# Video and Rich-Media Resources in HE Engineering Education

*Cheril Project – Final Report*

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## Introduction

This project aimed to answer the following questions:

- What forms of media-rich resource are most used by and useful to students?
- What techniques lead to high levels of student adoption of various types of media-rich resource?
- How should media-rich content be produced to be most helpful for learning? Length, production techniques and links with other material will all be considered.
- What similarities and differences are there between how students studying broadly qualitative and quantitative subjects use video resources?

The project was highly successful and met these aims in full, on budget and to time.

The findings are significant for future development of media-rich material and have been fully reported in a paper submitted to the ISI ranked journal Computers and Education. This is attached and gives a complete discussion of the academic outcomes of the project. The following sections summarise these academic findings and report in full on other aspects of the project.

## Summary of Academic Novelty, Robustness and Findings

(As above, for a full discussion of the academic findings, see the attached manuscript)

The project was timely and ground breaking. It was the first major study examining how "digital natives" use a variety of rich-media material on technical courses in higher education. Given the rapidly changing teaching environment as a result of, for example, smart-phones, tablets, MOOCs and increasingly versatile VLEs; knowledge of how students engage with new media is vital for ensuring high-quality, engaging course material. The use by over 300 students of three types of rich-media material was examined using a combination of surveys, interviews and internet analytics data. Together with a thorough literature review, this has provided a robust body of knowledge that can be used by individual practitioners when planning teaching material and institutions when deciding on resource allocation.

The key academic findings of the project are:

- All types of rich-media are valued by students as they allow for learning at any time and in any place. They also allow repeated viewing of presentations of difficult material – something traditional lectures do not allow. This aspect is particularly useful for students with certain disabilities, and those who have English as a second language.
- Reduced lecture attendance is often cited as reason for not producing media-rich material, particularly lecture podcasts. The effects on lecture attendance are however found to be small (and two-way). Further, concern about lecture attendance is only relevant if lectures are seen as *the* central way of teaching – by adopting a blended learning philosophy and accepting that students will use whichever communication channel is most useful to them, concerns about lecture attendance disappear.
- Media-rich material is best produced to be as short and information-dense as possible. Five minutes is a sensible upper-bound for a key-concept video because beyond this time it is difficult for viewers to keep focussed. This is very much in contrast to traditional lectures and something academics should bear in mind when producing

material, with much existing material on, for example, YouTube, being too long to be effective. This also has implication for planning lecture capture systems.

## Dissemination

Dissemination of the findings has been undertaken in various ways and to diverse audiences. This will continue over the next year. The full set dissemination activities completed and planned is:

- A paper has been submitted to the journal "Computers and Education" for publication as a peer reviewed article. The manuscript is attached to this report. This will form a permanent record of the project and ensure global dissemination of the work.
- This submitted paper has been discussed at the University Lecture Capture Academic Steering group and circulated to all members of the group. Consequently, the findings will be used at University level when developing lecture capture and other media-rich infrastructure in the future.
- The findings were presented to the MACE e-learning community of practice group in July 2015, ensuring that they can be adopted in a practical way for teaching from academic year 2015/16 for engineering courses
- Summary findings have been posted on Martin Gillie's blog, making them immediately available to a general audience http://tinyurl.com/pvboqjy
- A blog post will be made on the HEA website so the findings are available to the wider academic community.
- A paper will be submitted for presentation at the 6th International Symposium of Engineering Education to be held at Sheffield University in 2016.
- A presentation is planned for the Cheril Conference to be held in December.

## Implications for the University

The project has a number of implications for the University. It suggests that:

- Since media-rich material is valued and used by students, further investment in producing such material would be wise. This might include, hardware, software, and staff encouragement and development.
- The lecture capture system is valued and used by students but that there are questions to consider about whether producing such full-length media resources is the best way to invest in this area.
- If developed with care, media-rich material offers valuable routes to meeting the University strategic aims of providing individualised learning, equality in learning and public engagement.

## Future Plans

This project focussed on how students use rich-media material. No comprehensive attempt was made to correlate usage with attainment, and still less to find a causal relationship (although some data was obtained incidentally). These are both areas of interest and data on these questions would be illuminating. Blackboard offers limited means of correlating student attainment with usage; the University lecture capture system more detailed data. This information will be recorded for potential future analysis from 2015/16.

# Use of Rich-Media Resources by Engineering Undergraduates

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## Abstract

The ability to develop and distribute digital teaching resources in higher education has developed rapidly over the last decade but research into how students use such resources has received limited attention. This study uses questionnaire results, internet analytic data and semi-structured interviews to examine the use of three types of rich-media teaching resources – lecture podcasts, key-concept videos, and tutorial solution videos - by engineering undergraduates. It is found that students value all three types of resource, especially for revision and as a supplement to lectures. Students find short focussed resources more useful than longer ones. Non-native English speakers and those with disabilities derive particular benefits from the resources. The effect of rich-media resources on lecture attendance is found to be small, and two-way.

