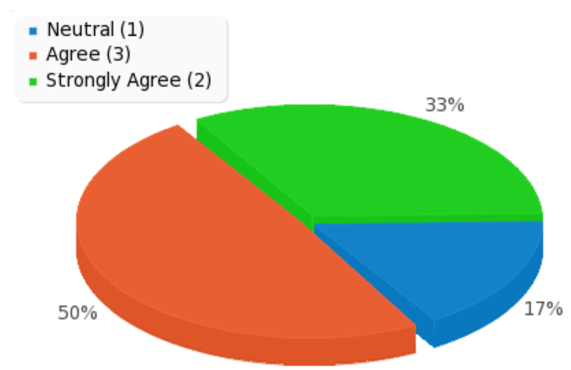

Figure 45. More storage space.

Problems and issues of using CBTs in MOOCs and e-learning settings for learners:

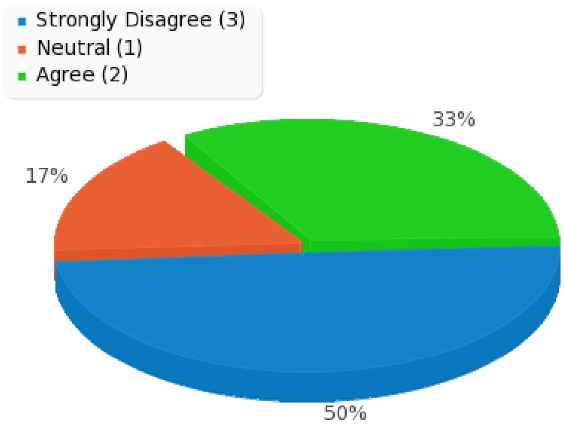

Figure 46. Difficulty of use.

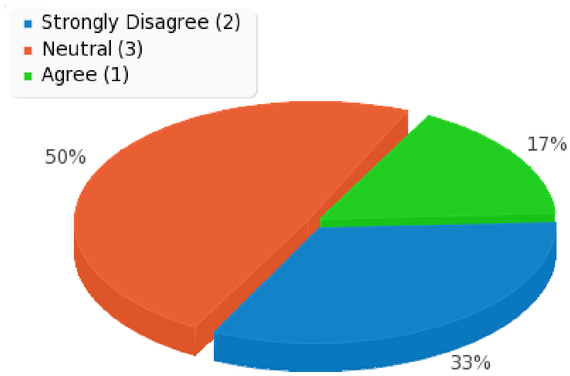

Figure 47. Increased effort for learning.

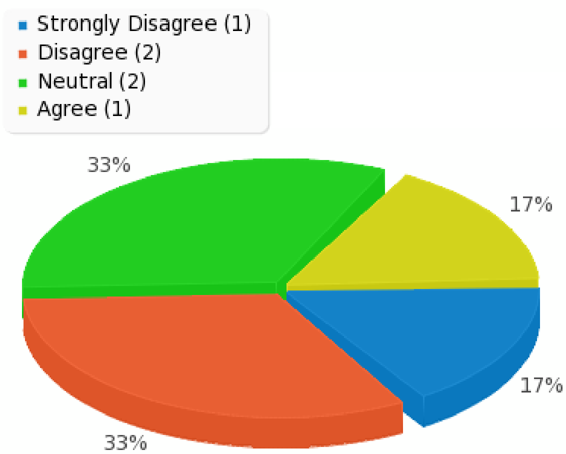

Figure 48. Increased time for learning.

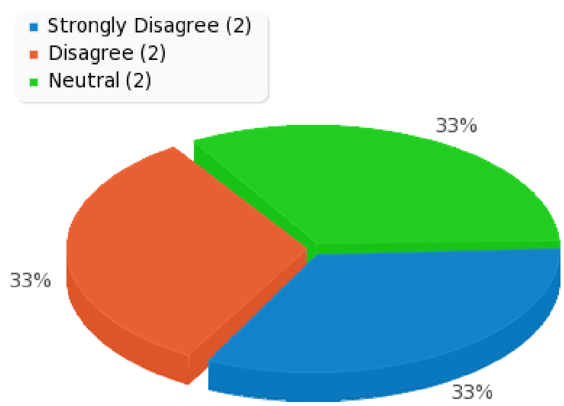

Figure 49. Decreased motivation to learn.

