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Know your stuff, show enthusiasm, keep it on message: Factors influencing video engagement in two mechanical engineering courses

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ABSTRACT

CONTEXT

Video usage in higher education has increased markedly over many years, but ongoing disruptions caused by the COVID-19 pandemic have accelerated this trend. Consequently, a growing number of educators are grappling with how to best approach video production. Although a range of factors such as video quality, video length, and the presenters' style are known to influence student engagement with videos, more research is needed to understand the extent to which these factors impact, particularly in higher education. This can support educators producing video content that prioritises those aspects which are most critical.

PURPOSE

This research seeks to understand what factors are most influential on students' decisions to engage versus disengage with video resources in the higher education context. This aims to develop a series of recommendations for educators to focus on when producing videos for inclusion in higher engineering education courses.

APPROACH

This research considers two mechanical engineering courses taught at different Australian universities. These courses used videos as the primary delivery mode during Semester 2 (July to November) of 2020. Approximately half of each course explicitly applied production recommendations of a highly influential study. Students were surveyed at the end of the semester about their engagement preferences.

OUTCOMES

The quality of the presenter's explanations and their enthusiasm in delivery were the most important factors influencing engagement, while seeing the presenter was least important. Video length and quality were more likely to cause disengagement when poor, than drive engagement when done well.

CONCLUSIONS

Characteristics of the presenter's delivery (that is the quality of their explanations and their enthusiasm) are more influential in producing engaging video content than technological choices relating to the video capture and length. Therefore, educators should seek to prioritise the quality of their explanations and their stage presence, before working to improve the video/audio capture quality and reducing video durations. Including the face of the instructor in educational videos has little impact on students' usage decisions.

KEYWORDS

Educational videos, student engagement, video production

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Introduction

Video usage in higher education has increased markedly over many years (Fyfield et al., 2019), but ongoing disruptions caused by the COVID-19 pandemic have further accelerated the trend. Consequently, a growing number of educators are grappling with how to best approach video production within their contexts. Although a range of factors such as video quality, video length, and the presentation style are known to influence student engagement with videos (Dart, Cunningham-Nelson, et al., 2020; Guo et al., 2014; Kay, 2014), more research is needed to understand the extent to which these factors impact, particularly in higher education. This can support educators to prioritise those aspects which are most critical when producing video content.

The increase in videos in educational contexts been motivated by improved accessibility of authoring tools, and research demonstrating the benefits of videos for learning (Berger & Wilson, 2016). Videos have subsequently been incorporated in a wide range of ways to engage students, with video styles varying according to learning objectives (Winslett, 2014). Overwhelmingly, research has shown that students value learning with videos because of increased accessibility of the resources, enhanced flexibility that enables tailoring to students' individual needs and preferences, and better learning outcomes (Dart, Cunningham-Nelson, et al., 2020; Dart, Pickering, et al., 2020).

A body of research has examined what factors influence video engagement and the quality of learning undertaken. For example, Di Paolo et al. (2017) emphasises the importance of the instructor's social presence within videos given the lack of real-time, face-to-face interactions in asynchronously delivered online courses. This presence can be achieved through visual representations of the instructor on screen, their use of language, and non-verbal cues such as body language. Kay (2014) highlight the criticality of instructional explanations in supporting students to understand and apply concepts using videos. They note that the use of examples is particularly effective in maths-based subject areas as it supports simplification of abstract concepts. Mayer (2021) developed a series of principles for designing effective educational multimedia content. This advises educators to avoid extraneous material while signalling key material, locate printed text near relevant graphics, and present words as narration rather than printed text.

One of the most influential studies on educational video production was performed by Guo et al. (2014). This study empirically analysed user interaction logs from videos used in four massive open online courses (MOOCs). Based on this analysis, seven key recommendations were made (Guo et al., 2014, p. 2):

1. Invest heavily in pre-production lesson planning to segment videos into chunks shorter than 6 minutes.
2. Invest in post-production editing to display the instructor's head at opportune times in the video.
3. Try filming in an informal setting; it might not be necessary to invest in big-budget studio productions.
4. Introduce motion and continuous visual flow into tutorials, along with extemporaneous speaking.
5. If instructors insist on recording classroom lectures, they should still plan with the MOOC format in mind.
6. Coach instructors to bring out their enthusiasm and reassure that they do not need to purposely slow down.
7. For lectures, focus more on the first-watch experience; for tutorials, add support for rewatching and skimming.

