Technical Analysis of MOOCs

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Abstract **– Lately, the globalization and massification of higher education offer involved more and more e-learning techniques inside universities. The article brings a perspective on our analyses of different trends in online education, especially MOOCs (Massive Open Online Courses). Our research raised some questions, which are answered in this article, such as: What are the most important players/MOOCs? How can educational video content be classified? We analyse the technological particularities of MOOCs and focus more on what we think to be one of the main pillars of e-learning, the video lectures, offering our findings, together with recommendations for future MOOC creators.**

Keywords **– MOOC, video lectures, audio-video metadata, video distribution platform, profile technology.**

1. MOOC definition and terms

MOOC is an acronym for Massive Open Online Course, where:

- Massive refers to the potential of extremely large enrollments; thousands of students register from all over the globe [1];
- Open can refer to the methods, tools and all content [2]; it can also be related to the enrollment of anyone who has Internet access regardless of their prior learning;
- Online, as Decker [1] says, is the mean of content delivery. From Levine's perspective "Online is not just where it lives, but Internet culture is woven into the course itself as an ethos";
- The Course implies some non-official agreements/conventions of how it operates (the start and end of it, design, credits, distribution methods, type of video lectures chosen etc.).

The original aim of MOOCs was to open up education and provide free access to university level education for as many students as possible. In contrast to traditional university online courses, MOOCs have two key features [3]:

- Open access - anyone can participate in an online course for free;
- Scalability - courses are designed to support an indefinite number of participants.

The term was probably first used during a Skype conversation between Cormier and Siemens [4]. In 2008, Siemens and Downes delivered an online course called Connectivism and Connective Knowledge as the first MOOC - Massive Open Online Course (CCK08), based on connectivist pedagogy [5]. The course aimed to foster the affordances of social and participatory media. It relied on the benefits of scale through significant interaction with a distributed network of peers. Participants were encouraged to use a variety of technologies, to reflect on their learning and to interact with others. There was no "right way" through the course; the emphasis was on personalized learning through a personal learning environment. The course attracted a number of around 2,200 people [5].

MOOCs are usually divided into two different types: cMOOC is based on distributed learning and connectivism, a theory of learning, whereas xMOOCs, the most often we encounter, lean towards behaviorism and use more conventional instructor - centered delivery methods with objective assessment and automated grading. George Siemens, one of the original MOOC facilitators, describes them: "cMOOCs focus on knowledge creation and generation, whereas xMOOCs [1]. The xMOOCs have a formal (traditional) course structure and flow while the cMOOCs have some content as a starting point and then the learners are expected to create and extend the content. Cormier [6] defined five steps for success for a connectivist MOOC [7]: orient, declare, network, cluster and focus. xMOOCs have been criticized for lacking any innovation in what pedagogy is concerned. However, it has a huge success amongst students, possibly because of the effervescent nature of their discussion forums and their available learning tools and virtual laboratories [8]. They have been criticized for adopting a knowledge transmission model; in essence, they are considered to be technology-enriched traditional teacher-center instruction [9], or as Caulfield [10] put it, the intersection of Wall Street and Silicon Valley.

One of the big advantages of MOOCs is the possibility of users to connect no matter what their expertise, age or background. No one who wishes to participate is excluded and students negotiate the extent and nature of their participation according to their individual needs and wishes, regardless of whether those needs are defined, for example, by personal interest or workplace requirements. From a theoretical perspective, this creates a very broad form of "legitimate peripheral participation" [11], which

allows individuals to be drawn into the community of practice at whatever rate, is comfortable. The first generation of MOOCs, sometimes called cMOOCs, were aimed at maximizing connections between learners, whereas the xMOOCs that emerged in 2012 adopted a behaviorist, top-down style of teaching. The present phase of evolution is marked by the multiplication of MOOCs initiatives across the world (e.g. the IITs in India, FutureLearn in the UK, OpenUpEd across Europe) and the trend to give credit to successful students [12].

Distance education has done a long journey since the postal correspondence study. The evolution is remarkable, and the new technologies continuously developed, make us believe that even better e-learning platforms will emerge. The discussion about openness remains "open", but we tend to think that this is more of an OCW open than a company based MOOC open. There are only 13% MOOCs that are truly open [13] and this makes one wonder if the commercial type of MOOCs are really part of OER (Open Educational Resources) or are just using the open mirage as an entrance in the education market. However, it is undoubtable, from our point of view, that the benefits of the education materials these platforms provide (by themselves or their university partners), are not to be neglected. Even though, only six years passed, since the first MOOC, CCK08, appeared, the behavioral habits of MOOC users have evolved [14]. The number of online educational platforms increased, the teaching and communication primordial element remaining the video, although in practice and in terms of instructional view it is difficult to adapt a classic course material to the video paradigm. It is necessary to redesign the course and to restructure its content. "The vision is: change the world by bringing education to places that can't be reached today," said Dr. Thrun [15].

In the last years we were engaged in online learning at different levels, developing, managing and participating in various e-learning platforms: https://cv.upt.ro,http://www.vicadis.net,http://www.e-start.ro,http://www.proiectconcord.ro.

Our experience is manifested totally online or as Angel [16] said: "flipped or hybrid or just lecture capture for on-demand reply". We have been following the MOOC movement and in the above context, questions inevitably arose: Who are the most important players/MOOCs in educational area? How can educational video content be classified? What types of video lectures are used in a platform? What are the main audio-visual metadata specific for an educational video? What video distribution solution is used in MOOCs applications? What is the technology profile of these platforms (Server Information, Content Management System - CMS, Framework etc.)?

