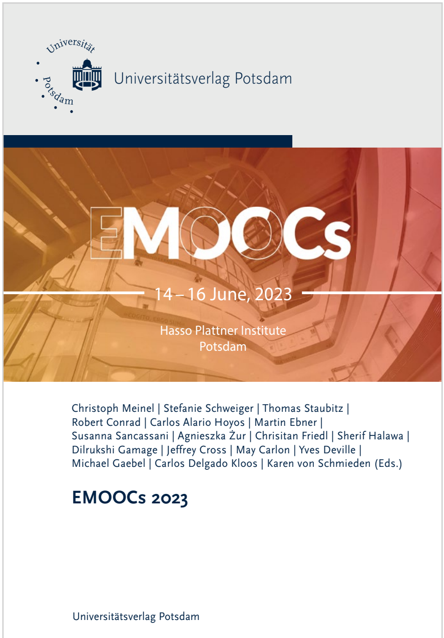
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What makes an educational video?

Deconstructing Characteristics of Video Production Styles for MOOCs

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In an effort to describe and produce different formats for video instruction, the research community in technology-enhanced learning, and MOOC scholars in particular, have focused on the general style of video production: whether it is a digitally scripted "talk-and-chalk" or a "talking head" version of a learning unit. Since these production styles include various sub-elements, this paper deconstructs the inherited elements of video production in the context of educational live-streams. Using over 700 videos – both from synchronous and asynchronous modalities of large video-based platforms (YouTube and Twitch), 92 features were found in eight categories of video production. These include commonly analyzed features such as the use of green screen and a visible instructor, but also less studied features such as social media connections and changing camera perspective depending on the topic being covered. Overall, the research results enable an analysis of common video production styles and a toolbox for categorizing new formats – independent of their final (a)synchronous use in MOOCs. Keywords: video production, MOOC video styles, live-streaming

1 Introduction

"We may value a medium and prefer to learn from it simply because we like it, not because it represents an easier way to learn or because the learner perceives him or herself as more or less capable with it". Clarke & Sugrue, 1988 [1].

MOOC producers love video – and so do students. In fact, the overall popularity of video is unbroken. Rather than decreasing, we see new video formats emerging, in two extremes: Shorter and vertical-orientated and longer and community-driven live-streaming. Further advantages are cost-efficient production, a re-usable property of recorded video and an omnipresence out side of the educational usage.

Naturally and intuitively, MOOCs and videos come as a package deal. The quote above could be then seen as a discussion starter, why we even use video.

Although nobody questions the overall usefulness and effectiveness of educational video[1], a major research stream has focused on the question whether one particular format is more effective than another. Depending on the specific time-horizon, this discussion then includes the current medium-meta: be it the first arise of virtual avatars in the 2000s, the initial MOOC cohorts from 2010 or the current discussions about language models as personal tutors. In regards to video as a medium, the academic discussion has focused on specific formats (drawing versus talking) or in- or excluding a specific characteristics (e.g. speaker yes vs. no). While these research questions yield a specific insight, the actual out-in-the-wild examples of successful – in the sense of modern social media metrics – leverage a plethora of variety. If one compares the average MOOC of recorded conference video with the average YouTube, multiple differences can be seen and analyzed. Since MOOCs are usually embedded in an academic environment, conducted and taught by Professors and their PhD research team, the design and visual style guiding these teaching teams are influenced by their natural working environments. Both use video, and apart of some institutions, academic video usage is relatively one-dimensional [11]. The default video style for recorded conference talks are a Picture-in-Picture, lower angle shot of an individual in front of a computer, presenting the well-known slide-format in one take. This stands in contrast to the aforementioned YouTube formats, that would not be using this academic conference production style, but incorporate cuts, scene transitions and less slide-based knowledge presentation. Same can be said for MOOC video production. While the early days of classroom recordings are behind the MOOC community, videos seem less purposefully recorded than for social media sites. Similarly, the popularity of video channels and major MOOC platforms are equally mature and established.

In order to overcome specific styles and deconstruct their characteristics, the given paper provides a more fine-granular overview of video characteristics. Instead of reciting the *KhanAcademy style* for instance, we provide the characteristics of educational videos. Then, the discussion does not resolve around one specific style, but the characteristics of a educational video: How the channel KhanAcademy leverages a bright,*handwritten* font on a *digital blackboard*, *without* a visible *speaker* seen in order to produce videos with a typical length of *six to twelve* minutes. As we bootstrapped a total of 19 channels with three videos each from YouTube and 172 Twitch streamer the found characteristics are grounded in successful and educational video content, that allows a projection to academic and traditional video content, such as MOOC courses.

[1] E.g. see the Cognitive Theory of Multimedia Learning by Mayer 2001 [8] as one often cited source.

Against this background, the research question (RQ) is *what characteristics can be derived from of popular educational video channels*?

