Assessing the Impact of Educational Video on Student Engagement, Critical Thinking and Learning:
The Current State of Play

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Background

Video-based learning has long been used as an educational tool to assist in classroom teaching, with earliest usage noted during the Second World War (Yousef et al., 2014). A number of recent advances, most notably the rapid growth in access to high speed internet through homes, schools and personal devices such as tablets or smartphones, have had a significant impact in changing the learning environment and accelerating video use in higher education. Researchers note an "explosion" in online courses and a rapidly changing comprehension of how video can be used effectively to enhance learning (Schneps et al. 2010).

Within this explosive space of change and development, educational institutions and libraries now sit with huge amounts of curiosity about what video can and will do for their faculty and students. This is similarly the case for educational publishers and video distributors who are investing large sums of money in the creation and distribution of this content. Some fundamental, key questions exist that have been and continue to be explored via numerous research endeavors: How is video making a tangible difference in the higher education space; what impact is it having on student engagement with their course and learning; and, perhaps most crucially, what are the measures of success of video use both for students and researchers?

Overview

This paper collects much of the best and most recent research addressing these questions in the context of higher education, and makes some research contributions that are presented here for the first time. We do not promise to provide all (or even many) of the answers to the huge questions identified above, but instead aim to help interested parties find and then make sense of the existing knowledge, or as we call it, "the state of play"; to provide some new insights to this existing body of knowledge via new research; and to identify areas where exciting opportunities for further investigation beckon. As indicated, although some of the findings and recommendations may be relevant to other levels of education and students, this paper addresses educational video and students in higher education first and foremost.

Key Findings

The primary findings in this white paper are as follows:

- A significant way in which educational video is having an impact on student learning is both through the benefits it provides in the changing university landscape (e.g. with the emergence of "flipped classroom" teaching), and also in how it is having a direct influence in changing practices in teaching and learning more generally.

- Video provides great benefits to teachers and learners, stimulating stronger course performance in many contexts, and affecting student motivations, confidence and attitudes positively.

- The concept of "student engagement" has many definitions and no single, universal understanding. However video is seen as having advantages for engagement in some specific ways, notably in widening participation, emotional engagement and overall course engagement. On the flipside, video can put up some barriers to engagement (e.g. challenges with technology).

- Very little is known about video's role in knowledge development and helping critical thinking, and this is identified as a major gap in the research that requires more investigation.

- The "cognitive theory of multimedia learning" (Mayer 2014, Clark and Mayer, 2016) is an important framework through which to understand the processes involved and ways in which video may assist or hinder learning. It also sets out some key principles for effective video design, spelling out recommendations for the interaction of visual, verbal and text-based content in video.

- Shorter videos can increase median viewing times for videos, can improve learning outcomes and the likelihood that repeat usage will occur. However, this can also be achieved with proper segmentation on a video platform.

- Students appear to find videos which include the instructor's image to be more engaging, or they engage more with course content as a result of instructor presence in video. An appropriate balance is needed to ensure that instructor presence is not distracting while allowing for the inclusion of appropriate social cues which are essential for enhancing learning outcomes.

- The use of graphics/visuals in videos generally makes a marginal difference to student's judgment of their likely learning performance; their attention, interest and engagement levels; and their eventual learning performance compared with videos with no graphics/visuals. However, more research is needed to test this some more, and on whether specific types of graphics/visuals can make a significant difference in these respects.

Methodology

Given this background as well as the research aims, our study focused on four, specific questions that we wanted to undertake with some original research:

1. What is the impact of video on student learning in higher education?

2. Does the use of video in higher education impact on student engagement?

3. What evidence is there that the use of video in higher education affects critical thinking skills and knowledge development?

4. What types of content/video presentation make a difference to these aims?

To help answer these questions, the following research strategies were employed: a full-scale literature review in relation to these questions, and the implementation of an original, online experiment to assess perceptions of video content, as well as learning where graphics are used and not used.

Literature Review

Initially, an online search for peer-reviewed articles was carried out through JSTOR (an online library with access to over 10 million journal articles, books, and primary sources in 75 disciplines) as well as a general internet search. The following four journals were identified as the current, leading journals in education and technology (listed in no particular order):

1. *Computers & Education: An International Journal* (Elsevier)
2. *British Journal of Educational Technology* (John Wiley & Sons)
3. *Journal of Educational Technology & Society*
   (International Forum of Educational Technology and Society)
4. *The Internet and Higher Education* (Elsevier)

Within the boundary of "educational technology" these journals provided, further searches were then carried out using the search terms: "critical thinking"; "knowledge development"; and "student engagement" to help focus the scope of the search. Other areas were filtered out, for example search results on video games or virtual reality as well as video conferencing. Finally, to avoid potential publication bias, a search of Google Scholar was undertaken using the following search terms: "video and higher education"; "e-learning and video". This search was carried out for articles from 2013 onwards in an effort to focus on the most recent research on the topic. All other searches were non-date specific. The eventual yield was approximately 270 articles being selected for either further scrutiny or analysis.

This white paper references only a few of these articles, but a complete reference list from this literature review can be supplied upon request.