2. Technological profile of MOOCs

Our first goal was to establish a list of the most popular educational platforms that align to the MOOC paradigm. The classification criteria was based on: the number of existing courses in a platform, global users number, popularity, Alexa actionable analytics for the web, literature suggestions and recommendations made by the specialists in e-learning topics [17].

We gathered up everything we have been analyzing, reading and searching for. People who have time, motivation and a desire for free education [18] can choose from our list, presented below in alphabetical order:

Table 1.MOOCs list

Name	Hyperlink	Logo
Acade.me	http://acade.me	
Alison	http://alison.com	
Canvas Network	https://www.canvas.net	
Code_cademy	http://www.codecademy.com	
Coursera	https://www.coursera.org	
Creative	https://www.creativelive.com	
edX	https://www.edx.org	
Eliademy	https://eliademy.com	
France UniversiteNumeriqe	http://www.france-universite-numerique.fr/moocs.html	
FutureLearn	https://www.futurelearn.com	
iDESWEB	http://idesweb.es	
iversity	https://iversity.org	

Khan Academy	https://www.futurelearn.com	
MiriadaX	https://www.miriadax.net	
MOOEC	http://www.mooec.com/	
MRUniversity	http://mruniversity.com	
Novoed	https://novoed.com	
Open2Study	https://www.open2study.com	
OpenHPI	https://open.hpi.de	
OpenLearning	https://www.openlearning.com	
P2PU	https://p2pu.org/en	
Standford	http://online.stanford.edu	
TedEd	http://ed.ted.com	
Udacity	https://www.udacity.com	
Udemy	https://www.udemy.com	
Unimooc	http://unimooc.com	
Veduca	http://www.veduca.com.br	

According to Avangate [19], alexa.com represents a ranking system that displays information about the frequency of visits on specific Web sites. The algorithm is based on the amount of traffic recorded over a period of three months and includes two parameters, reach and page views. The reach is a mathematical value, a number of users that visit a specific Web site in one day. The page views represent "the number of time a particular page (URL) is viewed by Alexa users".

Figure 1.Alexa.com - futurelearn.com popularity analysis

For analyzing each platform we enrolled as users/students in 2-3 courses per MOOC (different domains: information technology, history, economics,mathematics or geography). We created for each MOOC platform an account with our credentials.

We took into consideration the following: the technological profile, the types of video lectures and the audio-video metadata for the video content itself.

Each system has its own unique advantages to offer:

- Content management systems with respect to the flexibility of the management and delivery of learning content;
- Collaborative platforms with respect to the communication features;
- Learning management systems with respect to the support for quizzes and course design [8].

E-learning technologies that are widely used in MOOCs include:

- High-quality indexed video;
- Data capture and analytics;
- Delivery platforms that combine the qualities of social networking sites like Facebook with the content delivery, discussion and grading functions of the traditional learning management system.

For the technological profile we referred to and analyzed: Hosting Providers, Web Server, Nameserver Providers, CMS, Frameworks, Analytics and Tracking JavaScript Libraries, Audio/Video Media, Widgets, CDN, Document Information (HTML5 DocType, Conditional Comments, X-UA-Compatible, JavaScript, CSS, HTML5 Specific Tags, WAI - ARIA, X-Frames-Options, Apple Mobile Web App Capable, Handheld Friendly, Mobile Optimized, Viewport Meta, Canonical Content Tag, Meta Keywords, Meta Description, MetaRobot, JavaScript, Open Graph Protocol), Encoding and Server Information.

To identify the information listed above we chose the BuiltWith application - http://builtwith.com - and

the Chrome Developer Tools [20]. We investigated three different web pages: the index page (e.g. https://www.futurelearn.com), one with all the courses available (e.g. https://iversity.org/courses) and the third one with a video lesson included (e.g. https://open.hpi.de/courses/semanticweb2014).

BuiltWith represents a tool for identification of technologies used in web applications. It is designed for a small group of users, including web developers and researchers. The generated results provide an overview of the complexity of technical parts required in the development process.

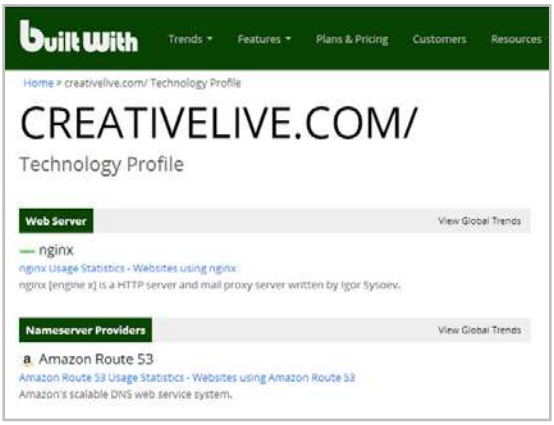


Figure 2.BuiltWith.com - creativelive.com profile

Figure 3.Chrome Developer Tools - eliademy.com network analysis

As found on Chrome.com - devtools [20], Developer Tools are a "set of web authoring and debugging tools built into Google Chrome. The DevTools provide web developers deep access into the internals of the browser and their web application".

A **Web server** represents a computer where a program runs that combines a standardized language of communication between browsers and web servers, called HTTP (HyperText Transfer Protocol) and is based on a specific model, known as client/server model. Dipak [21] says that "web servers often come as part of a larger package of Internet - and intranet - related programs for serving e-mail, downloading requests for File Transfer Protocol (FTP) files, and building and publishing Web pages". When a user on a remote computer types in the address field of his browser the URL http://www.example.com/doc/sample.html, (Uniform Resource Locator), the browser slices the URL in 3 parts [22]:

- http://, indicates that the document/file can be retrieved from a web server, which understands the HTTP protocol;
- www.example.com, the host name of the computer from which the document can be downloaded;
- /doc/sample.html: This is the virtual path of the document in the www.example.com's web server.

