Making Effective Videos and Live Online Lectures Quickly with a Live Composite Format

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Abstract

Instructional videos are the dominant mode of content delivery in higher education. They can be an effective tool for delivering educational content, providing flexibility in time and location and improving students' understanding of the material. The effectiveness of such videos may be enhanced by applying principles for multimedia design, which are based on a cognitive theory of multimedia learning. One way to adhere to those principles is by showing the instructor together with additional visuals on screen. Some studies suggest that this may have a positive effect on student learning and overall performance.

The combination of the instructor and other visuals is usually done in post-production editing, which can be a time-consuming process. In this paper, a live composition video format is proposed, where the instructor is integrated into the presentation during recording. Using this approach, it is possible for the instructor to interact with added visuals directly, requiring little to no post-production. Furthermore, this method can also be used to enrich and increase the efficacy of synchronous live online lectures.

Introduction

Online and hybrid learning formats have been growing in the past years, especially after the COVID-19 pandemic conditions (CHLOE 8, 2023). The crisis-driven shift to online teaching has accelerated digital transformation in higher education. While challenges exist, the experience has also revealed opportunities for improving online education practices (Hofer, Nistor & Scheibenzuber, 2021). It is possible to implement online courses in a way that shows no significant difference in student satisfaction between online and face-to-face formats (Driscoll, Jicha, Hunt, Tichavsky & Thompson, 2012). Good courses may achieve equivalent or better student course performance than the same in-person courses (Zheng, Bender & Lyon, 2021).

The use of videos or synchronous video conferencing often plays an important part in implementing such formats (Hansch et al., 2015; Dinmore, 2019). Such videos may improve learning outcomes compared to other teaching methods, especially when supplementing existing content rather than replacing it. (Noetel et al., 2021). Some studies show an overall positive effect on student learning, satisfaction and success rates when using instructional videos as primary means of delivering instructional content (Brecht, 2012; Dunleavy, Kestin, Callaghan, McCarty & Deslauriers, 2022; Klein et al., 2021; Mayer, 2017).

Educational videos can have different formats, such as a recording of an in-person lecture (lecture capture) or interview-style recordings of an instructor. Another form is the recording

of narrated slides (slidecast), explanations on the presenter's screen (screencasts, for example Khan Academy style), or top-down recordings of the instructor writing on a surface (Hansch et al., 2015). These forms of presentation can either include a video recording of the instructor in a separate area (picture-in-picture) or the instructor is not visible (voice-over) (Deng, 2024; Mayer & Fiorella, 2022).

To facilitate synchronous communication between instructors and students for live online teaching, in many cases, videoconferencing systems are utilised (Turnbull, Chugh & Luck, 2021). These systems are often used in the following fashion: a screen-share shows the instructor's slides or similar material; the video feed of the instructor and other participants are shown in small tiles on a side of the screen. From a viewer's perspective, this form of presentation or explanation may appear like a recorded video lecture, similar to a slidecast or a screencast.

Being dissatisfied as both, the recipient and producer of such online-lectures and videos, I aimed to change the format and improve the students' satisfaction and learning outcome. The result is a live composite format, where the instructor's video is digitally combined with a separate video feed. This way, additional multimedia elements can be incorporated, and the instructor may seemingly interact with the content. Unaware to me, this approach was also employed by Rosenthal and Walker (2020). In addition, the developed method may also be used to produce educational videos with reduced production time.

In this paper, relevant design principles for effective educational videos are summarized. Particular emphasis is placed on principles that may be relevant for synchronous live online lectures and for instructor presence. By introducing a method to create a live composite video format, synchronous online lectures may better adhere to multimedia design principles that support learning and possibly foster social aspects that could benefit learning.

Cognitive theory of multimedia learning

Videos are multimedia artefacts in the sense that they combine (animated) images, text and sound. A framework for how to design videos to be an effective tool for teaching and learning is Richard Mayers cognitive theory of multimedia learning (CTML) (Mayer, 2017; Mayer, 2021a).

The premise of the cognitive theory of multimedia learning is that students learn more effectively and efficiently when information is presented in a combination of words (audio) and pictures (visual) rather than words alone. This theory is based on cognitive psychology and the idea that learners have limited cognitive capacity and information-processing abilities. Thus, multimedia materials should help them select, organise, and integrate information into long-term memory. The goal of CTML is to understand how to optimise the presentation of multimedia materials to guide the students' learning process (Mayer & Fiorella, 2022).

