

2020

Going digital to enhance the learning of undergraduate students

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Introduction

While lectures have been a fixture of higher education since its inception, within today's tertiary landscape the use of technology for online content delivery is ubiquitous and continues to expand (Altbach et al. 2019; Sherer & Shea 2011). An annual survey carried out by the EDUCAUSE Center for Analysis and Research (ECAR) over the past 15 years provides reliable data from over 64000 students worldwide, and indicates that use of technology is unavoidable in 21st century tertiary learning environments (Galanek et al. 2018). These reports consistently indicate that technology is embedded in students' lives, and they have a positive relationship with technology.

Students are offered a plethora of resources and must choose which to use and how to engage with them, and the basis of their choices is of great interest. The Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al. 2003) has been widely used across multiple disciplines and contexts (Venkatesh et al. 2016) to relate acceptance of, and intention to use technology to its actual use. Relevant factors include the perceived usefulness of the technology, users' own experiences and users' attitudes. This is the established model for analysing student choices and use of technology in their learning (Dečman 2015; Persada et al. 2019). The main forms of resources that students are offered are documents containing text only or mixtures of text and images, and videos, which may be produced in-house by their institution or externally.

Multiple older studies (Baggett 1984; Jonassen et al. 1999; Kozma 1991; Mayer 2001) found that people learn better with visual representations rather than simply through text. The seminal work in this area from Mayer (2001) established the Principles of Multimedia Learning, and a later review from the same author verified the key features of effective instructional materials (Mayer 2017). In brief, videos are valuable in terms of knowledge retention and comprehension, and they enable learners to more easily understand and recall content when compared to expository text. For these reasons, use of videos in learning is expanding and encompasses all disciplines, and research into the use of videos in education is correspondingly also growing (Giannakos 2013; Winslett 2014). A wide variety of types of videos and delivery routes exist, with an equally broad range of learning objectives for students (Winslett 2014), and so far there is no agreed best practice in this area.

Massive Open Online Course (MOOC) platforms such as *Coursera* and *edX* offer structured online courses including a range of video learning resources (Guo et al. 2014). Guo and colleagues analysed nearly 7 million video watching sessions within MOOCs in an effort to provide general recommendations about video production for optimal engagement, which included that videos should be shorter than 6 minutes, made informally, with drawings and showing the enthusiasm of the lecturer. A study on an early MITx MOOC "Circuits and Electronics" found that students spent the majority of their time watching videos (Breslow et al. 2013; Seaton et al. 2014). This is important because although MOOC students have a different set of resources to tertiary students enrolled at brick and mortar institutions, they also have a choice as to how to spend their time in their learning, and clearly watching video is one of the favoured choices.

Among the types of video resources available to students enrolled at university, the most common is a recording of the live lecture at the time that it is presented to students who attend face to face. Many institutions automatically record audio and screen capture for all lectures (Dona et al. 2017); these are variously known as lecture capture, Echo360, screencasts, lecture recordings, iLectures as well as other terms. In this manuscript, the term "lecture recordings" will be used. A detailed analysis of motivations for use of lecture recordings found that different students used them in many different ways, and they are valued by students. However, academic staff had concerns related to didactic translation of what happens in located face-to-face lectures to an online version of

lectures, and with no consideration of how best online students learn in digital environments (Dona et al. 2017).

One major benefit of lecture recordings is that they do not require any extra time or effort from academic staff members. However, there has been some debate about whether offering students access to recorded lectures contributes to lower face to face class attendance (Dona et al. 2017). Recent publications support the proposition that for students who access the recordings as a supplement to lecture attendance, it improves their learning outcomes, but for those who use recordings as a substitute perform worse than students who attend face to face (Bos et al. 2016; O'Callaghan et al. 2017; Traphagan et al. 2010; von Konsky et al. 2009; Wieling & Hofman 2010; Williams et al. 2012). At our institution, face to face attendance is not required, and lecture recordings are available to all students. These capture the whole lecture in a single recording, which is typically 50 minutes or 100 minutes for a double hour such as in the unit in this study.