There are many web server software applications, including public domain software from NCSA and Apache, and commercial packages from Microsoft, Netscape and others [23]. The two leading Web servers are Apache, the most widely-installed Web server, and Microsoft's Internet Information Server [24]. In the particular case of the MOOCs' analysis, we found out that the main player remains Apache (http://www.apache.org) followed by nginx server (http://nginx.org) that released in 28th October 2014 the 1.7.7 mainline version.

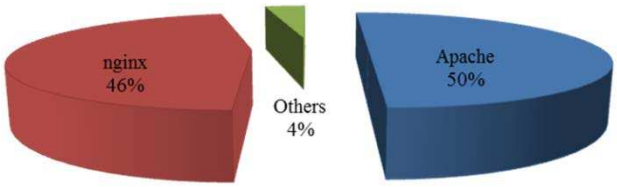


Figure 4.MOOCs' web servers

According to Dipak [21], "considerations in choosing a web server include its ability to handle server-side programming, security characteristics, and publishing, search engine, and site building tools that may come with it". A connection channel between the web server and the remote computer is possible with the assistance of a **DNS**, an abbreviation for Domain Name System. A DNS represents a system for naming computers and network services and is often used in TCP/IP networks, such as the Internet to locate computers and services through user-friendly names, instead of IP address associated with the name [25]. The DNS for our MOOC list includes GoDaddy DNS, Dyn DNS, Zayo, Amazon Route 53, Cloud Fare DNS, RackSpace DNS Cloud, Linode DNS and DNSimple, as it is shown in the next diagram:

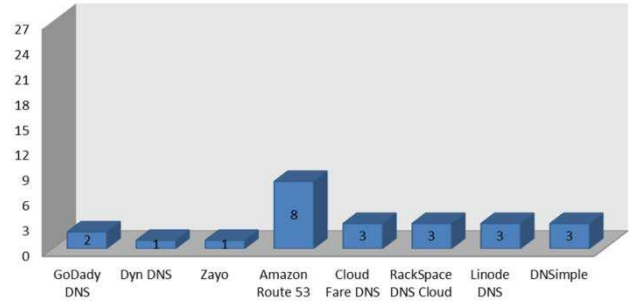


Figure 5.MOOCs' DNS

Hosting (also known as Web site hosting, Web hosting, and Webhosting) is, as mentioned in Business News Daily [26], the service provided by a Web host, an organization that sells or leases memory space on its servers. Web hosting is typically done in a data center, which provides services to clients that enable them to publish websites on the Internet. A Web host can also provide data center space and Internet connection for servers owned by others. The MOOC platforms show a large diversity, from our study it resulted the types of hosting from figure 6.

"Those looking for a Web host need to examine their requirements before choosing a Web hosting service. Some of these may include database server software, software for writing scripts, emails for business purposes, streaming media and the operating system offered. Often, the technical aspects of managing a website may be more easily managed if the Web host also provides a **Web Content Management System**" [26].

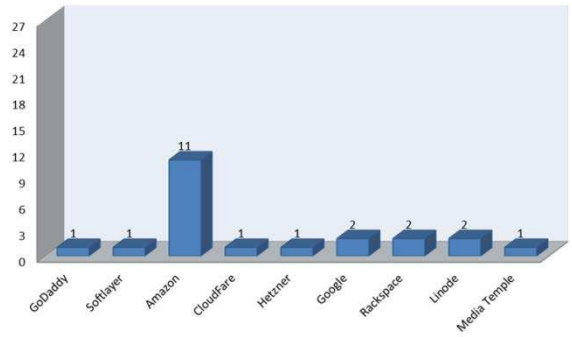


Figure 6.MOOCs' Web Hosting

Managing content refers to creating, editing, archiving, and publishing, collaborating on, reporting, distributing website content, data and information (Joomla 2014). Several web-based CMSs are available, the most popular, from our research point of view, in MOOCs are:

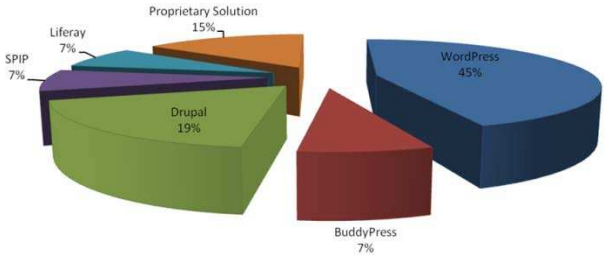


Figure 7. MOOCs' CMS

The profile technology synthesis ends with the **CDN** which is the acronym for Content Delivery Network. The goal of a CDN is to serve content to end-users with high availability and high performance. As more aspects of daily life move online, organizations use CDN to accelerate static and dynamic content such as: text, graphics and scripts, downloadable objects (media files, software, and documents), applications (e-commerce, portals), live streaming media, on-demand streaming media, and social networks [27]. The MOOCs' CDN analysis provides two main players (figure 8): Amazon Cloud Front and Akamai.