A detailed description of CTML and the corresponding design principles can be found in the literature (Mayer, 2021b; Mayer & Fiorella, 2022). The following is a short overview of this framework.
With instructional videos, the learning process begins with the learner's exposure to a multimedia instructional message. This message is processed through both auditory and visual channels (extraneous processing). The information is then further processed in the learner's working memory, which has limited cognitive capacity (essential processing). An internal

representation of the material is constructed and integrated with relevant prior knowledge retrieved from the learner's long-term memory (generative processing). This newly formed knowledge can then be consolidated in long-term memory, which has an unlimited capacity to retain meaningful information.

For the different processing stages, various problems may occur that require instructional design solutions:
If the demands on extraneous processing are too high (extraneous overload), the remaining capacity for essential and generative processing is insufficient. Distracting elements, such as interesting but irrelevant images, additional text or unneeded sound, can cause this phenomenon.
If the lesson is too complicated or too much relevant information is presented at once, the learner's capability for essential processing is overwhelmed (essential overload).
On the other hand, if an instructional video is presented in an uninteresting fashion or the viewer finds it to be of no value, generative underutilisation takes place: the available cognitive capacity is not used to its full potential.
Generative processing is the cognitive task of making sense of the material. Understanding requires effort, and the necessary level of capacity for generative processing depends on the learner's motivation.
Therefore, three goals should be pursued when designing multimedia lessons: reduction of extraneous load, managing essential processing and fostering generative processing. The principles addressing these goals are summarised in Table 1.

Table 1: Cognitive Theory of Multimedia Learning Principles (Mayer, 2017; Mayer, 2021a; Mayer, 2021b; Mayer, & Fiorella, 2022)

Goals	Name	Description
Reduce extraneous processing	Coherence	Exclude unnecessary words or images.
	Signalling	Use highlighting cues.
	Redundancy	do not narrate on-screen text.
	Spatial Contiguity	Corresponding words and pictures should be close to each other.
	Temporal Contiguity	Words an pictures should be presented simultaneously.
Manage essential processing	Segmenting	Split units into smaller segments.
	Pre-Training	Learn information in advance.
	Modality	Use spoken words and pictures.
Optimise generative processing	Personalisation	Present in conversational style.
	Voice	Use human voice.
	Embodiment	On-screen instructor uses gestures.

Current Practices in Educational Video Production

Besides considering the multimedia principles for educational videos, the choice of format in which the video is produced may also affect learning outcomes (Chen & Wu, 2015; Korving, Hernández & De Groot, 2016; Castillo et al., 2021). Capturing the content in the form of a

lecture recording may help as a start in student learning. Still, a more deliberate and purposeful approach to producing videos should be adopted (Witton, 2017). Slidecasts or screencasts with picture-in-picture of the instructor may improve the perceived learning of students but shows little effect on actual learning (Wang & Antonenko, 2017).
In a live composite video, the instructor is visible on the screen. Therefore, a closer look at the more speaker-centric formats in use today may give information about the effectiveness of the proposed format.
Several studies have investigated the effect of a visible instructor on student engagement, satisfaction, learning outcomes.

Other studies (Jose, Kochandra &Daniel, 2021; Guo, Kim & Rubin, 2014) found that students show a preference for videos where instructors are present, instead of screencasts. Another study (Chan, Kok, Razali, Lawrie & Wang, 2022) suggests that on-screen instructors lead to higher student engagement and are generally perceived as more helpful.
Instructor presence may also positively affect learning satisfaction. Online learning self-efficacy is positively associated with learning satisfaction and motivation (Lim, Rosenthal, Sim, Lim & Oh, 2021; Alemdag, 2022).

Carefully designed videos may significantly improve students' understanding of material, and may have an overall positive effect on student learning and success rates with instructor presence (Dunleavy et al., 2022; Ng & Angstmann, 2017).
A systematic review on instructors' presence (Polat, 2023) shows that learners generally have positive feelings towards instructor-present videos. The effect on learning outcomes is inconclusive, due to many other additional factors like video style (picture-in-picture, lecture style), difficulty, instructor characteristics (Beege, Krieglstein & Arnold, 2022).
On the other hand, no positive or even a negative impact on learning (knowledge acquisition and transfer) and social presence is also reported (Alemdag, 2022; Beege, et al., 2022; Deng, 2024), probably due to an increase in cognitive load. Although students prefer and believe that they learn best from formats where the instructor is visible, experiments showed that actual learning can be impaired (Wilson et al., 2018).