The RQ will be answered by a table that is the result of coding the individual channels. A second artifact of this study is a morphological table, summarizing the 92 characteristics.

The results provide producers and media teams new ideas and inspiration for academic and educational video production styles. At the same time, researchers can conduct efficiency-led study-designs, testing similar characteristics (e.g. hand-written or digital-written) in the same or different production style. As a result, MOOCs could break out of the ever-same looking video shot in front of a book-shelve or monochromatic studio green screen background, while prototyping a format that fits the specific learning goal of a video.

The given paper contributes two core aspects to the research community. First, a deconstruction of sub-elements, that *could* make an educational video. Instead of aiming for one final production style, we deliver multiple aspects, that allow fine-tuning and planning a video-based learning intervention. Second, examples of successful and specific usages of videos in major science and education-focused YouTube videos are highlighted. Therefore, the examples are grounded in a realistic context of other educators.

2 Related Work

The relevant literature can be clustered into two groups: The underlying methodological approaches and the MOOC-specific literature that frames video-based (higher) education.

Part of the first cluster are previous attempts from the research community to analyze existing (video) data sets. While YouTube itself has the "8M dataset" [14] the raw input is less suitable for a manual coding approach and filtering options are limited. Cojocea and Rebedea (2022) [2] have filtered their dataset through the keyword "school" to understand its representation across the sample. A content-specific analysis, and especially one that target higher educational content, as often seen in MOOCs, is not feasible with this approach.

The school of thought around medial analysis work by Macnamara (2005) [7] builds the grounding framework of this study. The same author suggests combining human and automated coding. Previous related works centered around the European MOOC stakeholder summit are Reutemann [11] and DaSilva et al. (2016) [3]. The first highlighted a frequency analysis of used video styles in MOOCs, underlying the repetitive visual techniques. The latter proposed a video classification grid, allowing to break down the composition of 26 MOOC teaser videos. As both publications apply their analysis to higher educational topics and deconstruct the medium video as a pedagogical and creative tool, our works extends these aspects by providing a current view with a more in-depth analysis of individual video characteristics.

Specifically on a MOOC course level, Schneider (2013) [12] conducted a similar approach, developing (sub-)categories for MOOC aspects and features of an "Integrated Learning Environment" (p. 6), characterized through Instruction, Content, Assessment and Community. In that regard, the given study lacks the assessment part, due to the public available type of content and the lack of assignments on general purpose video platforms such as YouTube.

As mentioned above, various papers focus on one distinct characteristics (e.g. speaker & social-cues y/n: [5] or handwriting: digital vs. analogue [10]). Two publications extends these discussions. The first is Lackmann et al. (2021) [6], by a study that compares two video-based condition (info graphic vs. lectures) and analyzes them on various levels of engagement, including emotional and cognitive. Usually, a lot of work is focused on learning performance alone (see the systematic review by Poquet et al. (2018) [9]). The second noteworthy work is done by Hansch et al. (2015) [4]. The work generalizes key learnings for producers, derived from existing educational videos. One of these recommendations, that motivated the given paper is "There is no one-size-fits-all approach to making a learning video" (p.13). One caveat is the overlap of video characteristics: While they underline 18 different video styles, the final (visual) product is once again treated as a priori known - something that we argue would be the result of various factors and thus an output. A novel insight is delivered by Xia et al. (2022) [13], interviewing science creators and viewers alike. They highlight different motivations (sharing knowledge about a topic, change users' behavior and education) as well as the difficulty to engage (science) enthusiasts, while also including lay people and a broader audience.

3 Methodology

The research design applies the following steps to derive the characteristics:

Identifying suitable educational channels: First, 19 established channels in the realm of science and education on YouTube.com were identified. Based on Blog articles and Top-Lists, 59 channels were considered[2]. The first quantitative requisite was at least one million subscribers, which most niche and newer channels naturally

[2]See https://www.geekwrapped.com/posts/youtube-science-rockstars-shows and https://www.reviewgeek.com/104955/the-best-youtube-channels-for-science-enthusiasts/

cannot fulfill. By focusing on larger channels, we made sure that enough content and viewers represents an established video format. In order to have a broad field of subjects, the usual representative of university faculties were preferred (STEM, jumanities, life sciences). Another qualitative requisite was set regarding the the general topic, as larger general educational and science communication channels were included as well. Content that was not specifically recorded and produced for a primarily digital audience, such as classroom and seminar recordings, were excluded. Although larger channels with educational purposes exists[3], less video production features are obtainable from this kind of material.

For each channel, the three most popular videos (used YT owns filter option) were chosen, arguing that the most often watched would represent popular and hence successful features of general science and educational content. Each of the total 57 videos were then downloaded and processed by an ffmpeg script[4] to extract an image series of snapshots from each video. As a result, a still image summary was created which was used as a start to code the characteristics. Since some of the characteristics are not obtainable from still images alone, the research team carefully watched the included material and extracted the respective aspects.