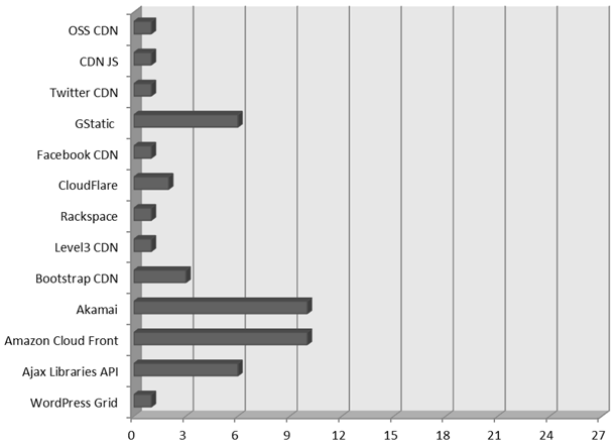


Figure 8.MOOCs' CDN

2.1. Video distribution systems, format profile and audio-video metadata

The main core of a MOOC platform is the video element, which ensures the right delivery of educational content. Using robust video distribution systems becomes mandatory. Following the study results (figure 9), six commercial or part-free solutions (Youtube, Vimeo, Ustream, DailyMotion, Google Video, Brightcove) interlaced with MOOC platforms' proprietary method (22%) were identified by us.

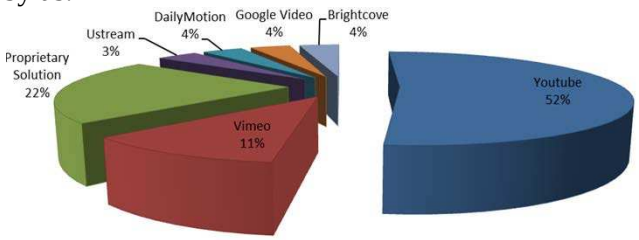


Figure 9.MOOCs' video distribution systems

After the establishment of the video distribution platform used for the particular case of each MOOC, we proceeded to the next step of our case studies.

We analyzed the compression and encoding parameters characteristic to a specific video content that plays inside the MOOC. We downloaded the video lessons (using Video DownloadHelper) on our local machine to extract the audio-video metadata information with specific free software like GSpot®, MediaInfo® and VideoInspector®. Video Download Helper is a tool for web content extraction. Its purpose is to capture video and image files from many sites. It has Add-ons for Firefox - Mozilla.

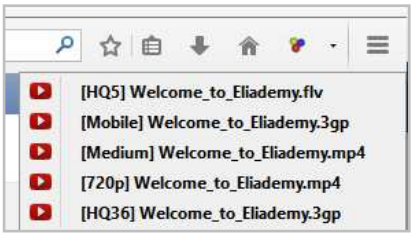


Figure 10.Video DownloadHelper

GSpot (figure 11) provides a single-window view of the metadata available in a video; most of the data extracted is technical metadata. But if there is any information published by the author, the application provides this as well. GSpot has an export function that allows the user to save the metadata for being included in a report. A disadvantage of this software is that GSpot has not been updated since 2007.

VideoInspector provides to the user the essential metadata present in the video file. The tool was designed to assist the user in identifying missing codecs required to play the video, reading all the available metadata not being its main function.

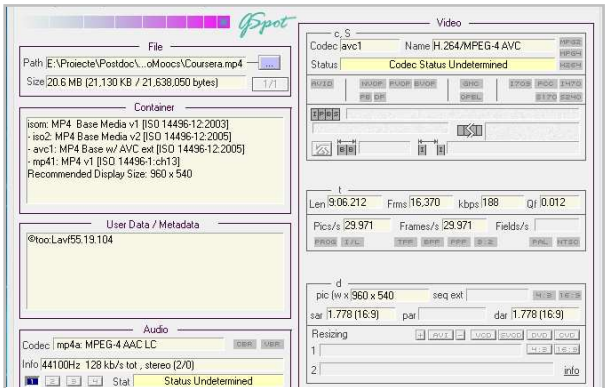


Figure 11.GSpot - Coursera video parameters

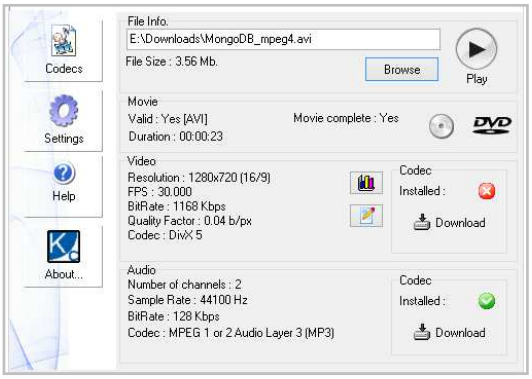


Figure 12.VideoInspector - MongoDB audio-video parameters

MediaInfo has a much simpler display than GSpot, but it offers several different visualizations of the information that allow you to determine what metadata are present. MediaInfo offers technical metadata. In the same time it has an interface with a tree structure; it can quickly make reports and export them in text or HTML format.

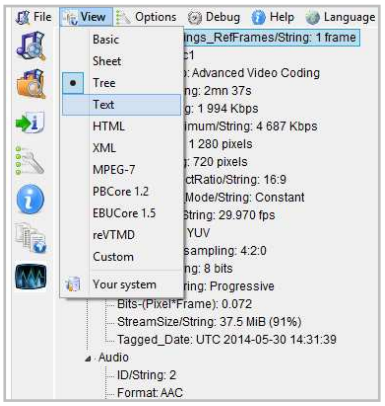


Figure 13.MediaInfo - MiriadaX video parameters

We extracted values for the following components:

- Format profile: format/container, file size, duration;
- Audio parameters: audio codec, (maximum) bit rate, channel(s), sampling rate, compression mode, stream size;

- Video parameters: video codec, profile@level, settings (CABAC or CAVLC, GOP, M, N), video frame size, (maximum) bit rate, display aspect ratio, frame rate, color space, chroma subsampling, bit depth, scan type, Qf - bits/(pixel*frame), stream size.

An overview of relevant parameters is found in table 2.