Regarding the ideal useful length for learning resources, the typical attention span of students in a learning environment has been proposed to be approximately 10-15 minutes, although this is affected by many variables (Davis 2009; McKeachie & Svinicki 2010). Thus, it is likely that as a student watches a longer video, their attention waxes and wanes, similar to a student in a face to face class. In the study of use of video within MOOCs described above, Guo et al (2014) measured engagement by analysing how long students were watching each of the videos, and if they attempted to answer a range of questions that were available after the video was finished. They discovered that shorter videos were more engaging and videos which included drawing tools (e.g. maths formulas etc.) were the most engaging (Guo et al. 2014).

Of course, it is not only the length of a video that affects user engagement; there are also important factors of production quality and delivery. With the proliferation of high-quality videos created for MOOCs and YouTube, learners' expectations for access to such premium resources have increased. In a large study of over 2 million views of live streams, long and short videos, Dobrian et al. (2011) demonstrated that buffering ratio had the greatest impact on video viewing, and join time is also important. Considering the quality of the video watching experience for sport, education and comedy videos, Zhu et al. (2015) highlighted a number of factors, including that watching with others increased the viewers' levels of enjoyment and enhanced the endurance of the experience. Although viewers noticed different levels of quality, it did not affect their perception of their experience.

Considering educational videos, Gilardi et al. (2015) compared student engagement with four types of video lectures, including videos with and without the face of the lecturer, and also to face to face lectures. They found that there was a link between video lecture delivery format and the engagement felt within the video content, and in particular many of their respondents specifically mentioned the importance of feeling that the lecturer was talking to them directly. Giannakos explored the relationship between video lecture usage patterns and student attitudes to the videos (Giannakos et al. 2016). Their study focussed on software engineering students and so is directly relevant to our research on information technology (IT) students. The students in that study were offered video lectures as a supplement to their face to face lectures and were surveyed on their usefulness and intention to use the videos in the future. In the context of their use of the video lectures, the students were asked what their ideal length for a video lecture was and responses varied widely, from 15 – 100 minutes with a mean of 37 (SD 20) minutes. This contrasts with the typical attention span reported above and shows that students may perceive the value in a longer format presentation that mimics their typical face to face experience. The students watched the videos both in full and also in parts, depending on their requirements. Prior experience with videos was significantly correlated with finding videos useful and watching longer videos or watching videos in full was significantly correlated with future intention to use videos. In this context is it im-

portant to differentiate between content made for a specific unit at an institution, typically available through a Learning Management System (LMS), and content that is freely available online and not linked to any unit or institution such as many YouTube videos (Sherer & Shea 2011). In the study described above, the videos were available both through YouTube and via an institutional platform, and were watched nearly twice as often on YouTube; however, the students who watched on the institutional platform found the videos more useful (Giannakos et al. 2016).

García, Pérez-Navarro, & Conesa (García et al. 2018) examined student use of custom-made videos for physics, which is a discipline requiring abstracted thought, like IT. They found that students perceived the videos to be a complement to the text-based instructional materials. In their interactions with videos, students jumped forwards, backwards and paused videos in their use (García et al. 2018). The availability of these functions and the ability to watch a specific part is a critical aspect of the perceived usefulness of video (Giannakos et al. 2016).

Video learning resources provide students with the possibility of a personalised learning approach, and it has been found that overall preference for flexible delivery does not vary with learning style preferences (Becker et al. 2007). Web 2.0 technologies can offer more personalised learning environments but students may require scaffolding to take advantage of the resources (McLoughlin & Lee 2010). As educators some caution is required in the use of video, because a study of secondary student use of third party educational videos showed that while the videos did assist with the engagement and learning of scientific ideas, some video-graphic features distracted students and constrained their learning (Higgins et al. 2018). The question of what type of digital resources optimise student learning outcomes is still open. Whilst there has been much research conducted about the use of all forms of educational video (O’Callaghan et al. 2017; von Konsky et al. 2009), there has been little research conducted to determine student preferences and engagement with particular learning resources for IT students.