Online Experiment

Secondly, an online experiment was set-up and run in Professor Karpicke's lab at Purdue University using two pre-selected SAGE Videos and involving 100 undergraduate students from across the institution (profile of participants: all students aged 18–22 years old; 58 percent female; all reported English as their native language; all participated in exchange for course credit in an introductory psychology course). The aim of this experiment was to examine the effects of embedded graphics in educational video on measures of student learning, judgments of learning, and engagement (see section SAGE Graphics Experiment for more details).

Each of the videos selected incorporated a similar variety of different types of graphics (9 or 10 graphics in each case) and were comparable in style, namely being tutorial videos involving an instructor on film speaking directly to the camera. One video described strategies for sharing research (referred to in this paper as "Sharing"), and had a female speaker. The second video described how an educational scientist conveyed his research to public policy makers. This video (referred to here as "Policy") had a male speaker. Both videos were approximately 15 minutes in length, and both were intended for an interdisciplinary student wanting to sharpen their research skills.

This white paper references only a summary of this online experiment, but, again, a complete experimental report can be supplied upon request.

Analysis

1. The Impact of Video in Higher Education

The Changing University Landscape and Video

The changing higher education landscape is paving the way for greater amounts of video to be used in (or out of) the university classroom and particularly given the advent of the "flipped classroom", one of the biggest developments over the past decade in higher education (so called because it flips traditional higher education teaching methods on their head). In place of the traditional lecture followed by class, students use video to become familiar with the lecture material in advance and attend a face-to-face session after viewing the video. This is a relatively new phenomenon, heavily reliant on video as a medium, and one that is igniting a rapid growth in research in this area. Searches of leading journals/databases carried out by Uzunboylu and Karagözlü (2017) returned no relevant articles in both 2010 and 2011, but 194 articles in 2015. Much of the research is carried out in the U.S.A. which suggests that this country might be leading the way in this pedagogical approach (Uzunboylu and Karagözlü, 2017).

Another concept that has emerged in the past few years and which lends itself well to video is that of "blended learning" (the combination of multimedia resources and traditional classroom methods). One cited challenge with video use in course teaching generally is that excessive use of unregulated open-source digital content can lead to less course structure which can in turn present problems for students in their learning (Jackman and Roberts, 2014). Blended learning offers pedagogical solutions here; video-based learning offered alongside other pedagogical tasks and methods, offered both online and face-to-face, can make for a very beneficial learning experience and strong outcomes (Kinash et al., 2015, Yousef et al., 2014). Indeed, the blended learning approach appears to be strongly backed as a preference of students (Ramlogan et al., 2014, Scagnoli et al., 2017, Mitra et al., 2010).

On the flipside, the digital revolution in higher education has created some cause for concern among education leaders. While online provision is an "emergent priority" for many of them (Kinash et al., 2015), the MOOC ("Massive Open Online Courses") industry is challenging "institutional certainties" (Crook and Schofield, 2017) which has led to a nervousness around these developments and change; in short, a reluctance to relinquish control and a tension between commercial and academic approaches exists (Crook and Schofield, 2017). Despite this, it seems that the changing environment presents huge opportunities for innovation and improvement, and video is seen as having a big role to play in this new environment.

Pedagogical Uses of Video

With the emergence of the flipped classroom, the use of video can make fundamental changes to teaching and learning. The process of re-thinking and re-designing academic course content in response to technological changes for a market of students who have very different experiences and expectations can in itself have a significant impact in improving material. For example, the challenge of rethinking one-hour lecture content to provide succinct podcast segments might have been responsible for students finding this more engaging than a traditional lecture divided into sections (Guo et al., 2014). Researchers refer to "disruptive innovation" (Kirkwood and Price, 2013) or a "disruptive pedagogy", (Kinash et al., 2015); video can shift the concept of teaching from didactic approaches to constructivist learning with students able to control aspects of their learning.

Video is being used in a variety of ways to support various pedagogical strategies successfully. By no means a comprehensive list, within just the context of problem-based learning, video clips can be used to present a problem to students to trigger problem-solving; to provide information around the topic;

or to present solutions to the problem at the end of the process (Rasi and Poikela, 2016). Videos can include content that might be academic in nature or material that is supplementary to academic content, such as a news or film clips. They can be used in support of both practical and conceptual teaching (Kay, 2012) through formats which include the video lecture, video tutorial, short knowledge clips, and "how-to" example-based video-modelling.

Although much video-based education is still top-down and teacher-centered (Yousef et al., 2014, Kay, 2012) there is an increasing trend towards combining both teaching-focused and learning-focused methods (Kirkwood and Price, 2013). Students are showing an increasing desire to be more independently in control of their learning journey and to create "personalized learning environments" in and outside of the classroom (Rasi and Poikela, 2016). Video provides that opportunity for students to take fuller control over their learning, both the flexibility over when it's watched but also as a tool to create video material as part of their act of learning.