The present study investigates how strongly selected attributes of educational videos contribute to students' decisions to engage and disengage with videos. This is explored in the context of two mechanical engineering courses, which each adopted the above recommendations of Guo et al. (2014) to varying degrees throughout the courses.

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Method

Context

This study considers two mechanical engineering courses taught during Semester 2 (July to November) of 2020. The courses were:

- "Modelling and Control" at the University of Newcastle, which was compulsory for students in mechanical, mechatronics, electrical, aerospace, and medical engineering programs during their second or third year of study. The course enrols about 250 students per semester.
- "Dynamics" at the Queensland University of Technology, a second-year course taken by students in the mechanical engineering stream that also enrols about 250 students per semester.

Both courses were team-taught, and utilised pre-recorded lecture videos for the first time in 2020. In Modelling and Control, the course content had long been delivered through two consecutive streams – the former focused on mathematical modelling of physical systems and the latter focused on design of controllers for these systems. While both streams utilised pre-recorded lecture videos, they approached the production of these videos differently, owing largely to different teaching styles of the two lecturers. The modelling stream – as much as possible given time constraints – explicitly applied each of the recommendations made in Guo et al. (2014). The control stream applied only some of these recommendations. Similarly in Dynamics, the first half of the course that focused on particle dynamics primarily used classroom lecture recordings with minor editing from the previous year. The second half of the course's lectures that focused on rigid body dynamics were pre-recorded by applying many of the recommendations made in Guo et al. (2014). A direct comparison of adoption is given in Table 1, and indicative screenshots of videos from each stream (with the faces of presenters blurred for anonymity) are shown in Figure 1. It is worth noting that the lecture videos are described as either concept introduction (CI) videos where a new theory or idea is discussed, or worked example (WE) videos where a problem is worked through step-by-step (Dart, 2020).

Data Collection

Given each course had experienced a range of production styles, students in these courses were considered well-positioned to comment on their preferences. An anonymous online survey was circulated at the end of the semester. This asked students about their engagement with the videos throughout the semester, including frequency and methods of interaction, perceptions of learning, and preferences. This paper focusses on two high-level questions from the survey, which probe student perceptions around video attributes that incentivise and disincentivise engagement. The attributes of interest were:

- Audio Capture Quality
- Video Capture Quality
- Seeing the Presenter
- Enthusiastic Delivery from the Presenter
- High Quality of Explanation
- Short Video Duration

Students were asked to score each of these attributes on a 5-point Likert scale (where 1 represented low impact and 5 represented high impact) according to:

1. How strongly they contributed to their decision to *engage* with a video.
2. How strongly they contributed to their decision to *disengage* with a video.

Survey response data is summarised in Table 2. Overall, 109 responses to the survey were received, representing a response rate of 21.7%.

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Table 1: Characteristics of lecture videos by course component

Recommendation from Guo et al. (2014)	Modelling & Control		Dynamics	
	Modelling	**Control**	**Particle**	**Rigid Body**
1: Create short videos	Average length (mins): CI 3.8, WE 14.0	Average length (mins): CI 14.7, WE 11.1	Average length (mins): CI 80.2, WE 25.4	Average length (mins): CI 18.8, WE 23.2
2: Display instructor's head	Face present in all videos	Face present in all videos	Face present in all videos	Face present in CI videos only
3: Create for personal feel	Videos filmed with presenter 'full screen' and graphics added in post.	Screen recording of PowerPoint slides.	Classroom recordings of lecturer presenting slides and writing under document camera.	Screen recording of PowerPoint slides for CI videos and OneNote for WE videos.
4: Motion and continuous visual flow	WE screen-recorded iPad writing	WE screen-recorded iPad writing	WE solved on paper under document camera	WE screen-recorded Microsoft surface writing
5: Create with online format in mind	Videos newly created exclusively for online format	Videos newly created exclusively for online format	Minor editing of previous classroom recordings	Videos newly created exclusively for online format
6: Speak fast and with high enthusiasm	Average 203 words per minute	Average 119 words per minute	Average 122 words per minute	Average 169 words per minute
7: Design lectures for first watch experience, tutorials for re-watch	Popups used to highlight important information. Longer WE timestamped.	Boxes used in PowerPoint slides to highlight important information.	Boxes used in PowerPoint slides to highlight important information.	Highlighting of final answers for WE videos.