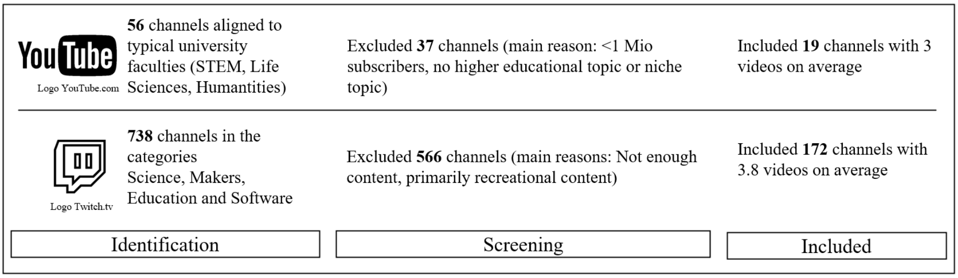

Figure 1: Data collection procedure

Table 2 summarizes the included channels and the production style they use.

Combining recorded and live-content: Finally, the existing dataset of educational live-streams have been incorporated. As part of previous work of the research group, it follows the same collection process and coding procedures. As every live-stream is a recorded video once the broadcast ends, these two formats

[3] https://www.youtube.com/@stanfordonline/ or https://www.youtube.com/@mitocw

[4] The scene-detection class with a threshold of 0.05 and 0.25 was used, which applies a sum of absolute differences to each frame.

are related and similar production styles can be derived. From a content point of view, if a live-setup is feasible and successful regarding learning gains and retention, arguably its recorded – and an even more condensed version due to post-production and cutting techniques – is sufficient as well. Even more so, as a live-stream can be cut in various smaller videos for MOOC settings or can be enriched with other video footage and narration.

Table 1: Applied procedure to code characteristics from included video data

For coding labels: 1) Take new channel out of list 2) Open extracted image summary 3) Extract visible characteristics (c) 3.1) If c is unkown: Insert new line in spreadsheet 3.2) If c is known, but new parameter (p): Insert new parameter value 4) Open video, apply steps 3.1 and 3.2	For coding categories: 1) Find mutually exclusive labels 2) Define difference between them 3) Re- and sub-group according to aggregation level Schedule: Two channels per session to minimize carry-over errors. Once c is stable, assign reference point: Asynchronous (A) Synchronous (B) or Both (B)

At end of coding session, check for coherence and over- and undercoding of c and p.

Repeat if overlap detected, in case of doubt: Generalize c for future content.

Coding the material: As a final step, the material was viewed and the open coding procedure was followed, see Table 1.

All videos were watched with the educational purpose and higher educational learning contexts in mind. While the general call to action in *any* video might be "Like, share and subscribe", we found learning-specific call to actions. Among these are "pause the video to think for yourself" and "do the exercise we linked in the video description". For the same reason, purely recreational and gaming related activities – as these have a large subscriber and activity count – are excluded.

Comments and demographics of hosts and lecturers were excluded. The first category cannot be analyzed without further data, as the publicly visible comments are already filtered and moderated. As for the the speakers demographics, this is likely nothing a teaching team could change to produce a MOOC. Lastly, platform specific (technical) features were excluded. One example are information cards in YouTube videos, that indicate a recommended video by the currently watched creator. As we are driven by the possibilities that the medium itself provides, these features are secondary.

4 Results

Each of the channel leverages different approaches and styles, attracting millions of viewers across disciplines:

Table 2: Production style summary of the 19 included Science & Educational YouTube channels. Subs: Subscribers in Millions. Derived at March 2023.

Channel	**Topic**	**Subs**	**Characteristics Summary**
3Blue1Brown	Math	5.03	Scripted animation, dark background with brighter ascent colors, mascot
Bozeman Science	Biology	1.29	PiP View of visible lecturer with images or naturalistic material
CGP Grey	History & Geology	5.81	Image-based narration digital avatar, fast-paced
Chubbyemu	Medical Science	2.77	Partial display of host, stock photo and display of medical equipment
computerphile	Computer Science	2.27	Interview-driven lecture in office spaces, paper-based or IDE
CrashCourse	General Edu	14.6	Talking-head studio recording, enriched with animations and b-rolls