Table 2.Format profile and audio-video metadata

Name	Format	File size	Duration	Audio codec	Audio bit rate	Sampling rate	Video codec	Video bit rate	Video frame size	Frame rate
Acade.me http://acade.me	mp4	216 MiB	18mn 2s	AAC	192 Kbs	44.1 KHz	AVC	1477 Kbps	1280 x 720 pixels	29.97 fps
Alison http://alison.com	mp4	1.52 MiB	1mn 37s	AAC	54.8 Kbps	22.05 KHz	AVC	62.5 Kbps	640 x 480 pixels	15 fps
Canvas Network https://www.canvas.net	mp4	18.6 MIB	1mn 29s	AAC	147 Kbps	48 KHz	AVC	1604 Kbps	1280 x 720 pixels	25 fps
Coursera https://www.coursera.org	mp4	20.6 MiB	9mn 6s	AAC	128 Kbps	44.1 KHz	AVC	180 Kbps	960 x 540 pixels	29.97 fps
Creative https://www.creativelive.com	mp4	68.3 MiB	1mn 17s	AAC	125 Kbps	48.0 KHz	AVC	7273 Kbps	1280 x 720 pixels	59.94 fps
edX https://www.creativelive.com	mp4	7.11 MiB	2mn 44s	AAC	102 Kbps	44.1 KHz	AVC	265Kbps	640 x 360 pixels	29.97 fps
Eliademy https://www.creativelive.com	mp4	14.9 MiB	1mn 46s	AAC	192Kbps	44.1 KHz	AVC	982 Kbps	1280 x 720 pixels	25 fps
France Universite Numeriqe http://www.france-universite-numerique.fr/moocs.html	mp4	78.5 MiB	1mn 50s	AAC	126Kbps	44.1 KHz	AVC	5851 Kbps	1920 x 1080 pixels	25 fps
FutureLearn https://www.futurelearn.com	mp4	61.7 MiB	9 mn 34s	AAC	128 Kbps	44.1 Kbps	AVC	768 Kbps	646 x 364 pixels	25 fps
iDESWEB https://www.futurelearn.com	mp4	30.6 MiB	15mn 6s	AAC	192 Kbps	44.1 Kbps	AVC	235 Kbps	1280 x 720 pixels	25 fps
iversity https://www.futurelearn.com	mp4	30.6 MiB	15mn 6s	AAC	48.0 Kbps	44.1 KHz	AVC	235 Kbps	1280 x 720 pixels	25 fps
Khan Academy https://www.futurelearn.com	mp4	4.03 MiB	2mn 22s	AAC	96.0 Kbps	44.1 KHz	AVC	138 Kbps	576 x 360 pixels	30 fps
MiriadaX https://www.miriadax.net	mp4	41.2 MiB	2mn 37s	AAC	192 Kbps	44.1 KHz	AVC	1 994 Kbps	1280 x 720 pixels	29.97 fps
MOOEC https://www.miriadax.net	mp4	5.15 MiB	3mn 26s	AAC	129 Kbps	48.0 KHz	AVC	74.9 Kbps	640 x 360 pixels	30 fps
MRUniversity http://mruniversity.com	mp4	53.8 MiB	9mn 17s	AAC	192 Kbps	44.1 KHz	AVC	615 Kbps	960 x 720 pixels	30 fps
Novoed https://novoed.com	mp4	169 MiB	2mn 49s	AAC	317 Kbps	44.1 KHz	AVC	8 043 Kbps	1920 x 1080 pixels	23.97 fps
Open2Study https://www.open2study.com	mp4	26.9 MiB	2mn 48s	AAC	192 Kbps	44.1 KHz	AVC	1 148 Kbps	1280 x 720 pixels	25 fps
OpenHPI https://www.open2study.com	mp4	35.1 MiB	14mn 19s	AAC	112 Kbps	48.0 KHz	AVC	226 Kbps	640 x 360 pixels	25 fps
OpenLearning https://www.openlearning.com	mp4	320 MiB	36mn 28s	AAC	144 Kbps	44.1 KHz	AVC	1 080 Kbps	1280 x 720 pixels	25 fps
P2PU https://p2pu.org/en	mp4	10.9 MiB	7mn 7s	AAC	93.5 Kbps	44.1 KHz	AVC	117 Kbps	480 x 360 pixels	15 fps
Standford http://online.stanford.edu	mp4	59.8 MiB	12 mn 36s	AAC	192 Kbps	44.1 KHz	AVC	469 Kbps	960 x 720 pixels	30 fps
TedEd http://ed.ted.com	mp4	23.4 MiB	3mn 54s	AAC	192 Kbps	44.1 KHz	AVC	641 Kbps	1280 x 720 pixels	29.97 fps
Udacity https://www.udacity.com/	mp4	9.20 MiB	1mn 5s	AAC	192 Kbps	44.1 KHz	AVC	979 Kbps	1280 x 720 pixels	29.97 fps
Udemy https://www.udemy.com/	mp4	52.7 MiB	4mn 22s	AAC	192 Kbps	44.1 KHz	AVC	1 490 Kbps	1280 x 720 pixels	25 fps
Unimooc http://unimooc.com/	mp4	11.2 MiB	8mn 53s	AAC	53.5 Kbps	44.1 KHz	AVC	277 Kbps	480 x 360 pixels	29.97 fps
Veduca http://www.veduca.com.br	mp4	157 MiB	58mn 36s	AAC	96.0 Kbps	44.1 KHz	AVC	277 Kbps	480 x 360 pixels	29.97 fps

A *format*, *container* or *wrapper* brings together several streams (e.g. audio, video, subtitles, metadata, data synchronization) and they are played simultaneously. In most cases, the header, the synchronization data and part of the metadata are specific to the container. The audio-video stream is encoded using different codecs, multiplexed with subtitles, metadata and data synchronization. In the end we have the format/container. It is like a box full inside with the stream components [28].