Sometimes instructors struggled with transitioning from traditional lecture formats to shorter, more focused video content. Staff needed training to communicate effectively on camera, which is quite different from preparing for a lecture or tutorial (Guo et al., 2014). This is important, since an instructor's appearance or behaviour may also have negative effects (Beege et al., 2022). In general, the mere presence of the instructor does not improve learning outcomes. It may potentially distract students. Instructors should be engaged in activities intended to direct students' cognitive processing towards constructing meaning from the learning material (Fiorella & Mayer, 2018).

In conclusion, there is evidence that carefully designed and produced videos with instructor presence can have a positive effect on student learning and engagement.

Live Composite Video: An Innovative Approach

One of the distinct features of the presented live composite video format is the fact, the instructor is visible on screen. This method may be well suited to adhere to certain CTML principles. The instructor may be framed in a way that allows to see his gestures (embodiment). By actively pointing to elements on the screen, the attention of the viewer might be directed

(signalling, spatial and temporal contiguity, modality). If the speaker looks into the camera, a conversational style may be achieved (personalisation, voice). Since the image of the instructor takes up some on-screen space, there is less room for other material to be presented simultaneously. This may be a chance to remove unnecessary words or images from the material (coherence).

There are several methods for producing videos with instructor presence (Deng, 2024). A technically simple solution is to screen-record a slide-show presentation and to record the instructor with a camera. In post-production editing, a cropped version of the instructor video can be laid over the slide-show or the slide show can be placed next to the instructor in the video-feed (picture-in-picture). However, this method does not allow the instructor to interact with the material, as the two video feeds are separated and one video feed obscures the underlying video.

Another method is to integrate the instructor by creating a composition of the video feed of the instructor and the material. This is usually done by using a single colour background, usually green. In this case, the background colour of the video signal is selected and made transparent (a process called “keying”). This way, several different visual elements can be layered on top of each other. If the instructor is standing in front of a green-screen, the background can be keyed out and the instructor is visible in front of another video feed (for example a power-point presentation). The instructor is now a part of the presentation, and better able to achieve embodiment, spatial and temporal contiguity and the ability to gesture and signal.

This content composition in the form of pictures, slides or animations is usually created during editing in post-production. However, some limitations need to be considered: the time required for this type of post-production can be very high (Guo et al., 2014). In addition, it requires creative and technical competencies to produce such videos (Castillo et al., 2021). Furthermore, the instructor is unaware of the exact positioning of the visuals that will be added after recording. Interacting with the material can therefore be difficult.

Some of these limitations can be overcome by a live composition of the instructor and the visual elements.
In a live composite video lecture, input signals from different sources are layered on top of each other during recording. This technique can remedy the limits of picture-in-picture formats and may also require little to no editing in post-production. Furthermore, instructors are able to apply this technique using freely available software on their computers, which can be an essential benefit (Witton, 2017).

Using a secondary monitor or a teleprompter, the instructor can be enabled to see the video during recording. In this case, the instructor can be aware of the utilized visuals and their positions on screen. The instructor may actively take a position that ensures that the other media content is visible and is able to point to certain areas of the additional elements. A control monitor may be placed in a way that creates the appearance of the instructor looking at the superimposed material (Rosenthal & Walker, 2020. By using a teleprompter, the instructor is able to look into the camera, generating the sensation of eye contact.

Since multimedia elements are already present during recording, the extent of editing in post-production may be reduced. If no additional elements or effects need to be included in the video, trimming alone may already be sufficient.

The finding of one study suggests that the perceived quality of a live composite video lecture is similar to a face-to-face class but much worse for picture-in-picture (Rosenthal, & Walker 2020). This may be attributed to the spatial contiguity principle, since the instructor and content are in the same space. In addition, the ability to interact with the content satisfies the signalling and embodiment principles. The same study also found that viewers experienced the most instructor social presence. This is especially valuable in online learning spaces (Richardson et al., 2015).