Table 2: Survey response summary

Attribute	Modelling & Control	Dynamics	Overall
Responses	81	28	109
Population	250	252	502
Response Rate	32.4%	11.1%	21.7%

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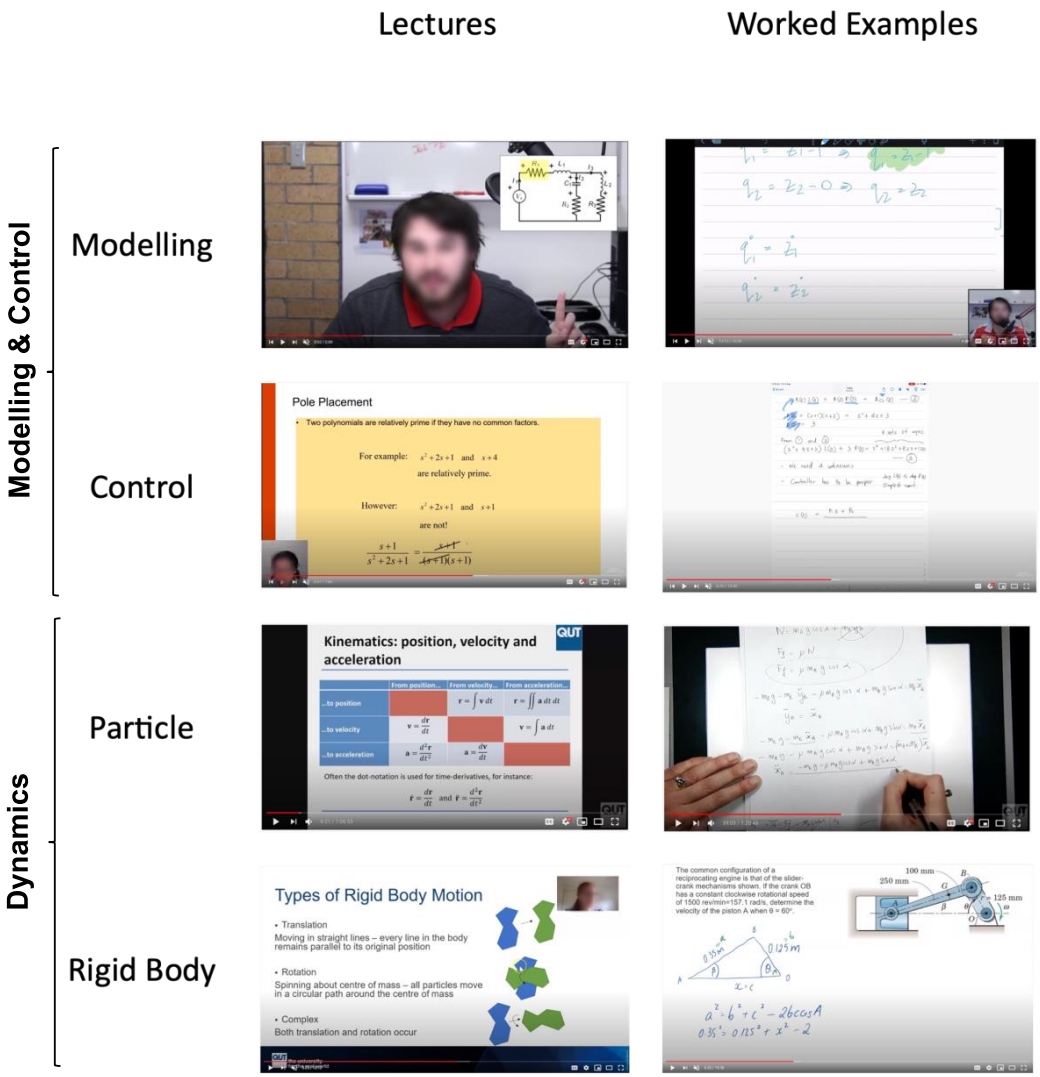

Figure 1: Indicative screenshots of videos from each course component

Results

The distribution of responses for the survey questions are shown in Figure 2 and Figure 3. The mean Likert score for each attribute is further summarised in Table 3. This shows that the contribution of the attributes to engagement and disengagement follow a similar pattern.