## Key-words

*computer-mediated communication; pedagogical issues; post-secondary education; teaching/learning strategies*

## Introduction

In recent years the possibilities for using video and related "rich-media" resources in engineering higher education have increased dramatically. The technical possibilities (YouTube, lecture capture, etc.), distribution aspects (tablets, virtual learning environments (VLEs), mobile devices) and student expectations have all changed rapidly. Consequently, engineering education has moved from a state where using rich-media to support teaching was the exception to one where it is increasingly expected by institutions and students alike.

Despite this, research into how students use rich-media resources, how the existence of such resources affects use of other material, and how to make useful and effective resources has been limited. Moreover, the rapidly changing possibilities and expectations of students means previous findings rapidly become dated. With these points in mind, this study uses a combination of quantitative and qualitative data to address the following questions:

- To what extent and for what purposes do students use various kinds of rich-media resources?
- How does the provision of rich-media affect students' use of other teaching methods, in particular lectures?
- How should media-rich content be produced to be most helpful for learning? Length, production techniques and links with other material are all considered.

The results provide an insight into the benefits of rich-media material within higher education; information on how students use it; and pointers to how it can be best developed, both in terms of production techniques and allocation of resources.

## Context and Previous Studies

As with digital developments in other fields, the ability to provide digital media resources in higher education has arrived rapidly. For example VLEs have developed largely since the advent of the internet, and have grown in sophistication in line with general web-based developments (e.g. Mikropoulos & Natsis, 2011) yet they now form a fundamental part of most higher education delivery. The ability to provide video material in a digital and widely accessible form is even newer, with widespread adoption growing in parallel with websites such as YouTube (founded in 2005), and the development of platforms such as smartphones (from *c*2007) and tablets (from *c*2010). These developments have resulted in efforts to change delivery in higher education from a form dominated by "chalk and talk" style teaching to a more blended approach, incorporating media-rich possibilities. Attempts have included fully digitised education such as "MOOCS" to various levels of incorporation of rich-media in courses at traditional universities. The discussion here focusses on the latter approach, where modern digital resources are blended (e.g. Garrison & Kanuka 2004) with traditional teaching methods such as lectures and tutorials.

Rich-media materials are defined as "any pre-prepared video, audio and images (both still and animated) which are created for the purposes of teaching and learning." (Saunders & Hutt, 2014). Previous research on rich-media materials has involved pod-casting – both audio and video (Kazlauskas & Robinson, 2012; Van Zanten, Somogyi, & Curro, 2012; Walls et al., 2010), the use of narrated PowerPoint slides (Copley, 2007; Holbrook & Dupont, 2011; Parson, Reddy, Wood, & Senior, 2009) short video segments (Walls et al., 2010) and lecture capture (whether audio only or video plus audio) (Davis, Connolly, & Linfield, 2009; Leadbeater, Shuttleworth, Couperthwaite, & Nightingale, 2013; Parson et al., 2009; Pearce & Scutter, 2010). In the vast majority of case studies, the rich-media materials served to supplement rather than to replace traditional face-to-face lectures. Despite this, the aims of rich-media materials varied considerably (purposes have included assignment preparation, revision materials, lecture capture, and provision of class information) as indeed did student preferences for the use of materials and the final performance achieved by cohorts. A comprehensive review of the use of media rich resources in university-based higher education can be found in Saunders and Hutt (2014) This work highlighted a number of broad conclusions including a general (but not universal) agreement that rich-media material delivered learning benefits; that it had a small but significant detrimental effect on attendance at traditional lectures; and that students generally value the flexibility that rich-media are able to provide in terms of time and location of delivery. In the same publication Saunders and Hutt examined how students on a (non-technical) project management course with a large internationalised cohort used various kinds of rich media. They found benefits including a positive student reaction to core concept videos, particularly from those students with English as a second language. They also sounded a note of caution, noting that rich-media could not effectively replace face-to-face interactions.

Since 2012 the widespread adoption of tablets and smartphones among students has grown and it has become correspondingly easier to produce media-rich material. However, there has been little work looking at how these developments are best deployed in a blended learning environment. A

review by Nguyen, Barten and Nguyen (2015) on the use of IPads in higher education, highlighted that while they were generally seen as having great potential "it is not clear how best to align and integrate it [use of Ipads] within the academic programmes". Other work by Fried (2008) and Risko, Buchanan, Medimoriec & Kingston (2013) draws attention to the ubiquity of laptops, tablets and smartphones within the live lecture environment, and their use for both learning related and more mind-wandering and less learning related activities.

Thus it is clear that rich media has become part of the landscape of higher education teaching, and that earlier studies have examined the use and adoption of certain forms of rich media in selected areas. However, there are gaps in our detailed understanding of how students use recently available devices such as smartphones and tablet computers with rich-media resources, and also how students studying technical (rather than more qualitative) subjects engage with material generally. This study aims to address these gaps in knowledge by answering the questions set out in the introduction.