Implementation of Live Composite Video

There are several possibilities for creating a live composite video, two of which are described in the following examples. Using video composition software such as the freely available Open Broadcaster Software (*OBS, 2024*), different video sources can be superimposed: The video output of a camera recording the instructor serves as one source, and the display capture of another computer display serves as the second source. The following examples will use *OBS*, but the same principles apply to other video composition software as well.

Instructor behind multimedia content

In the first example, the camera records the instructor while standing in front of a relatively homogeneous background. The background of a slide presentation on another computer display is set to a solid colour. This colour will be made transparent in *OBS*. The two sources are layered on top of each other in the scene arrangement of *OBS*, the display capture on top of the video camera. A chroma-key filter is applied to the display capture source, keying out the background colour of the slide presentation (Figure 1). As a result, the slides appear in front of the instructor. To reduce keying artefacts, the colour keyed out should match the colour of the presenter's background. This method is easier to implement, as it has less demand for perfect lighting and on the look of the actual background.

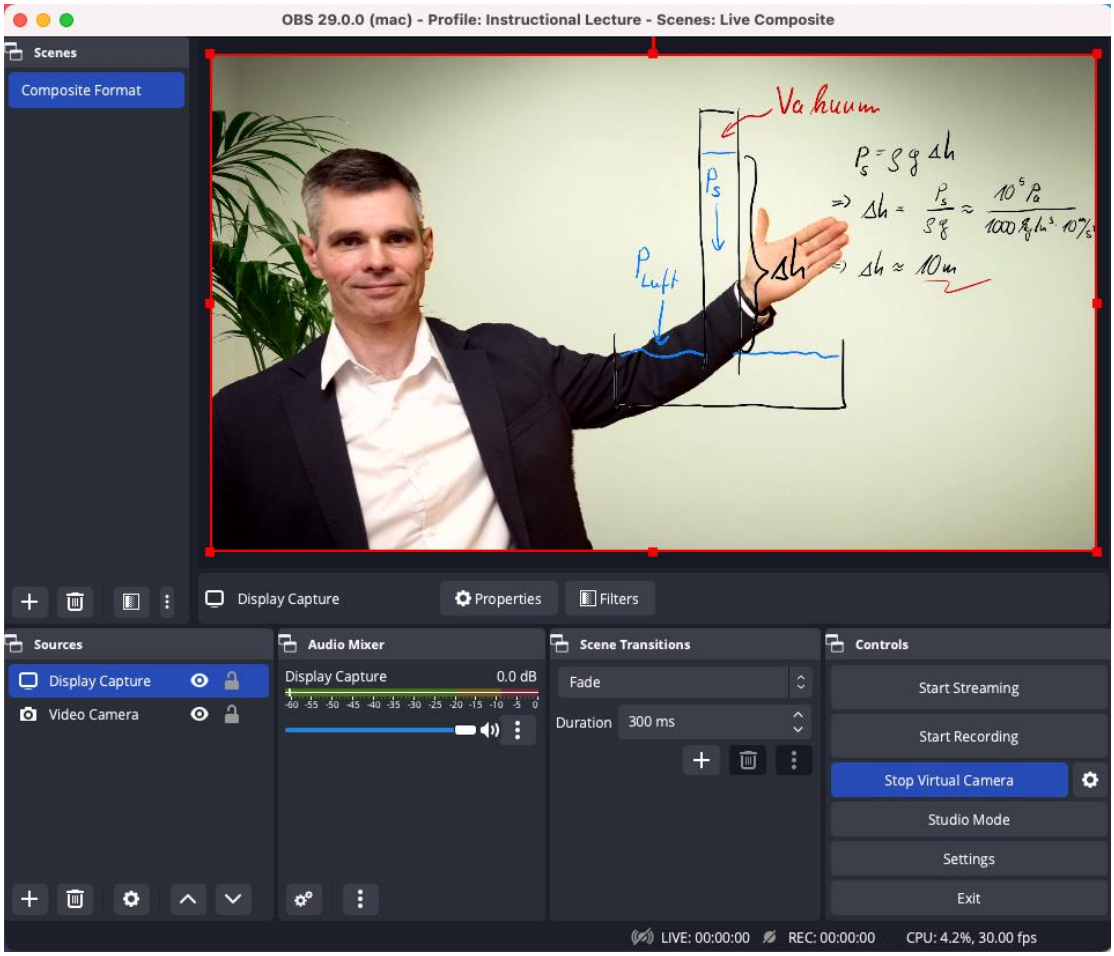

Figure 1: The instructor is standing in front of a homogeneous background. The video feed is an input source in *OBS*. Overlayed is a slide presentation on a different screen, the second input source in *OBS*, where the background is keyed out. Using this method, the slide appears in front of the presenter.