DIY Perks	Practical Engineering	4.15	Video summary of hands-on tutorial, various close-shots
Khan Academy	General Edu	7.78	Bright handwritten font on dark background, few anchor images,
Kurzgesagt	SciComm	20.2	Custom animations one fluid motion
numberphile	Math	4.24	Similar to computerphile; slightly more tangible items as anchor prop
PatrickJMT	Math	1.34	Top-down view of hand-written solutions to specific problem sets
Physics Girl	Physics	2.67	Documentary recordings, studio-narration, breakdown of recorded experiments
SciShow	SciComm	7.43	Talking-head, studio, green screen setting, narration with anchor images
SmarterEveryday	General Edu	10.9	Documentation style, interviews and guests, phenomenon-led narration
TheBackyardScientist	Mech. Engineering	5.57	Outdoor experiments: “what happens if?”-narrations, slow-motion perspectives

ThioJoe	Technology	2.95	Talking-head of IT problems, office environment, step-by-step PC instructions
Tyler DeWitt	Chemistry	1.33	Studio environment of two main perspectives tangible hand-written material
Veritasium	Physics, SciComm	13.5	Documentary-like videos of physics phenomena, interviews, problem-driven
Vsauce	SciComm	18.5	Informal or studio talking heads; stock-material and handwritten as well as anchor images´

The following section outlines the found characteristics and their respective categories.

4.1 Categories of Video Production

In total, seven categories with 92 characteristics that describe (a)synchronous, educational video usage have been found. Additionally, an eighth characteristics summarizes existing formats, which we labeled "the output" as the overall production style should be seen: A final result of the recording procedure and targeted learning goals. Figure 2 shows example parameters, the whole table with clickable examples can be accessed under https://www.dropbox.com/sh/e355i0773f370by/AAC5sYrbzUqzY9CDhhobXn-ra.

Audio – 5 characteristics Audio summarizes the technical container that holds information about the audio context. Among them are sampling and bit rate as well as the amount of silence or pauses a video has. This could then be used as a proxy to measure how fast-paced a learning video is.

Channel – 20 characteristics Channel describes the decisions a channel makes as a whole and what is true as an overarching characteristics. The general difficulty and main audience, including social media links and how many uploads are given are all broader information.

Chat – 12 characteristics Chat only applies for synchronous video feeds, but encapsulates the process of moderating, level of interaction, topics and usage of automated content.

Content – 28 characteristics Content is the primary aspect of how video production can be tuned and changed. Often characteristics like green screen usage, drawing style and the recording environment are included. At the same time, the used media are deconstructed through nine different parameters. Noteworthy is the information *Initial Educational Point* as most analyzed videos start with a phenomenon or layperson's questions, and not with a textbook problem. Additionally, the used material is also rather video- instead of slide-based and more than one camera perspective is used.

Content	**Main Purpose of Video**	Organizational Message	Topic Introduction	Problem set Introduction	Hands-on Problem
Content	**Initital Educational Point**	Question-led	Phenomenon result	Textbook problem	Buzzword Definition
Content	**Media**	Slides / PPT	Browser	IDE	Write (Analog)

Figure 2: Excerpt from derived characteristics for "Content"

Monetization – 2 Characteristics Depending on the MOOC platform, economic interest vary. Most of the analyzed channels pursuit economic interest. In order to outline the most common ones, two items were included (*Payment Types* and *Advertisements (embedded)*.

Output (Format) – 1 characteristics The overall video production style is as mentioned above the output of all the other decisions and input characteristics. Furthermore, one video could leverage multiple formats, e.g. starting with slow-motion footage of an experiment, followed by a narrated explanation of the underlying concepts through formulas and still images

Thumbnail – 5 characteristics Thumbnails are vital for general purpose platforms, for MOOC courses the course description and initial trailer video might be more important. As every individual encounters thumbnails and also large streaming platforms experiment with them, five found characteristics were included.

Video – 18 characteristics Similar to Audio, the video category is the technical container, describing the possibilities of a video description, frame rate, recording speed and other characteristics with 18 elements. The often discussed length of a video is included with eleven parameters, covering everything from less than three minutes to lecture-like sessions of over 100 minutes.

5 Discussion & Conclusion

Although it is intuitively understandable to compare different learning conditions against each other, measuring output variables and recommend a specific usage, the generalization of these results into other learning scenarios remain limited. For video production, there is no "golden cut", to secure learning gains or even interest in a video – recorded or live. This requires two major components: First, access to a dedicated recording and post-production process, including equipment and staff. Second, a flexible usage of these two. While it is tempting to settle for one specific style, different scenarios require different video formats. Through a general description of the 92 found characteristics, future settings can be categorized: Be it about the purchase of a lightboard, a hybrid seminar room or the incorporation of student-created material for the next MOOC. Similar to on-going questions about the ideal length of a MOOC video, the discussion then shifts to the reasons, *why* a specific production styles is more suitable for the given context. The outlined toolbox can then be used by teaching teams and course designers to match the lecturers preferences, the learning goal and the context of a MOOC unit. For research, this deconstruction of sub-elements allows to control smaller details of different conditions, while having a realistic projection of existing video-based education that our MOOC learners face on different platforms.

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