The aim of this study was to determine the use and perceptions of IT students of video and other learning resources. Within this manuscript, we review the video usage of IT students when provided with alternative digital learning materials and compare this with their stated preferences for learning resources. This area of research is particularly important as technology advances and expectations that education providers should provide digital resources evolve. This manuscript includes an analysis of self-assessed attention span, student experience quality, and perceived comprehension and knowledge retention.

The research questions for this study were:

1. Given a choice, what types of video resources do IT students access most for their learning?
2. Which resources do IT students perceive to be most valuable to their learning?

Context

This study was conducted at a large Australian university which has a focus on online learning and teaching (a ‘cloud first’ approach). The unit involved focuses on students being able to analyse and critique the information they see; problem solve using the most appropriate methods and ask necessary questions to determine the credibility of the information. Understanding how arguments work and how to analyse them along with checking claims, issues and statements to determine if an argument is valid or invalid are also covered. To demonstrate this thinking and analysis, algorithms are presented and discussed so students can understand what decisions look like in pseudo-code when designing and developing IT solutions.

A total of 496 students were enrolled, studying across three campuses (two local campuses in Victoria, Australia and the ‘cloud’ (online) campus (26% of students)). A total of 144 students (29%)

voluntarily agreed to participate in the study by responding to the invitation email and completing the survey at the end of the teaching period. The survey was anonymous and was intentionally administered before the summative final assessments to counterbalance any bias. Institutional ethical approval was obtained for the study (STEC-29-2017-PATTERSON-MOD-01).

Conceptual Framework

We are applying the conceptual framework of Mayer's Multimedia Principles (2001, 2017), shown in Table 1. There is compelling evidence from multiple metastudies that students prefer materials designed based on these principles and that they lead to enhanced learning outcomes (Mayer 2019). Out of the twelve principles that Mayer proposed, the five highlighted in bold in Table 1, in particular, were incorporated into the design and development of the short premium video resources for this study.

Table 1: Mayer's multimedia principles

PRINCIPLE	EXPLANATION	HOW APPLIED
COHERENCE	People learn better when extraneous words, pictures and sounds are excluded rather than included.	
SIGNALING PRINCIPLE	People learn better when cues that highlight the organization of the essential material are added.	Videos offered in carefully structured order within unit site.
REDUNDANCY PRINCIPLE	People learn better from graphics and narration than from graphics, narration and on-screen text.	
SPATIAL CONTIGUITY PRINCIPLE	People learn better when corresponding words and pictures are presented near rather than far from each other on the page or screen.	
TEMPORAL CONTIGUITY PRINCIPLE	People learn better when corresponding words and pictures are presented simultaneously rather than successively.	
SEGMENTING PRINCIPLE	People learn better when a multimedia lesson is presented in user-paced segments rather than as a continuous unit.	Videos kept to under 2 minutes
PRE-TRAINING PRINCIPLE	People learn better from a multimedia lesson when they know the names and characteristics of the main concepts.	
MODALITY PRINCIPLE	People learn better from graphics and narrations than from animation and on-screen text.	On screen text used ONLY to highlight key principles
MULTIMEDIA PRINCIPLE	People learn better from words and pictures than from words alone.	
PERSONALIZATION PRINCIPLE	People learn better from multimedia lessons when words are in conversational style rather than formal style.	Informal conversational style was used
VOICE PRINCIPLE	People learn better when the narration in multimedia lessons is spoken in a friendly human voice rather than a machine voice.	The teacher's own voice was used.
IMAGE PRINCIPLE	People do not necessarily learn better from a multimedia lesson when the speaker's image is added to the screen.	