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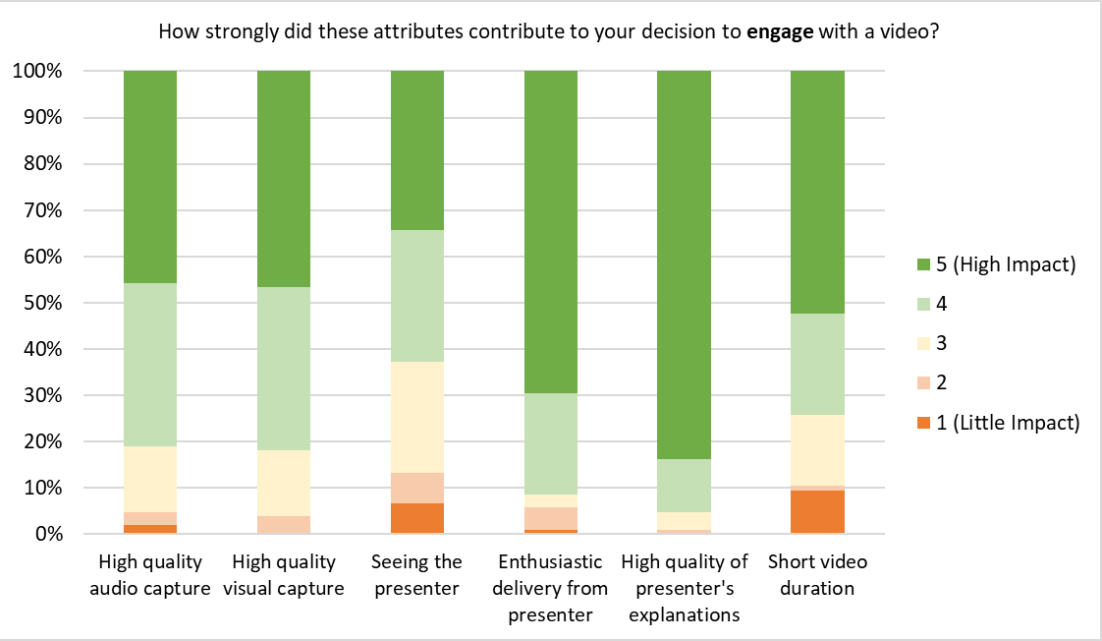

Figure 2: Likert scale responses to how strongly video attributes contributed students' decisions to engage with a video [N=109]