The *codec* has the origin in the association of two words: "coder - decoder" or "compress - decompress". The codec represents a device or a program itself, a software implementation that allows people to create video based material by choosing precise parameters with particular values [28] , such as those shown in table 2.

The *bit rate* refers to the number of bits stored in a unit of time when it is operating the audio-video recording process. The unit of measurement is bps - bits/second or multiple: Kbs - Kilobits/seconds, Mbps - Megabits/seconds.

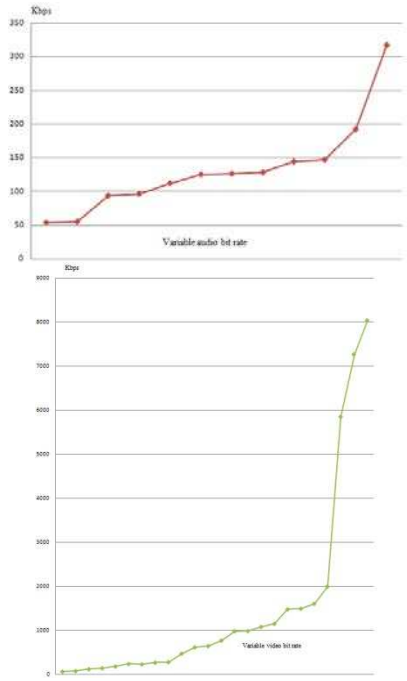


Figure 14.Audio and video bit rate variable values in MOOCs

A *Video frame size* or video resolution is a dimension in pixels for the video element, more accurate, a product between the number of horizontal pixels and vertical ones (e.g. 480 x 360, 640 x 360, 1280 x 720, 1920 x 1080).

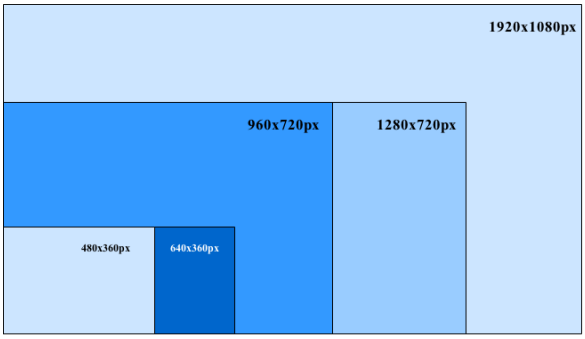


Figure 15.Most popular video frame size in MOOCs

The *Aspect ratio* for an image implies a ratio between the length and height of the screen (l/h) with 4/3 values in classical videos - standard definitions (SD) or 16/9 in high definition materials (HD).

The *Video frame rate* (the number of frames per second) appears in the temporal sampling process of moving pictures and is an important parameter because the larger this number is the better the quality of the video presentation becomes. For a (video) transmission to seem continuous, it is recommended the use of minimum 15 frames per second[28]. The unit of measurement is obviously fps - frame/second or Hertz (Hz). We found that usual values in MOOCs are 23.97 fps, 25 fps (PAL standard), 29.97 fps, 30 fps (NTSC standard).

The *bit depth* is the number of bits used to represent the smallest unit of image video information (samples, bytes or pixels) and is closely related to the quantization process. If the value is higher, then the quality of the sound and video is larger. The MOOCs video distribution platforms propose a value of 8 bits.

The number of *audio channels* differs in values. We can discuss about the mono sound (one channel), the stereo one - the most spread in MOOCs - (two channels), quadraphonic (four channels) and the surround one (six - eight channels).

The *sampling rate* is the number of samples taken from the audio signal to transform a continuous wave in discrete values. If the number of samples is greater, then the signal accuracy is better. The sampling rate is usually expressed in kilohertz (kHz) and familiar values for audio materials in MOOCs are 22.05 kHz, 44.1 kHz and 48 kHz.

Finally, the literature treats *video length (duration)* as a very important factor. Teaching Center [29] suggests that videos should have between 2 minutes and at most 9 minutes in length. Whatley and Ahmad [30] implicitly recognize limitation times and propose a 5 - 10 minutes video. In the next diagram we reveal our results:

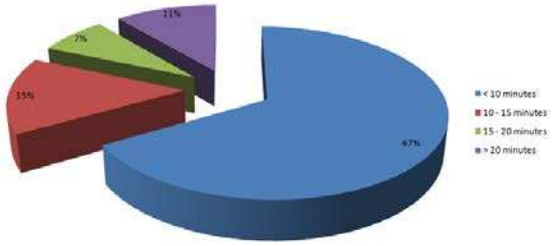


Figure 16.Video length (duration) in MOOCs

Based on our personal experience and on the results of the current study, we offer our recommendations for future creators of MOOCs. We suggest developers to choose between the next scenarios for audio-video parameters:

Table 3.Our scenarios proposals for audio-video parameters

Video frame size	Audio bit rate*	Codec Audio	Video bit rate**	Codec video	Container
240p , 426 x 240	64kbps 128kbps 196 kbps	MP3 Vorbis	700 Kbps 400 Kbps 300 Kbps	H.264, VP8	.mp4, .webm
360p, 640 x 360	64kbps 128kbps 196 kbps	AAC-LC Vorbis	1000 Kbps 750 Kbps 400 Kbps	H.264, VP8	.mp4, .webm
720p , 1280 x 720	128kbps 384kbps 512kbps	AAC-LC Vorbis	4000 Kbps 2500 Kbps 1500 Kbps	H.264, VP8	.mp4, .webm