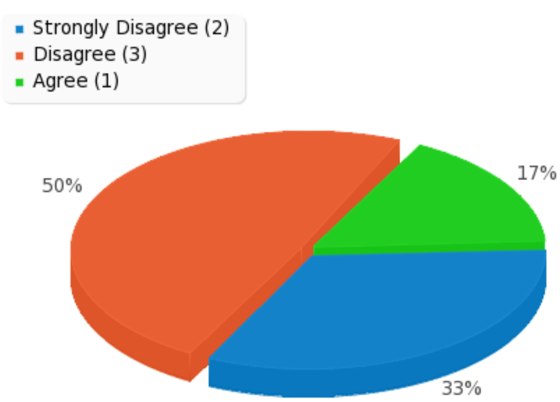

Figure 50. Decreased engagement.

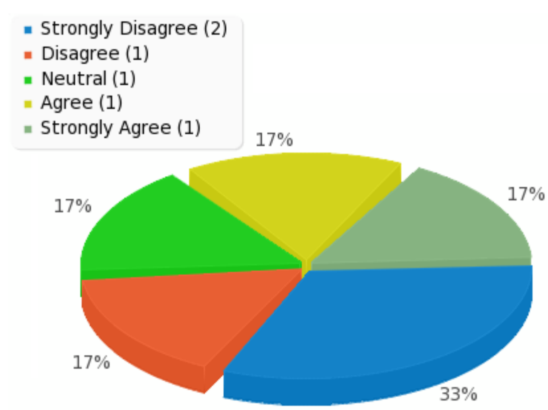

Figure 51. Difficulty in using different CBTs in the course.

Problems and issues of using CBTs in MOOCs and e-learning settings for teachers and tutors:

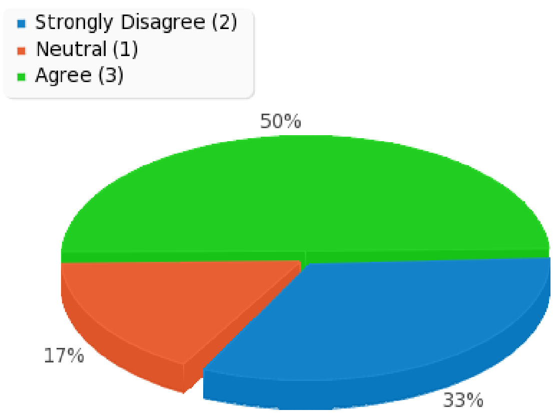

Figure 52. Difficulty of use.

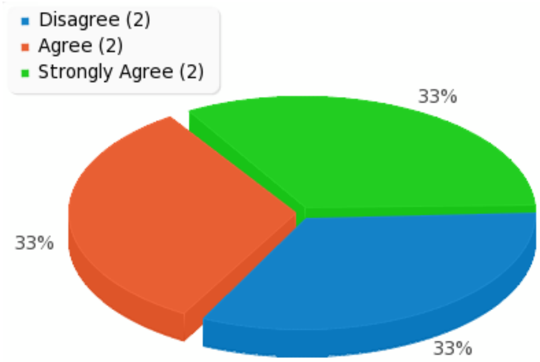

Figure 53. Increased time for training learners on using the CBTs.

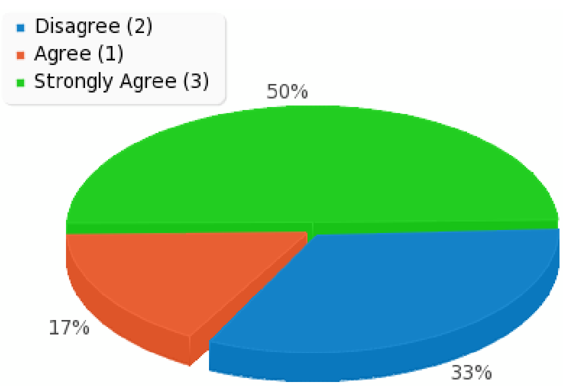

Figure 54. Difficulty in choosing proper CBTs for the course.