Benefits and Impact of Video Use

There are a number of ways in which video can make a tangible difference to teaching and learning in higher education. One study (Taslibeyaz et al., 2017) in the context of medical education from 2000 to 2014, predominantly case studies, showed that watching videos was beneficial for gaining clinical skills, changing attitudes, encouraging cognitive learning and retaining knowledge. Similarly, in a review of peer-reviewed qualitative and quantitative papers spanning from 2003-2013 sourced from 7 major databases and 21 academic journals, Yousef et al. (2014) found some evidence that use of video-based learning saw improvements in teaching methods and learning outcomes.

Furthermore, the visual benefits of video provide a vehicle for increasing access to practical demonstrations. Students can learn from field experts having the opportunity to view close-up expert illustrations, and with the option to view them repeatedly if necessary (Ramlogan et al., 2014, Cooper and Higgins, 2015). Additionally, these examples can illustrate real-life practices and highlight information visually that would be impossible to adequately describe verbally or through written text (Rasi and Poikela, 2016, Schneps et al., 2010). This can reduce the cognitive load of attempting to call concepts to life, or performing a process of "mental animation" to make sense of things, especially in STEM subjects (Castro-Alonso et al., 2018).

As well, students seem to have a bias towards the credibility of their own institution, rating videos provided by their university – and including their own experts – as more useful for improving learning and facilitating study than that of other providers, even when the content was identical (Giannakos et al., 2016). There's more on the value of the instructors' presence in video content later in this white paper.

Finally, the context of "ubiquitous learning", the opportunity of learning anywhere at any time, is being shown to be greatly supported by the advent of video. Video-learning offers a cost-effective, location-free method of flexible study, one that is available at all hours and can fit the individual needs of the learner, allowing them to learn at their own pace and view material repeatedly if necessary. This is seen as having tangible benefits to the student (Taslibeyaz et al., 2017, Lawlor and Donnelly, 2010, Ramlogan et al., 2014, Schneps et al., 2010).

2. Video and Student Engagement

Background and Context

Student engagement is a key priority for higher education and National Student Surveys are routinely undertaken to assess students' confidence and engagement levels with their course learning. For example, although a causal relationship cannot be established, analysis of data from 17,819 students from the 2008 National Survey of Student Engagement in the United States and Canada found a positive relationship between the amount of web-based learning technology used in a course and student engagement, a relationship which needs further exploration (Chen et al., 2010).

The starting point in understanding student engagement is challenging however, in that the concept itself is not well-defined across the literature and full of definitional inconsistencies. An analysis of 113 peer-reviewed articles relating to student engagement in higher education within the specific context of "technology mediated learning" (with video as one of the five most studied technologies) carried out by Henrie et al. (2015) found substantial conceptual variation in how engagement was measured, leading to a lack of clarity in findings. In this section of the paper, we attempt to unpack just a few of the different definitions where 'engagement' is discussed in published research and how video is affecting these contexts for engagement (or disengagement).

Definition 1: Access and Attendance in Higher Education

In its broadest sense, video as part of an online multimedia offering seems to be having a positive impact on engagement through a broadening participation perspective. Online courses are expanding the pool, rather than taking from a limited market of potential students (Goodman et al., 2016) and notably, racial and ethnic minority as well as part-time students are more likely to take online courses (Chen et al., 2010). Internet technology is opening access to people who might otherwise have been excluded from higher education, and educational video therefore becomes more accessible to these groups.

On the other hand, there is concern about whether the availability of video lectures online will increase levels of absenteeism. This is a source of tense debate and raises important questions regarding definitions of engagement. Does attendance matter if achievement is unaffected (Kinash et al., 2015, Kay, 2012)? If students are engaging with material online are they less engaged than if they attend a live lecture? There are mixed findings here with different studies showing different results, from less physical attendance but higher student performance (Traphagan et al., 2010), to no decrease in on-campus attendance but an increase in achievement (Kinash et al., 2015). It is not clear that attendance is affected by the availability of online video but what does seem to be consistent is that the availability of online video likely adds to achievement and does not harm it.

Definition 2: Emotional Engagement

Engagement, as defined by Fredricks et al 2004, can be considered to be behavioral (measuring attendance and participation); cognitive (looking at the focused effort students give to what is being taught); and emotional too (exploring feelings about the learning experience and gauging levels of interest). How students feel about their experience of learning will have an impact on how they engage with the course and potentially whether they will complete it (Martinez, 2001).

Across the literature, higher levels of student satisfaction are reported in groups with access to video (Yousef et al., 2014). Also, an overview of the literature specific to problem- based learning found a general preference for video over text (Rasi and Poikela, 2016). Finally, reported benefits of video podcasts include that they are enjoyable to watch, they are satisfying, motivating, intellectually stimulating, useful and helpful for learning (Kay and Kletskin, 2012). Ultimately, students appear to enjoy video and view it positively. They enjoy the independence it provides, with control over when and where to learn, the pace of learning and what to learn (Kay and Kletskin, 2012).

Definition 3: Engaging with Course Content

There is recent evidence to suggest that the incorporation of video within a course framework can influence students' motivations to engage with course materials. In focus groups and surveys, students report using video to improve learning and to study for exams (Kay, 2012). Logs of actual usage for 255 students with access to 18 recorded lectures showed a significant increase in accessing online lectures the week prior to the exam (Giannakos et al., 2016). These reports suggest that video aids engagement with course content, but this is also an area in its infancy for research that requires further investigation before any substantial conclusions can be drawn.