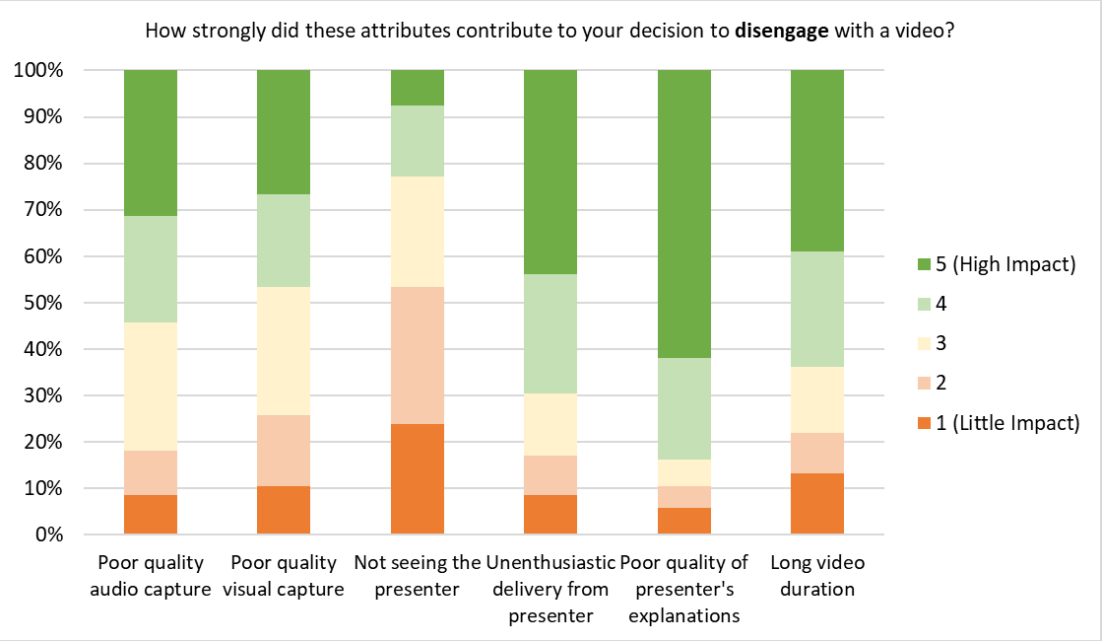

Figure 3: Likert scale responses to how strongly video attributes contributed students' decisions to disengage with a video [N=109]

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Table 3: Attributes ranked from highest to lowest impact based on mean Likert score

Rank (Highest to Lowest)	Contribution to Engagement		Contribution to Disengagement	
	Attribute	**Mean Likert Score**	**Attribute**	**Mean Likert Score**
1	High quality presenter explanations	4.78	Poor quality presenter explanations	4.30
2	Enthusiastic delivery	4.54	Unenthusiastic delivery	3.88
3	High quality visual capture	4.25	Long video length	3.68
4	High quality audio capture	4.20	Poor quality audio capture	3.59
5	Short video length	4.07	Poor quality visual capture	3.37
6	Seeing the presenter	3.77	Not seeing the presenter	2.53

Discussion

Interpretation of Results

Table 3 shows that the quality of explanation and enthusiasm of delivery were the most important factors in influencing students' decisions to use the videos. This was true in both directions – students indicated that high quality explanation and high enthusiasm were important factors in driving engagement, and where these characteristics were lacking, it drove disengagement. This finding is consistent with previous work by Dart, Cunningham-Nelson, et al. (2020) who found that narration that delivered explanations for understanding was a fundamental contributor to students' perceptions of the usefulness of educational video resources. Kay (2014) note that the narration is particularly important for worked example videos where a problem is worked through step-by-step to a final answer. They note that the explanatory component should seek to explicitly break down the problem "into meaningful cognitive steps, explaining the reasoning for each step…using visual supports" (Kay, 2014, p. 23). Delivering this in an enthusiastic manner clearly contributes further to the effectiveness of this approach.

Audio and video capture quality varied in importance – these were more likely to drive engagement when done well than to cause disengagement when done poorly. This implies making an effort toward enhancing these aspects of video production can help improve engagement, but that it is a case of diminishing returns. This result is consistent with Shoufan (2019) who analysed the likability of educational videos on YouTube. Their study found "a video is disliked due to bad quality 3.5 times more frequently than a video that is liked due to good quality" (Shoufan, 2019, p. 452).

Interestingly, the length of a video also varied in its importance depending on whether engagement or disengagement was probed. Having a short video was ranked fifth out of the six attributes explored in terms of its contribution to engagement. In contrast, having a long video was ranked third out of the six attributes for its contribution to disengagement (Table 3). Like the audio and video quality, this suggests that reducing the length of videos can lead to greater engagement, but this has diminishing returns.

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Finally, seeing or not seeing the instructor was perceived to have the least impact on both video engagement and disengagement. This implies that the second recommendation of Guo et al. (2014) to display the instructor's head at opportune times through editing in the video is not particularly important in determining the desire to use a video.

Recommendations

Overall, the results indicate that the most important factors influencing educational video engagement relate to the instructor's teaching quality rather than the production choices made within videos (such as visual/audio capture quality and editing). This is encouraging as it implies engagement can be improved irrespective of resources, budget, and video production skill limitations. Given the more 'mechanical' aspects of video production are less influential over engagement decisions, it is worth considering the extent to which these are worth focussing on.

For the modelling stream of Modelling and Control, which attempted to adopt all recommendations from Guo et al. (2014), it was found that video production was extremely time-intensive. This was despite the course already having reasonably well-developed content which tended to have natural places where this could be segmented in shorter chunks. In this case it was estimated that a single five-minute video would take approximately two hours to plan, film, and edit. In contrast, the particle component of Dynamics took a more efficient approach to production, which relied on a simpler style requiring less planning and editing. Here videos were typically filmed in one take with no post-production editing applied, and those demonstrating worked examples did not include the instructor's face. In this situation it was estimated that videos took about three times their length to pre-work, record, and then upload for students.