*mono, stereo, 5.1

**maximum, recommended, minimum

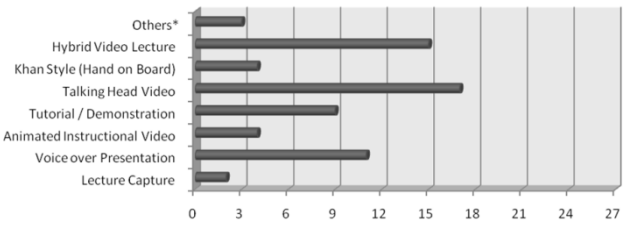
3. Types of video lectures

A notable question was raised by Guo, Kim and Rubin [31] in their online article "MOOC Design Tips: Maximizing the Value of Video Lectures": which kind of videos lead to the best student learning outcomes in a MOOC? It's an important fact for development teams and instructors of MOOCs. It's an essential part for the financial point of view: MOOC video production can range from a few hundred euro/dollars and run up to the thousands [31]. It is significant for the learning process itself. To ensure content and a subject rigor as the classrooms lectures, Florida State University Academic and Professional Program Services [32] sustain that a video lecture must have a framework for lesson delivery that should consist of six parts:

- "Gain the students' attention and establish expectations";
- "Review relevant, previously learned material";
- Link the new information to previous one;
- Offer learning guidance or elaboration;
- Offer time for practice and feedback;
- "Provide for spaced practice to enhance retention".

Video lectures became more and more portable, more and more focused on student's individual pace [33]. There are five broad types of MOOC students. Viewers "watch lectures, handing in few if any assignments." Solvers "hand in assignments for a grade, viewing few if any lectures." All-Rounders "balance the watching of lectures with the handing in of assignments." Collectors "primarily download lectures." And bystanders are "registered for the course, but their total activity is below a very low threshold" [34].

Our study identifies the most popular type of video lectures used in the MOOCs platform and the results (figure 17) include: Lecture Capture, Voice over Presentation, Animated Instructional Video, Tutorial, Talking Head Video, Khan Style (Hand on Board) and Hybrid Video Lecture.



*Others - image slide show, real time code editor

Figure 17.Types of video lectures

An explanation of each and a description of the pros and cons are mandatory. **Lecture Capture**, also known as classroom lecture, represents the recording of a live lesson from a school or university [31]. To create a kind of video material is quite easy, at first sight. It is necessary to have a video camera (professional or consumer) and to record one of the lectures. Live video capture preserves the classroom environment, the communication part between the teacher and his audience: questions from the students, the teacher's answer and the reaction to the new information, generally speaking. However, it offers no interactivity with the online student. Also, the quality of the video can be quite poor if the video recording equipment is not adequate to the classroom ambient [35]. In case of some technical difficulties live capture does not allow to stop the teacher and to record again some parts of his speech. An action like this will generate a kind of chaos in the real classroom.

Talking Head video consists of close-up shots of the instructor. He speaks directly to the recording equipment (video camera, webcam) and is filmed at his office or in a studio with no audience, during which he talks on the subject matter [31]. The audio part lets the voice do the teaching [36]. Preparation of a talking head video includes the setting up of a camera and a script for the lecture. The recording process is flexible, breaks are allowed, unnecessary information can be cut out and fragments of speech can be recorded again. There is no interactivity: the script of such lecture must be presented in a manner that does not seem boring to the online students. The value of the teacher enthusiasm, humor, intonation, face language and articulation cannot be underestimated [37].

It is actually difficult to insert interactive material, like external links for example. Instructor can refer to a book, a website, but students won't be able to access it from the video [35]. Nevertheless, an aural experience according to Udemy support [36] "can be useful to stimulate the imagination and promote independent visualization and knowledge association". Young [37] suggests that, although the Talking Head is a relatively passive use of video, if well designed and/or featuring a good performance, a virtual instructor can be surprisingly engaging.

Voice over Presentation includes a slides presentation, supplemented with a voice over that gives details/explain the slides. Technically speaking the slides are made in programs like PowerPoint or Keynote and voice over can be created with plenty of tools, commercial or free[36]. The combination of visual information (text, graphics, diagram and images) with audio narration makes learning operative. It allows using verbal skills to explain the subject reflected in the objects inserted in each slide. Such type of lectures knows certain limitations: interactive elements can be difficult to insert, the synchronization of audio records with the slides need time and specific skills, the motivation of creating (PowerPoint) presentations over and over again can reflect badly in the quality of lectures that become inappropriate for the student's attention [35].

In a **Khan Style** video the teacher's voice goes along with the "Freehand on a Digital Table". The video content focuses on what is being written or shown on the board [31]. The style is popularized by Khan Academy videos. Kaplan [38] highlights the characteristics of this type of video lecture with a consistent comment: "Khan Academy holds the promise of a virtual school: an educational transformation that de-emphasizes classrooms, campus and administrative infrastructure, and even brand-name instructors." On the other half in a Khan experience the face of the instructor never appears and viewers see only "the step-by-step doodles and diagrams on an electronic blackboard" [38], that can be inconvenient sometimes for a specific learners segment/niche.

A **Tutorial/Demonstration** proposes a video screen capture with the teacher's voice over, where the instructor demonstrates a concept, writes a code in a text editor or command - line prompt, using different programs or documents [31]. Software like TechSmith Camtasia® (http://www.techsmith.com) or Adobe Captivate® (http://www.adobe.com) can be used, but the trainer must learn to use the program and then make the recording and the video lessons by himself. It is a mandatory technique for the teachers who want to explain the functionality of a program. The best examples, http://www.lynda.com, contain the most popular online video tutorials.