Barriers to Engagement

The research on the benefits of video and engagement are well-described but the research also outlines some areas of risk. The freedom that video provides through flexibility of access, without the availability of an instructor, requires greater self-discipline on behalf of the student (Martinez, 2001, Sun and Rueda, 2012, Kay, 2012). Also, as students increasingly access materials partly or exclusively online, the potential for isolation, disengagement and drop-out grows (Kizilcec et al., 2014). Finally, and perhaps most importantly, self-regulation, harder to manage remotely, has been found to be a significant predictor of emotional, behavioral and cognitive engagement across a range of research results (Sun and Rueda, 2012).

Technology also plays a significant role in this dynamic. On the one hand, it can provide options to counteract the risk of isolation and lack of self-motivation, for example via video-based communication methods which can be used as a tool through which to interact and assess student performance and comprehension (Borup et al., 2011). On the other hand, computer anxiety is found to be a key factor affecting learner satisfaction in e-learning, as are the attitudes of the instructor, an element not reflected upon in this white paper, but present in the literature (Sun et al., 2008).

3. The Role of Video in Critical Thinking and Knowledge Development

Establishing whether video can be used as an effective tool to develop knowledge and facilitate critical thinking skills within a higher education setting is identified as a research gap requiring greater exploration. Very little research is available evidencing knowledge development or critical thinking in the context of video-learning. Instead, current methodological approaches typically rely on short-term, post-experimental tests to measure differences in learning outcomes from using video or other multimedia resources. These immediate tests are not equipped to assess deeper, fuller or longer term knowledge development. The shortfalls of this approach are noted as a methodological issue in the field (Kirkwood and Price 2013).

Cognitive Theory of Multimedia Learning

Much research draws heavily on Mayer's "cognitive theory of multimedia learning" as a framework through which to understand the processes involved and ways in which video may assist or hinder learning (Mayer, 2014, Clark and Mayer, 2016). The theory relies on three principles, the first that there are two different channels for processing visual/pictorial material and for processing auditory/verbal material. Secondly, each channel has a limited capacity and can deal with only a few pieces of information at a time. The third principle is that active processing is required for learning to occur. The three steps of selecting, organizing and integrating information across the dual channels works as follows: learners select relevant sounds, words, and images to be processed, and they organize the selected sounds and images into a "mental model" of the material they are learning. Learners then integrate a mental model of new material integrated with their prior knowledge. "Meaningful learning" occurs through suitable engagement in all three of these processes. In order for learning to have occurred we need to have not just stored knowledge in our long-term memory but be able to retrieve and apply it (Clark and Mayer, 2016). There is more on this theory of multimedia learning in the next section.

Schreiber et al. (2010) note the benefits of video in enhancing learning according to these theories. The visual and auditory nature of video stimulates the dual processing channels to enhance learning; the limitations of the working memory are eased by the ability to pause, rewind and repeatedly watch video; and finally video provides opportunities for interacting with interesting material, through attentive engagement with video content, which can be organizing and integrated with previous comprehension. Conversely, Castro-Alonso et al. (2018) note that transient forms of information can cause heavier cognitive load given the need to process current images while retaining and integrating those that have disappeared.

Video and Knowledge Development

Where knowledge development might have previously been considered a linear process of building one idea upon another, Schneps et al. (2010) note that the development of knowledge within science is non-linear and based on weighing up partially formed and potentially conflicting ideas. Video is well-placed to support this approach, particularly in its ability to provide broader context and visual detail that can help develop a fuller understanding of the topics concerned. In terms of imparting practical knowledge, video is clearly a superior tool to written materials for visually demonstrating "how-to". It can also serve as a trigger in problem-based learning (as mentioned earlier), through the presentation of authentic information (Rasi and Poikela, 2016).

Student Motivation and Performance

Echoed earlier, students report through surveys and interviews that video aids learning in a number of ways. These include assisting in comprehension and recalling information, providing alternative perspectives, stimulating interest, motivating further research and increasing knowledge (Mitra et al., 2010, Kay and Kletskin, 2012). Experimental studies find significant differences in test scores for students with access to video materials in the context of problem-based instruction (Choi and Yang, 2011) and across a number of studies considering video podcasts (Kay, 2012). One particular study looking at student data over three consecutive years, found that scores were increased by 2 percent overall for the one period where online videos were available. These videos demonstrated how to apply concepts to solve problems in molecular biology. It should be noted that the availability of video was accompanied by learning objectives provided at the end of each lecture that had not been available at other points.

4. Effective Video Design and Presentation

The rapid growth of video instruction within a variety of contexts is accompanied by an equally large range of available design options. These choices must consider the most appropriate content, style and platform for presenting material, taking into account how best to motivate students, raise learning outcomes and even consider students' affective state (emotions) in order to facilitate optimal learning (Chen and Wu, 2015).