Methodology

We offered three types of digital resources to all students within the LMS. The three categories of videos are summarised in Table 2.

Table 2: Summary of video characteristics

TYPE OF VIDEO	TYPICAL LENGTH	FEATURES
Short premium videos	1-2 minutes	high-quality production including special effects, animations
Front of classroom videos	1-2 hours	recorded with a digital camera from within the lecture theatre, showing the lecturer and the presentation slides
Lecture recordings	1-2 hours	the presentation slides and the voice of the lecturer, captured during the live lectures

The short premium videos were prepared using Adobe Premiere Pro & Adobe After Effects for animations. A screen shot of one video, showing how animations, text and the lecturer's face and body appeared, is shown in Figure 1. The use of several of Mayer's principles of multimedia when preparing the videos is summarised in Table 1.

Figure 1: Screenshot from a short premium video



The short premium videos were designed and recorded by the lecturer, with one per week corresponding to the lecture content. Topics for the short premium videos included an introduction to problem-solving and critical thinking, and concepts such as claims, issues, credibility and arguments. These were chosen because they cover key concepts from each week required to assist students in understanding the content. The time required to prepare these videos was around a business day for the initial software training. Each video then required approximately 10 minutes recording, 20 minutes editing and 15 minutes rendering. Note that no specific time was required for storyboarding because the content was very familiar to the lecturer.

The front of classroom videos were made during the face to face lectures by situating a video recorder near the front of the audience. The videos captured the lecturer, the slides behind him, and the audio of the lecturer. A screen shot is shown in Figure 2. These were made for all lectures in the unit; however, technical problems made three of them unusable so only eight were available to students.

Figure 2: Screenshot from a front of classroom video



The lecture recordings were captured automatically using Echo360. This records the slides and the audio during the lectures. Students have access to these recordings for all of their units at this institution and so are familiar with them.

Data collection and analysis

We designed the survey to determine participants' perceptions of their own attention span, the quality of resources offered, their comprehension and retention of knowledge as well as their preferences in learning materials. In the survey, the term Echo recording was used for the lecture recordings, and "short topical videos" or "short weekly videos" was used instead of short premium videos (used in this manuscript). The survey was hosted on *SurveyMonkey*. To analyse the survey data, we utilised Microsoft Excel and the Analysis ToolPak addon. This allowed the team to provide data and parameters for analysis within the tool, determine relationships between two or more data sets which aided in determining a story around the data. Once analysis was complete it allowed us to generate charts and tables.

We compared the results from the survey with the University-led student evaluation survey (eVALUate) to gain further insights. eVALUate collects information regarding students' perceptions regarding learning experiences, learning resources, teaching quality and unit satisfaction in a standard set of 11 Likert questions. This survey is administered to all enrolled students at the end of each trimester across the institution. Typical response rates for undergraduate units in the School of IT are around 20-30%.

Results and Discussion

The IT student cohort we focused on is often seen as being more technically minded than other students, because they often have an interest in technology from a young age and as a result may be more digitally literate.

Analytics of video resources

Data were calculated by the in-house video learning platform. The variables which were included in the analysis were: Average total plays (average number of times each video was started); Average completion (percentage of the video watched before navigating away); Average view time (how long on average did students allow each video to run) and total length of each video type (time). The data are presented in Table 3.