Instructor in front of multimedia content

Another example of producing a live composite video this effect is by keying out the background behind the instructor. In this case, the instructor is standing in front of an evenly lit single colour screen (usually green). The background is replaced with the presentation slides, and the instructor stands virtually in front of the presentation (Figure 2).

Figure 2: The instructor is standing in front of a green screen. The green areas are removed (keying) and replaced with the contents of another display, in this case, a slide presentation. Here, the resulting live composite video is used in a live video conference.

Live Composite Video

In both examples, after the instructor has designed and planned the video lecture, the lecture can be recorded. The instructor is able to progress naturally through the presentation, similar to a standard in-person lecture or screencast.

This method is not limited to displaying slide presentations. In the software, various scenes can be configured, which allows the incorporation and placement of multiple sources in the final composite video: static images, videos, websites, text, and the output of any other software can be included. The placement of different elements can be changed for different scenes, and some variety may be introduced into the video. If the software has the ability to serve the live video feed to other applications, it may also be used in a video conferencing system (as displayed in Figure 2).

Consequently, this method is not only limited to recording videos, but is also capable of being used in a synchronous video conference. In this case, learners may also benefit from the application of multimedia principles during the video conference. Furthermore, the lecture can be enriched by setting up scenes with different camera angles or changing between close-ups and wider shots. This way, more variation may be introduced. The lecture may be more interesting and motivating than a standard lecture, which is dominated by a static screen share with a small picture-in-picture video of the instructor (Brown, 2021).

Moreover, different effects may be incorporated to direct the synchronous video conference. A few examples are the use of animated text to signal certain activities, such as the participation in or the nearing end of a poll, waiting for participants to return from break-out rooms. Before

the actual lecture begins, an information screen about the beginning and content of the upcoming class, including a timer, can be presented. An on-screen timer can inform participants about the remaining time during a break or contemplation period.

Challenges and Limitations

The live composite video format is suitable for low-budget or at-home setups, which can be advantageous for individual educators or smaller institutions. It may be difficult to adopt for productions outside a designated recording space, for example laboratories or outside.

Instructors may have to invest a lot of time and effort to apply this video production technique, especially when there is little prior experience. This learning process may initially reduce the efficiency gains. (Castillo et al., 2021)

While the live composite method can save time in post-production, time investment in the preproduction phase may not be underestimated. The final image layout of the video should be considered when creating and organising visual aids, since the instructor will be included on screen during recording.

As discussed earlier, while much literature supports the benefits of instructor presence in educational videos, some studies have found no significant impact or even negative effects on learning outcomes. This discrepancy in findings suggests that the effectiveness of the live composite format may vary and is dependent on multiple factors.
The incorporation of additional effects and management of the recording process during content presentation may significantly increase the cognitive load on instructors. This elevated mental demand, which intensifies as more elements are integrated, can potentially impact the instructor's ability to deliver content effectively.

Conclusion

Instructors giving live online lectures or recording instructional videos may improve their effectiveness by utilising a live composite video format. This format can help them in implementing multimedia principles in that may promote learning. Especially, the ability to place themselves into the space of the presented content may be beneficial. Instructors may be able to produce high-quality videos with little or no post-production time required and may use these methods also in synchronous video lectures.

Research suggests that learner attention, positive emotion, perceived quality, and instructor social presence is higher for live composite videos (Rosenthal & Walker, 2020).
However, using the live composite video format is not without its challenges. Educators and institutions should consider these limitations and invest in appropriate training, planning, and resources to maximise the benefits of this approach while mitigating potential drawbacks

Future research on this topic could focus on the actual effects of live composite videos on several aspects, such as student learning gains, student engagement, long-term retention and student satisfaction. In addition, the actual amount of time and effort it takes to produce videos and the benefits gained by using the live composite method is also of interested. Probably due to technical limitations, the effect of different video formats in synchronous online

videoconferencing has not yet been studied. Since the live composite video method may open up new possibilities, evaluating its effect in this setting may be of interest.

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