Subject Matter

Specific subject matter and pedagogical strategies necessitate varying design considerations. Different decisions might be made when designing videos aimed at helping students solve maths problems, teaching a foreign language, demonstrating a medical procedure or lecturing in ancient history. Case studies which highlight the process of designing video for learning can only advise that it is imperative to draw on a close collaboration between expertise in the field/subject matter and in video production (Schneps et al., 2010, Chandra et al., 1990). There really is a lot more that can be researched and explored here, especially in terms of subject areas that see stronger levels of student engagement and impact where video is used in course teaching; the current body of knowledge is merely scratching the surface at this point.

Mayer's Theory and Design Principles

As introduced earlier, the cognitive theory of multimedia learning (Mayer, 2014, Clark and Mayer, 2016) should prove instrumental in effective video design. It proposes that multimedia design should aim to reduce extraneous processing (cognitive processing that is not in line with learning objectives, caused by poor design), manage essential processing (necessary cognitive processing within the working memory that is affected by levels of complexity of the material) and encourage generative processing (cognitive processing for making sense of the material which is assisted by learner motivation). Absolutely, video developers need to consider this theory in their design choices. This paper outlines a brief description of the six, key principles of multimedia learning with additional principles being discussed in Clark and Mayer (2016) and Mayer (2014):

1. Multimedia principle. Providing words with pictures, images, or other graphics enhances learning relative to materials that include only words. While this principle pertains to texts with pictures, it also applies to videos, which include audio and video components.

2. Modality principle. When combining visual and verbal materials, it is more effective to use audio than it is to use written text. Videos may be more effective when they present video in conjunction with audio narration as opposed to written text in the video.

3. Contiguity principle. Multimedia materials are more effective when words and pictures/images/ graphics occur in close proximity relative to when they do not occur in close proximity.

4. Redundancy principle. Eliminating redundancy enhances the effectiveness of multimedia. For example, text may be redundant with audio narration, and such redundant text should be eliminated.

5. Coherence principle. Adding flashy but unnecessary illustrations to multimedia can be distracting, reducing coherence and thereby reducing learning.

6. Personalization principle. Using a conversational style (e.g., in narration) can be more beneficial relative to a more formal presentation style.

Video Length

The research is pretty unanimous in finding shorter videos to be preferable to longer ones. This is expressed both through qualitative feedback from students (Lawlor and Donnelly, 2010) and supported by experimental design too. Shorter videos are found to be more engaging (Doolittle et al., 2015), increase learning outcomes (Pi and Hong, 2016), and influence students' decisions to use video again for future learning (Giannakos et al., 2016).

Data from an online MOOC covering 6.9 million video watching sessions in maths and science subjects showed that median engagement time was at most 6 minutes, regardless of video length. Median watching time for videos of 9–12 minutes was less than half-way through the video, dropping to less than a quarter for those of 12-40 minutes (Guo et al., 2014).

To address this concern over shorter length needs, videos can be offered in segments to overcome the challenges of processing images and integrating them with prior knowledge as new ones are being presented. Segmentation provides an opportunity to pause and process information at the learner's own pace thus reducing cognitive load (Doolittle et al., 2015).

The Role of the Instructor in Video

Multiple studies have asked the question: is it important to have the instructor within the video to aid engagement and learning? Two theories are useful considerations here and work in parallel with this question: cognitive load theory and social presence theory. According to cognitive load theory, the cues and additional information provided by the instructor's presence could overload the learner and distract them from the content. However, social presence theory posits that the social connections that might be gained from social cues such as eye contact, facial expressions and gestures could lead to greater engagement with the content and might outweigh those possible disadvantages. There is a general consensus that a suitable balance should be found between these competing factors to ensure the best outcomes (Pi et al., 2017 Pi and Hong, 2016, Lyons et al., 2012, van Wermeskerken and van Gog, 2017, Kizilcec et al., 2014).

There are a number of other factors to be considered relating to the presenter themselves (almost certainly requiring more research) for example, the effect of attributes, such as age and perceived expertise (Hoogerheide et al., 2016a), gender (Hoogerheide et al., 2016b) and speech (Guo et al., 2014). Generally speaking, students appear to find videos including the instructor's image to be more engaging (Pi et al., 2017), or that they engage more with course content as a result of instructor presence in video (Guo et al., 2014). Going further, evidence suggests that the act of watching video-modelling where an instructor performs a task has been shown to increase the confidence of students in believing they could also perform the same task (Hoogerheide etal., 2016b). It does seem that most learners state a preference for video with the instructor's image present, and that this can have positive impact.