Table 3: Watchability statistics

TYPE OF VIDEO	Short premium	Front of classroom	Lecture recordings
NUMBER OF VIDEOS OF THIS TYPE	11	8	11
AVERAGE TOTAL PLAYS	260.9	63.6	45.7
AVERAGE COMPLETION	78%	29%	58%
AVERAGE VIEW TIME	1 minute 34 seconds	22 minutes, 19 seconds	Not measured
AVERAGE TOTAL LENGTH	2 minutes	1 hour 20 minutes	1 hour 20 minutes

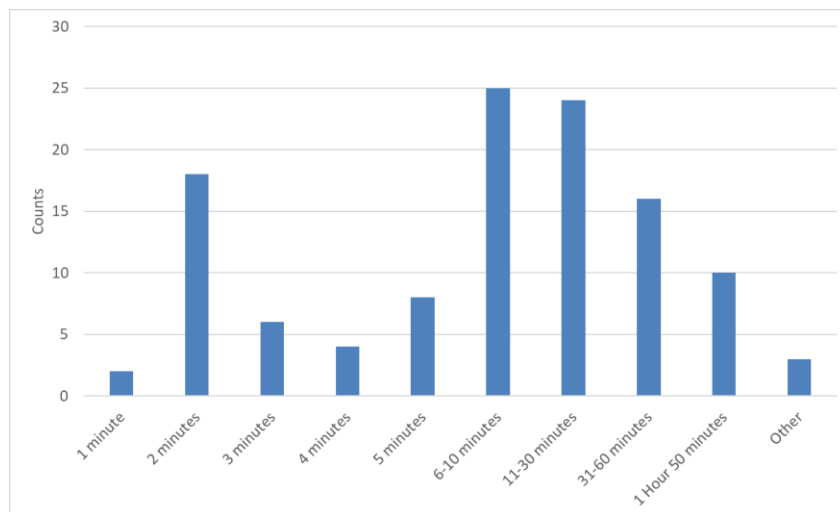
It can be seen that students watched the short videos to completion far more often than the other videos. We believe this to be related to the length and the quality, which we will elaborate later. This is consistent with the idea that students are time poor due to juggling many other commitments including work and socialising (both physically and social media). It is interesting to compare this data to the findings of Gilardi and co-workers that students preferred videos in which they could see the face of their lecturer and that videos should be personal (Gilardi et al. 2015). In our study, the IT students watched the impersonal lecture recordings to completion twice as often as the front of classroom videos in which the lecturer could be seen. The front of classroom videos were started more often, but the short premium videos were both started more often and watched to completion more often than either of the other options.

Attention Span

The question provided to students asked; “What is the longest learning video you would be prepared to watch without interruption or within your attention span?” The results showed that the most preferred video length was a maximum of 6-10 minutes (22%), consistent with general educational recommendations around attention span (Davis 2009; McKeachie & Svinicki 2010), while the least preferred was at 1 minute (2%) (Figure 3). However, more interesting than these values is the observed trend, which shows two maxima for the choice of longest video, one at a very short

time (2 minutes) followed by a dip from 3 – 5 minutes, then a second (overall) maximum at a longer time (6 – 30 minutes).

Figure 3: Self-assessed learning video attention span (n=116)



The three responses of “other” gave insight into the observed trend as follows.

- I personally would do *both long and short form videos*, but I think 45 min cycle they use in primary and secondary schooling bears looking at.
- 5-10 min for targeted concepts, 30 min or more for more general contextual explanations
- Anything as long as it is relevant. Lectures can waffle, whereas pre-recorded videos are presumably edited to be concise and to the point.

That is, students clearly see the value of both longer and shorter videos, depending on what is being covered and the format. Comparing this to the findings of Giannakos and coworkers shows a marked difference. Their students suggested that the ideal length of a video lecture was 15 minutes or longer, with a mean of 37 minutes (Giannakos et al. 2016). Further research is required to determine the origin of these preferences, although presumably our students’ experiences with the short premium videos of around 2 minutes has impacted their choice.

Quality of Experience

Because the purpose of this study was to evaluate perceptions of the short premium videos, students were asked “Throughout the unit, short topical video segments covering the weekly topics were provided. Do you think they are more beneficial to your learning compared to a traditional 2-hour Echo class recording?” and the results are shown in Figure 4.