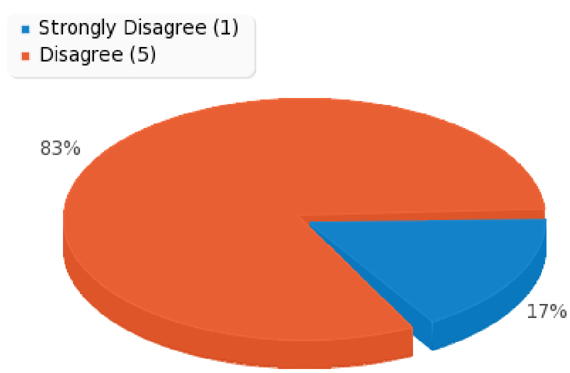

Figure 55. Less completion rates of MOOCs.

Problems and issues of using CBTs in MOOCs and e-learning settings from technical and organizational perspective:

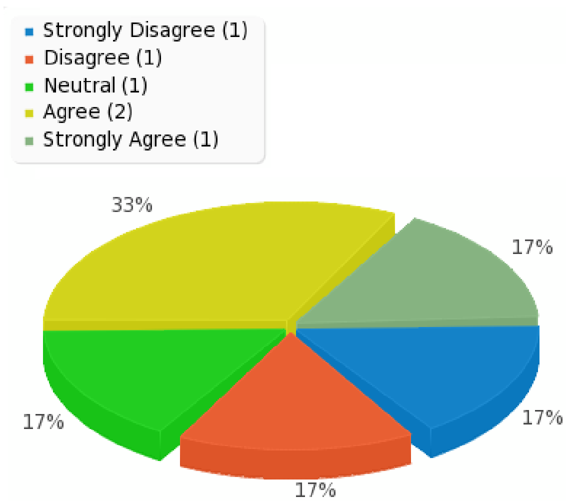

Figure 56. CBTs Integration issues.

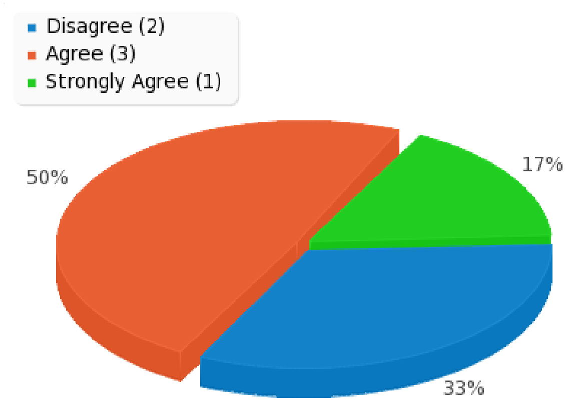

Figure 57. CBTs interoperability problem.

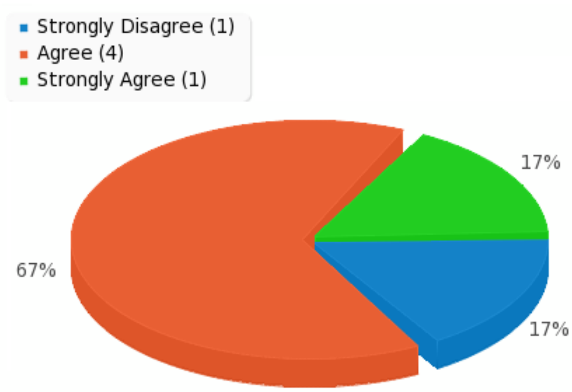

Figure 58. Security and privacy issues.

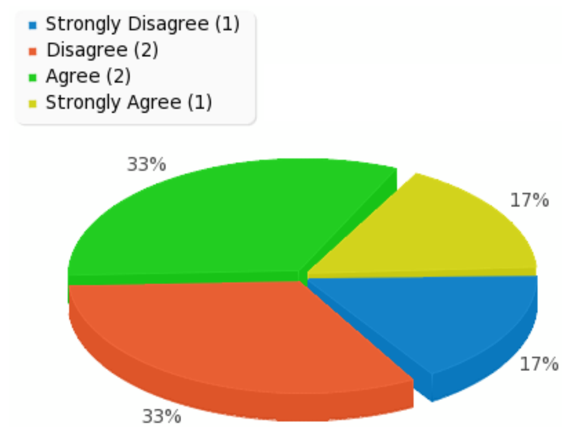

Figure 59. Limited control over the CBTs.