Graphics in Video: SAGE Graphics Experiment

As introduced at the start of this white paper, an original experiment was run to try and establish whether the use of graphics in educational video can make a difference to student engagement and learning performance. The experiment was not focused on what types of graphics and visuals make a difference here (though, as reported, this is cited as a follow-up experiment worth doing), more to assess whether the incorporation of such material in general would make a difference to these aims. As reported in this white paper, multiple elements are at play when determining whether video is impactful, and the concept of 'engaging' is seen as being a complex definition too. We wanted to explore this more deeply using graphics given that relatively little had been done to-date assessing whether graphics in video (versus not) could affect the following:

1. Students own judgment of their learning

2. The extent that students' attention levels are sustained

3. Engagement levels, defined as their emotional response to the content

4. Students' own interest levels in the content

5. And, students' memory performances on the key learning messages embedded in the content
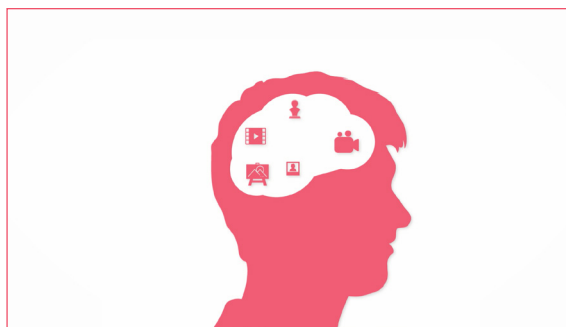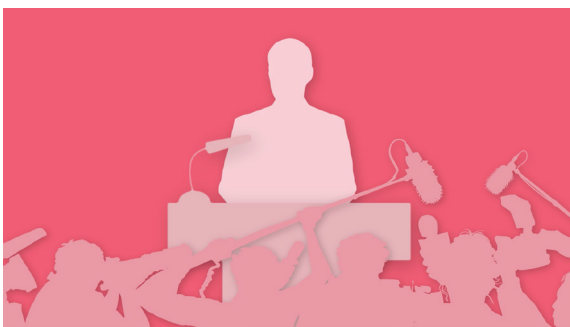
Above: Graphic images from Rankin, J. G. (2018) Strategies for Sharing your Research with Various Audiences: Branding, Speaking and Writing and Schmidt, W. (2018) Communicating Your Research to the Press and Policy Makers [Streaming Video]. Both retrieved from SAGE Research Methods (from March 2018).

In terms of set-up, the entire experiment took place online. Students were recruited via an experiment management site (Sona Systems) maintained by the Department of Psychological Sciences at Purdue University. After reading a consent form and agreeing to take part in the study, the students were given detailed instructions about the experiment.

The experiment employed a 2 x 2 mixed design (graphics condition: graphics or no graphics and video: Sharing or Policy). Each student viewed one video in one graphics condition and then viewed the other video in the other graphics condition (e.g., a student might view the Sharing video with graphics and then the Policy video without graphics). The order of videos and order of graphics conditions were fully counterbalanced across subjects, creating four counterbalancing orders. Twenty-five students were randomly assigned to each counterbalancing order, i.e. 4 x groups of 25 = 100 students in total. The break-down of the time-stamps as type of graphics within each video can be seen in Table 1.

Above: Graphic images from Rankin, J. G. (2018) Strategies for Sharing your Research with Various Audiences: Branding, Speaking and Writing and Schmidt, W. (2018) Communicating Your Research to the Press and Policy Makers [Streaming Video]. Both retrieved from SAGE Research Methods (from March 2018).

Table 1 Descriptions of graphics and locations (timestamps) within each video

| Sharing				Policy	
Animation Number	Time	Description		Time	Description
1	1:32–1:45	Elevator pitch		1:41–1:54	Pictures with policy makers
2	3:17–3:22	Twitter logo		2:55–3:01	People around a laptop
3	3:28–3:31	Pinterest scrolling		4:03–4:11	30 seconds to attract attention
4	3:42–3:51	Connect educators and LinkedIn		4:26–4:38	Businessmen shaking hands
5	6:09–6:18	Dominoes falling		5:23–5:37	Professor lecturing
6	7:27–7:31	Podium presentation		5:45–5:47	Head with speech bubbles
7	8:10–8:25	Brain storing images		7:34–7:40	Speaking to the press
8	9:33–10:01	Influence of teachers		9:49–10:57	Good and bad slide examples
9	11:50–11:56	Image of CERN		11:34–12:30	Graphs of SES inequality
10	——	——		14:25–14:42	Kids learning in a classroom

After viewing the video, the students made a series of four subjective ratings on a scale from 0 percent to 100 percent in increments of 10 per the above: a judgment of learning, a presentation style, an engagement, and an interest rating. These are more explicitly defined in Table 2.

Table 2 Wording of each subjective rating prompt

| Rating	Prompt
Judgments of learning	On a scale from 0% to 100%, how much of the material from the video that you most recently watched do you think you could remember on a test that will occur in a few minutes?
Presentation style	On a scale from 0 to 10, where 0 means not engaged at all and 10 means being completely engaged, to what extent did the presentation style of the video that you most recently watched sustain your attention throughout?
Engagement	On a scale from 0 to 10, where 0 means not at all engaging and 10 means extremely engaging, how engaging did you find the video that you most recently watched?
Interest	On a scale from 0 to 10, where 0 means not at all interesting and 10 means extremely interesting, how interesting did you find the video that you most recently watched?

After making the ratings, the students were then told that they would answer 8 short-answer questions about the video (questions in relation to some key learning points in each video) and given a minimum of 15 seconds to answer each question. No maximum time-limit was imposed for answering each question and the median time spent per question was 26 seconds. After completing the short answer questions for the first video, students advanced to the next video. The procedure for the second video was the same as the procedure for the first video: Students watched the video, made a series of ratings, and answered some short-answer questions.