This is consistent with the watchability data above, showing that students have not only watched the short premium videos far more often, but they perceive them to be more beneficial to their learning compared with lecture recordings. Presumably part of this perception relates to the use of the Mayer principles in Table 1, that reduce extraneous processing and manage essential processing during learning from the videos (Mayer 2019).

Figure 4: Student survey responses to question “Are short premium videos more beneficial to learning?” (n=120)

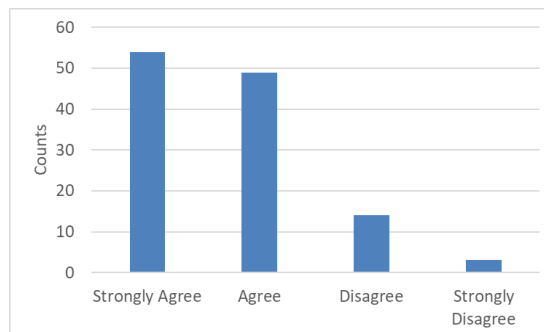
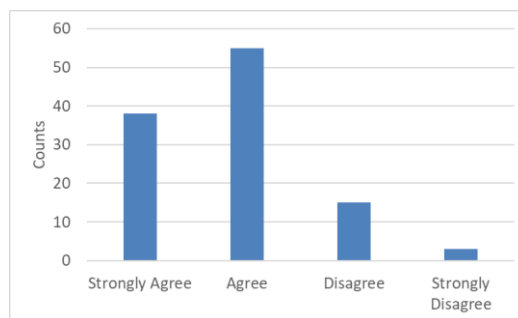


Figure 5: Student responses to whether quality of videos matters (n=111)



To probe the specific question of video quality (as opposed to length) students were asked; “Are premium quality videos (e.g. which exhibit special effects, animations, etc.) a more effective resource than a lower quality video production (e.g. teacher talking on webcam in their office)?” they responded strongly with agree (50%) and strongly agree (34%) (Figure 5). This indicates that our students preferred premium quality materials versus lower quality videos, even if they are exhibiting the same factual information. Follow-up research is required to determine whether the standard lecture recordings are perceived as low quality, and what level of animations and special effects are required for students to perceive a video as premium quality.

Choice of Resources

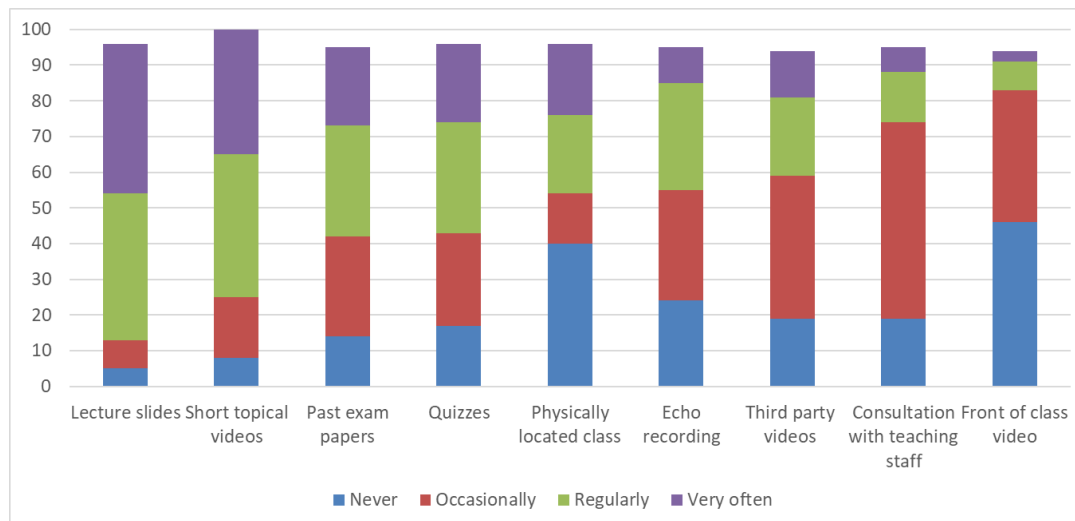
Several related questions were asked of students in an attempt to tease out their preferences and perceptions related to the whole set of resources on offer including static files, different video types, face to face classes and consultation with their teachers. Students were asked “In terms of resources, which would you utilise before completing an assessment task (quiz, assignment or exam) to be best prepared?” and were offered the following nine options:

- Class video recording from audience member view
- Consultation with teaching staff
- Echo recording
- Lecture slides
- Past exam papers
- Physically located class

- Quizzes
- Short topical videos
- Third party videos (including YouTube, Vimeo, etc)

For each option, the students could select one of the four choices “very often”, “regularly”, “occasionally” and “never”. The results are shown in Figure 6.

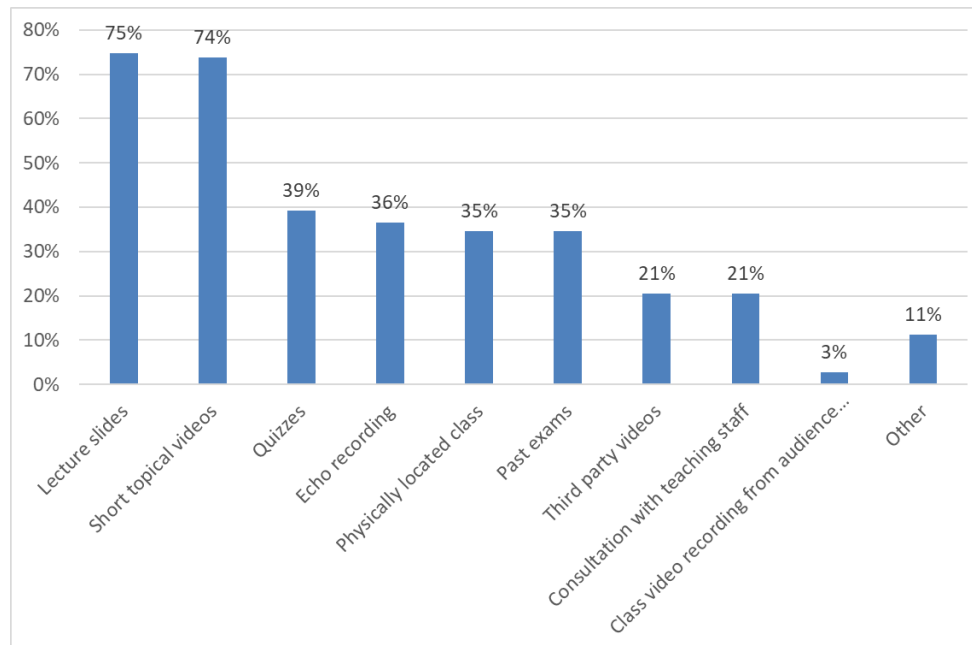
Figure 6: Responses (counts) to survey question “Which resource would you use before completing assessment to be prepared?”



It can be seen that while the short premium videos were popular, the most popular resource was the lecture slides (a static pdf file). The lecture recordings (Echo) were selected less often to use very often or regularly. Past exam papers and quizzes were used occasionally or more often by over 80% of students, which is not surprising as an exam preparation technique. Third party videos including YouTube were used at least occasionally by 80% of students, but over half of those students *only* used them occasionally, and few students used them very often. It can also be seen that physically located classes had an unusual response pattern, with very few occasional users, while consultation with teaching staff was used only occasionally by the majority (58%) of students, indicating that a significant proportion of students are indeed accessing their learning resources fully online.

A slightly different question probed “Which resources from the list below were most effective in your comprehension and retention of key concepts in the context of this unit/area of study?” and students could choose as many of the above nine options as they wished (or provide an “other” response). The results were very similar to the previous question, with lecture slides and short premium videos the most popular (Figure 7).