While employing a more polished production style contributes to engagement (as evidenced by students' ratings in this study), it appears that the extent to which the production recommendations of Guo et al. (2014) are followed could be relaxed without a substantial loss. This is particularly the case for the video length attribute, where Guo et al. (2014) recommended videos should be less than six minutes. Our results suggest that long videos drive disengagement, but that working to create extremely short videos (which is very time-consuming due to the amount of planning, filming, and editing required) does not have a large pay-off. This is consistent with Dart (2020) who found that the average view duration for similar videos held a reasonably linear relationship with video duration. This contradicted the relationship shown in Guo et al. (2014) which showed a significant drop in viewing time for videos longer than six minutes (which was how their video duration recommendation was derived). Thus, we recommend instructors should seek to minimise video durations by keeping on message and concise, but to not work excessively to trim time through over-planning and editing. Additionally, we recommend against post-production editing where this is needed to include the instructor's face.

Limitations

This study considers only student responses to 12 Likert scale survey questions. Some ambiguity exists in these questions, such as what constitutes a 'short' or 'long' video. The sample size and demographic are also limited - only a 21.7% response rate across a single iteration of two engineering courses, during the COVID pandemic. Future work will centre on validating these findings across a larger and more diverse sample, as well as triangulating the results using thematic analysis of free-text comments and correlation with quantitative usage analytics.

Conclusion

This study has investigated what factors are most influential on students' decisions to engage versus disengage with video resources in the higher education context. This found that

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characteristics of the presenter's delivery (that is the quality of their explanations and the enthusiasm in their delivery) are more influential in producing engaging video content than technological choices relating to the video capture and length. Therefore, educators should seek to prioritise the quality of their explanations and their stage presence, before working to improve the video/audio capture quality and reducing video durations. Including the face of the instructor in educational videos has little impact on students' usage decisions.

References

Berger, E. J., & Wilson, M. (2016). *A Laboratory Study of Student Usage of Worked-example Videos to Support Problem Solving*. Paper presented at the 2016 ASEE Annual Conference & Exposition, New Orleans, June 26-29.

Dart, S. (2020). *Khan-Style Video Engagement in Undergraduate Engineering: Influence of Video Duration, Content Type and Course*. Paper presented at the 31st Australasian Association for Engineering Education Annual Conference, Sydney, December 6-9.

Dart, S., Cunningham-Nelson, S., & Dawes, L. (2020). Understanding Student Perceptions of Worked Example Videos through the Technology Acceptance Model. *Computer Applications in Engineering Education, 28*(5), 1278-1290.

Dart, S., Pickering, E., & Dawes, L. (2020). Worked Example Videos for Blended Learning in Undergraduate Engineering. *Advances in Engineering Education, 8*(2), 1-22.

Di Paolo, T., Wakefield, J. S., Mills, L. A., & Baker, L. (2017). Lights, Camera, Action: Facilitating the Design and Production of Effective Instructional Videos. *TechTrends, 61*(5), 452-460.

Fyfield, M., Henderson, M., Heinrich, E., & Redmond, P. (2019). Videos in higher education: Making the most of a good thing. *Australasian Journal of Educational Technology, 35*(5), 1-7.

Guo, P. J., Kim, J., & Rubin, R. (2014). *How video production affects student engagement: An empirical study of MOOC videos*. Paper presented at the 1st ACM conference on Learning @ Scale, Atlanta, Georgia, March 4-5. https://dl.acm.org/doi/10.1145/2556325.2566239

Kay, R. (2014). Developing a Framework for Creating Effective Instructional Video Podcasts. *International Journal of Emerging Technologies in Learning, 9*(1), 22-30.

Mayer, R. E. (2021). Evidence-Based Principles for How to Design Effective Instructional Videos. *Journal of Applied Research in Memory and Cognition*.

Shoufan, A. (2019). Estimating the cognitive value of YouTube's educational videos: A learning analytics approach. *Computers in Human Behavior, 92*(2019), 450-458.

Winslett, G. (2014). What counts as educational video?: Working toward best practice alignment between video production approaches and outcomes. *Australasian Journal of Educational Technology, 30*(5), 487-502.

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