Figure 1 shows students' mean (a) judgments of learning, (b) presentation style ratings, (c) engagement ratings, and (d) interest ratings in the graphics and no graphics conditions. The left panels in the figure show the results for each video, the right panels show the overall results comparing the graphics and no graphics conditions, collapsed across the two videos. Overall, the presence of graphics produced very small increments in all four types of subjective ratings, and this pattern was evident for both videos:
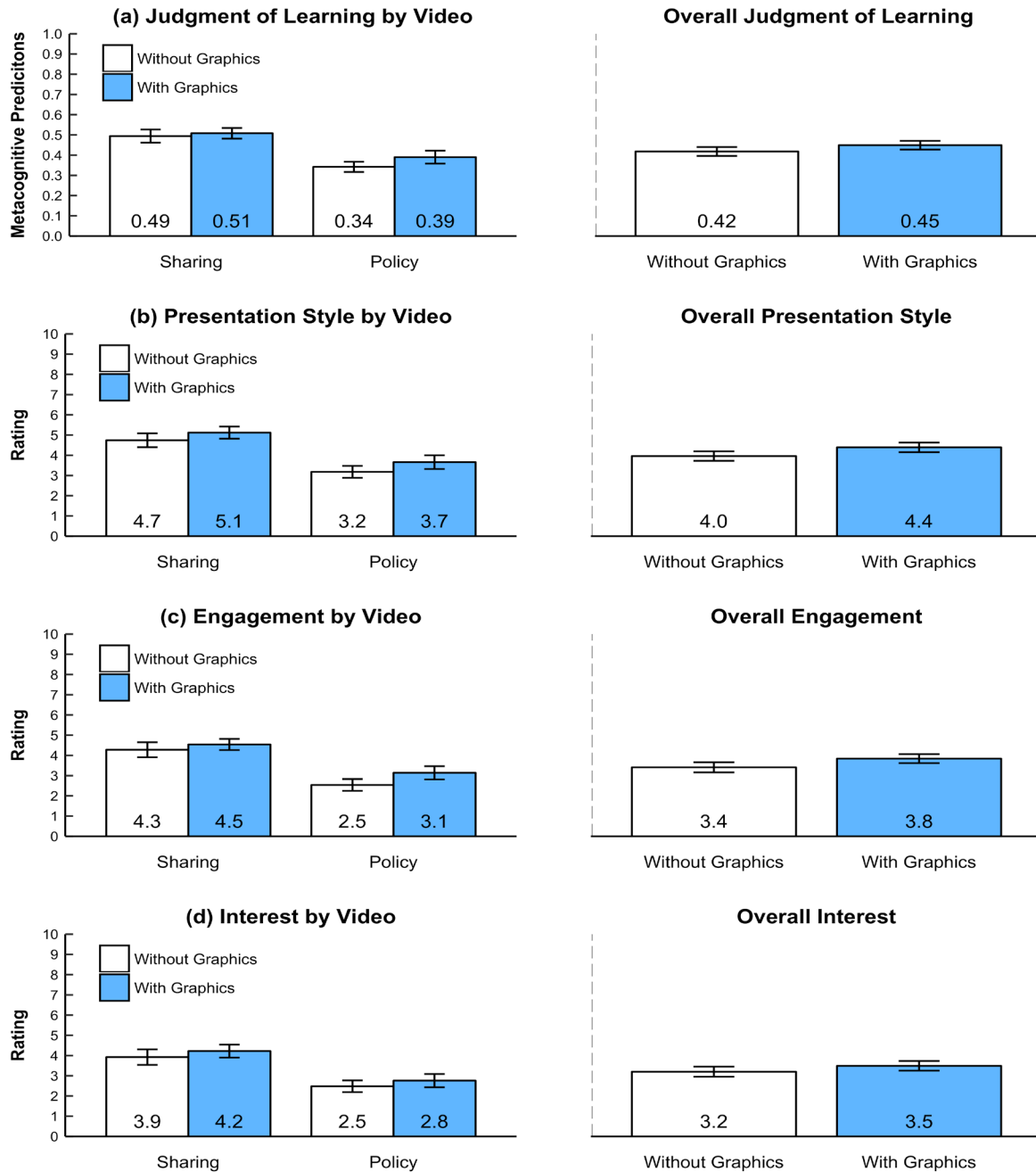
Figure 1 *Students' subjective ratings of videos with graphics vs. without graphics*

Figure 2 shows performance on the short-answer test in the graphics and no graphics conditions. The left panel shows performance for each video, and the right panel shows overall performance collapsed across the two videos. Short-answer scores, like students' subjective ratings, were slightly better in the graphics condition relative to the no graphics condition, with an overall difference of 4percent favoring the graphics condition.