Figure 7: Which resources from the list below were most effective in your comprehension and retention of key concepts? (n = 107)



The combination of the data shown in Figures 6 and 7 gives a clear indication of what resources students turned to most, because they perceive them to be effective. Lecture slides were slightly more highly rated than the short premium videos under both of these measures, but the short premium videos were a close second and far more often used and perceived as more effective than the next most highly rated items. The order of the remaining items differs slightly between Figures 6 and 7, because of the slightly different phrasing of the questions, but lecture recordings, quizzes, face to face classes and past exams comprised the next four most highly ranked resources.

Third party videos (including YouTube) were not considered effective in comprehension and retention, which is an important result given their prevalence. It is interesting that consultation with teaching staff ranked so poorly in both of these measures; this may reflect perceived unavailability or unfamiliarity with the concept of making appointments to see academic staff. The front of class videos were the lowest ranked on both scales, contrasting reports that having the lecturer's face visible is important in student engagement with lecture videos (Gilardi et al. 2015).

eVALUate Results: Learning Outcomes, Experiences and Satisfaction

Table 4 shows the percentage of students that agreed or strongly agreed with the statements from the University-led student evaluation of teaching (eVALUate). Note that the number of participants was relatively low; this may be due to the fact that the students had already been offered another survey as part of this project. The students' response to the learning design provided in this unit was positive across the board.

Table 4: Deakin University eVALUate results (n=86 students; 17%)

QUESTION	% AGREE/STRONGLY AGREE	Mean response across all School of IT units (n = 3604 students; 25%)
The learning experiences in this unit help me to achieve the learning outcomes.	94.2	83
The learning resources in this unit help me to achieve the learning outcomes.	95.3	82
The quality of teaching in this unit helps me to achieve the learning outcomes.	89.4	77
I make best use of the learning experiences in this unit.	87.1	84
Overall, I am satisfied with this unit.	90.4	79

The highest agreement was with the utility of the learning resources, which included the short premium videos. It can be seen that all aspects of this unit were rated significantly higher by students than is typical in the School.

Limitations of this Study

We did not collect attendance data, so we have no information as to whether students who attend classes also watch any of the videos and which ones. In addition, we do not know which of the survey responses came from students enrolled through the cloud campus and whether their use of video differs from students who have the option to attend in person. We did not correlate students' use of video with their results, so we do not know whether the perceived learning value is real. Other limitations are that the question design was leading regarding the comparison between lecture recordings and the short premium videos. The eVALUate questions are standard across the institution, so were not tailored to our study, meaning that it is not possible to determine how much of the positive response is due to offering the premium videos.

Future Directions

We plan to collect and analyse similar data from other study units within our institution where short videos have also been made by academic staff, allowing us to compare and contrast results. We also plan to test in more detail the attention span of students, and whether it is related to quality or simply the length of the video. We will also expand on our use of video resources to create interactive learning resources to investigate whether active engagement affects satisfaction levels. Finally, we would like to explore the learning outcomes of the students and whether use of video resources impacts their grades.

Conclusion

Students accessed the short premium videos more often than other videos, but they also accessed the longer videos. Students also perceived that short videos helped them to retain knowledge and

consistently rated them highly for preparation for assessment, comprehension and retention. However, overall the most highly valued resources were pdf lecture slides (without video). Modifying the student perception of the lecture slides as the ultimate resource may require a cultural shift in how teaching is conducted.

This study not only offers a set of considerations and recommendations for the education of IT undergraduate students but also for digital learning in higher education more generally. Short premium videos summarising the weekly lecture content are not difficult or time-consuming to make, are frequently watched by students and are perceived to have great learning value.

Given the limitations of this study, our further research will consider the outcomes of students learning, in other words, whether if the use of digital resources such as video, in fact, improved their learning outcomes - as opposed to their perceptions of knowledge retention.

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