Animated instructional video implies technical advanced skills for developing or learning commercial software (e.g. 87seconds.com, Video Scribe). We can classify this learning style in:

- Classic/Traditional Animation - like cartoons;
- Claymation, an animation process using clay or Plasticine figures that are moved and filmed using stop-motion photography to create a lifelike look;
- 3D animation, totally computer-generated with the images being made and animated using 3-D design and animation software;
- Vector animation, where art or motion is controlled by vectors (mathematical values) rather than pixels.

With or without the voice recorded, in this type of material the face of the instructor never appears. It is a lecture type fitting to certain areas, not all teaching materials can be animated in a way that brings quality and efficiency to the online student. It will remain a challenge for the virtual instructor in the future.

Interactive Lecture represents one of the most complex types of online lecture videos. Interactivity has multiple ways to manifest: switching mode between slide and video modes, supplement video part with hyperlinks, resource and files, annotations etc. [35]. The instructors can create the content in a way that allows students to choose segments of the video lectures they want to study. The video itself is divided into small segments that are played through an access-selection interface [33]. Zhang, Zhou, Briggs and Nunamaker [39] find that this direct choice and play interaction improves learning. Although the time and technical skills for developing are increasing, interactive video lecture can create a stunning presence effect for the students [35].

A **Hybrid video lecture** offers a combination of the lecture types listed above or particular teaching cases and can be identified as:

- Real live lecturer combined with a presentation or other multimedia materials;
- Instructor interviewing another expert or guest speaker [31];
- Instructor delivering lecture in another setting related to the course, (e.g. an art historian in a museum) [31];
- Panel Discussion of experts on specific course-related topic [31];
- Combination of Voice over Presentation and Talking Head Video;
- A Mashup, side-by-side video and presentation talk in a timed, sequenced fashion [36].

Does a good classroom lecture make a good video? What sort of interactive activities are most effective for learning? And looking longer term at teaching new topics on video, do we need to give lectures to focus groups before recording them? Or will online analytics give teachers better suggestions on how to improve their classes than puzzled looks across an auditorium? [40].These are some subjects for the future research.

4. Conclusions

The flood of popularity that came over MOOCs determines more and more research about them. Most of this research is concerned about the impact MOOCs have over Higher Education, usability and copyright aspects or the business MOOCs generate. We chose to analyze the technologies that stand behind MOOCs and offer some suggestions regarding the findings we presented in the chapters above.

Technologists are already actively working to augment MOOC platforms with a plethora of products such as tools to support contextual in-text and in-video discussions, formation of study groups and project teams, discussion boards with voting and other features, and ways MOOC learners can connect not only in real time, but also in the real world [41]. It is actually very rare to find media of any sort that is intended to be consumed in its entirely. Most of the time, in most things, we pick and choose what is important to us. That is the normal mode of

interacting with content, and it is the normal mode of interacting with a MOOC [42].

The MOOC platforms offer diversity from all perspectives, but we identify also some common areas.

We found that concerning the server applications the market is almost equally divided between Apache and nginx (figure 4). The most used DNS is Amazon Route 53 (figure 5), Amazon being also the main provider of web hosting (figure 6). Wordpress is the CMS responsible for almost half of the MOOCs we analyzed, but Drupal and proprietary solutions are also popular (figure 7). Akamai and Amazon Cloud Front are the main choices as CDN goes (figure 8). In the next paragraphs we underlined some key findings of our study, regarding our main focus, distribution video platforms, audio-video parameters and the type of the video lecture together with our suggestions.

- For the instructor it is important to identify the type of video lectures depending on the domain, course objectives and the goals that he wants to achieve. He has to plan each lecture for the MOOC format and its potential students. It is necessary to consider the copyright terms for multimedia elements used in videos and slides. The instructor needs to plan ahead by selecting appropriate multimedia elements, free from copyright during the planning phase;
- Engagement patterns differ between the lecture formats. The engagement is higher with the talking head, voice over presentations and hybrid which researchers suggest that are due to more "intimate and personal feel" [31]. Moreover, interactive materials become important, although you need supplementary skills for developing them (figure 17);
- Shorter videos are more engaging. Student engagement levels drop sharply after maximum ten minutes (figure 16);
- Invest in the pre-production planning phase. Segment the course content into chunks, using six-ten minutes per video as a guideline. Identify a purpose for each video lecture, and key content points to deliver within each. Write a script for each [lecture video format] and have the instructor practice before filming-reduces filming and editing time]. Video producers and edX design teams determined that pre-production planning had the largest impact on the engagement effect of the videos. Researchers used a data set within the study to test this idea [31];
- For tutorial/demonstration videos introduce motion and continuous visual flow into tutorials, along with extemporaneous speaking so that students can follow along with the instructor's thought process. Complete basic outline of the video beforehand, not a full script to be read word-for-word. For tutorial/demonstration videos, the Khan-style format where the instructor draws on a table and narrates was found to engage students more effectively than screen casts. A contributing factor is the instructor's ability to situate himself "on the same level" as the student;
- Choose between vimeo.com, youtube.com and a proprietary solution for the hosting of your videos;
- Choose between the scenario shown in table 3 for audio-video parameters;
- Provide more personal feel to your videos. Coach instructors to use humor, personal stories and convey enthusiasm where possible.

There are many providers for the different technologies you need for developing and running a MOOC, and depending on your requirements you can choose which of them you will turn to. We presented how the big fish are doing it and we offered some reasons regarding why they are doing it like this. Further research should analyze the importance of technology, by applying our conclusions for a new developed MOOC platform and seeing the impact it has.

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