Memory Performance by Video   **Overall Memory Performance**
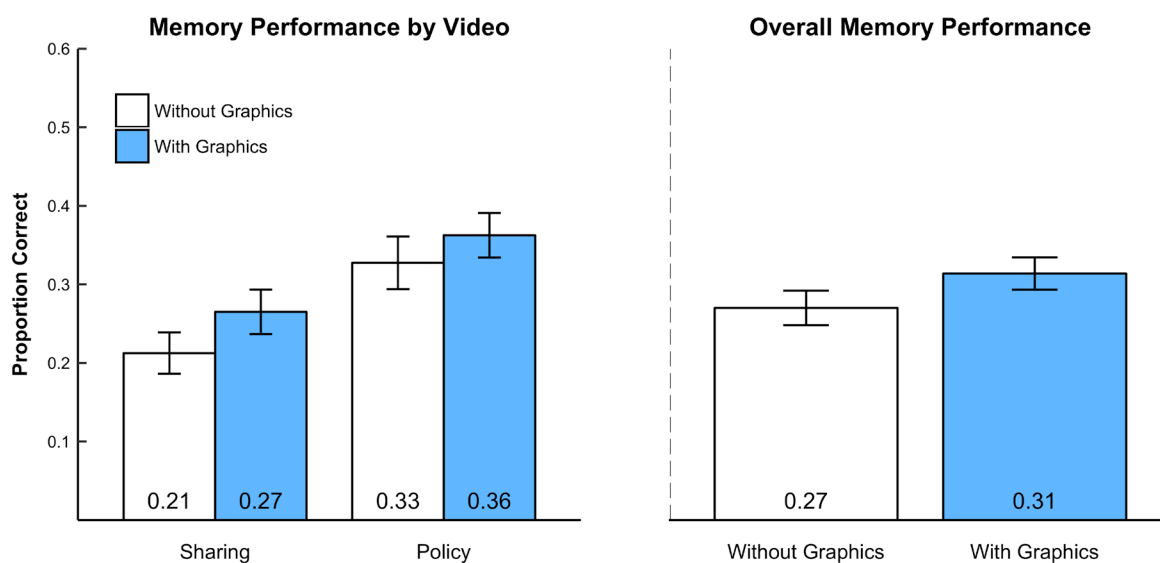
Figure 2 Performance on the short answer test for videos with graphics vs. without graphics

In general terms, the data shows that that there were overall differences in subjective ratings and short-answer scores across the two videos. As shown in the left panels of Figure 1, subjective ratings were higher for the Sharing video than they were for the Policy video. As shown in Figure 2, short-answer scores were higher for the Policy video than they were for the Sharing video. However, there were no condition (graphics vs. no graphics) X video interactions in this experiment which means that even though there were overall differences in ratings and short-answer performance across the two videos, the effects of graphics vs. no graphics were the same for the two videos (in other words, any effects of graphics condition did not depend on the particular video).

Further analysis of the data (which can be provided upon request) shows that the effect differences between embedded graphics versus without is not 'statistically significant' (e.g. margins are only 3 percent or 4 percent) and further experimentation with a broader sample size may yield different results. However, does this matter? Is the effect size practically significant, in the sense that it's of a sufficient size to warrant a change of practice for video producers? This is debatable and for the judgment of video producers themselves given that the margin of difference was quite small. However, the findings are certainly very interesting and would seem to chime with previous research on multimedia learning (Mayer, 2014) already discussed in this paper, particularly the Multimedia and Contiguity principles.

Finally, this experiment raises questions about possible future avenues for exploration. Do certain types of graphics aid engagement and learning over others? Echoing Mayer's research, are some types of graphics more redundant or distracting than others from a learning standpoint? What types of graphics or visuals add information that is not redundant and, therefore, help elaborate on video content? How many graphics are needed per minute of video content to make a significant or practical significance? Finally, what effects might be shown if these videos had been shorter, or if only discreet segments of the content had been used in the study (per findings reported in this white paper – see Video Length)? There is certainly plenty of scope for further investigation here.

Conclusions

The prevalence of the use of video in higher education has increased exponentially over the past decade, and this trend is likely to continue in the future. The advancement of the "Net" generation of students through higher education, the advent of new teaching methods (and video's role in changing some of these), a changing university environment, the development of digital media, and greater knowledge on the benefits of video in higher education will certainly contribute to this ongoing development. Furthermore, studies have shown that they can contribute positively to both student confidence, motivation and performance levels. In each of these ways, videos are already showing high levels of demonstrable impact in higher education.

However, there is much more to be learned about the measures of success this impact converts to and at SAGE Publishing we will be invested in exploring this much further in the coming period (and publishing our results in follow up white papers). For example, one very real measure of success could be the definition of some metrics (or 'altmetrics') for the understanding of the relative impact of video use as these are now known for scholarly journals (e.g. the "Impact Factor"). As one of the "newest kids on the block", the absence of these metrics for video raises questions for some in knowing whether it can drive good scholarly as well as pedagogical outcomes. As we have seen in this white paper, there is more to be investigated on whether video can play a role in the development of critical thinking, knowledge development and student engagement. Finally, there are a host of other interesting questions about what specific forms of design, graphics and content types in educational video will drive significant success in students' emotional response to watching video and their learning performance on courses.

This white paper has shown that many students indicate that they like learning from videos, empowering them to learn flexibly and independently, leading them to request online content in their courses. Because students enjoy and request access to video, it can be considered a positive, instructional format which should provide confidence to librarians, faculty members and other constituents that as an educational resource it has a very bright future.

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