## Method and Approach

This study examined student use of the media-rich material provided in two, technical first year engineering modules delivered at The University of Manchester, UK. The first was "Structures 1", a module covering many of the fundamental concepts of structural mechanics, such as truss analysis and beam behaviour, that was delivered between September 2014 and January 2015. It included many threshold concepts (Meyer & Land, 2013) - fundamental concepts that are essential for progression in a subject but which are difficult for students to "get". The second module was "Electrical Energy Supply and Circuits 1" (EESC) delivered between January and June 2015. This module also covered many fundamental threshold concepts.

Structures 1 was delivered to a cohort of 198 students, 107 of whom were studying aerospace engineering and 91 civil engineering. The EESC class size was 345, with students studying civil (91), aerospace (107) or mechanical engineering (147). The age range of these classes was narrow with 89% aged between 18 and 22. This implies the cohort were overwhelmingly "digital natives"; those who have grown up with digital sources of information as the norm (Margaryan, Littlejohn, & Vojt, 2011; Prensky, 2001). For example, 57% of the cohort had used online educational material prior to starting their degrees. The class can thus be contrasted with those of all studies prior to *c*2010 where students would have become exposed to online learning only as the internet developed. A second notable feature of the cohort was its international make-up. Forty-four percent of the cohort did not have English (the language of instruction) as their native language.

The media-rich material provided for these modules consisted of:

1. Full lecture podcasts that were recorded automatically using a system developed at the University of Manchester (University of Manchester, 2015). The podcasts captured audio from the lecturer's microphone and video from the lecture theatre projection system. Each podcast was made available to students shortly after the lecture was delivered via the University VLE. Both modules consisted of twenty, fifty minute lectures delivered at a rate of two a week, with all lectures being captured as podcasts.
2. Key-concept videos for Structures 1 (Gillie, 2015). These videos were short (4-6 minutes) and each examined one threshold concept associated with the module in a very focussed

manner. They were made available via a dedicated YouTube channel that was also provided as a mashup within the module VLE. The videos were produced as full-screen whiteboard style presentations with voice-over audio.

3. Video tutorial solution videos for EESC. These were written worked tutorial solutions with voice-over audio explaining each step and were typically 10 minutes long. Each video covered one tutorial consisting of several questions and part questions. As with the key-concept videos, they were made available via a dedicated YouTube channel (Gibson, 2015) and through the VLE.

To understand students' use of this material and address the questions of the study, the following data sources were used

1. Data from YouTube analytics (YouTube, 2015) for the key concept videos and video tutorial solutions. This provided fine-grained data on the use of the videos including number of views, percentage watched, demographics and device used. The videos were publicly available so some data from this source will have come from YouTube users not on the modules considered in this study. However, viewer location data suggests these were a small proportion of viewers, and that many were students at other institutions. Therefore drawing conclusions from the data about how the videos are used by students on technical courses will be valid.
2. Data from Google analytics (Google, 2015) on the use of the lecture podcasts. This data was similar to the YouTube data but slightly less fine grained. As these podcasts were not publicly available, the data relates solely to students on the modules being studied.
3. Results from a written survey of students undertaken in April 2015. This survey provided self-reported statistical data on how students used the media-rich resources provided. It also allowed consistency checks with the automatically generated analytics data from sources and 1 and 2, thus increasing confidence in the results and conclusions of the study. Additionally the survey provided a free-text response for comments on the media-rich resources. The survey questions are provided in Appendix A. The return rate for the survey was 141 students or 40% of the cohort.
4. Analysis of semi-structured interviews of 20 students. These interviews provided qualitative data on how students used resources and what they found useful. to ensure objectivity. The interviews were conducted by a researcher (author Dahli) who was not involved with the delivery of the modules being studied. The question structure of these interviews, which typically lasted fifty minutes, is presented in Appendix B.
5. Data from VLE usage on when students accessed media-rich resources. This data was not fine-grained or complete. However, it was the only data source that could identify individual users. It was thus possible to link student usage of media-rich material to performance. While this link was not the focus of the study, some useful data was nonetheless obtained.

Taken together these data sources provided a comprehensive set of information about student use of the media-rich resources being considered and enabled the researchers to investigate how students use rich-media resources, how the existence of such resources affects use of other material, and how to make useful and effective resources

# Results

## Degree of Usage

Figure 1 shows the number of views of the Structures 1 key concept videos and lecture podcasts against days from the start of the module. These usage curves are typical of all the resources made available to students – a steady usage during the module delivery period with a sharp spike immediately prior to the associated exam. This data suggests usage was heavy: there were a total of 2142 lecture podcast views and 3224 key concept video views, or an average of 27 views per student. Such raw figures do hide details. For example, on average only 30-50% of a key concept video was watched (Figure 7). The percentage for lecture podcasts is lower still, with students reporting that typically only 15 minutes was spent watching a lecture podcast implying at most 30% was watched. Themes arising from the structured interviews support the quantitative data. Students reported using media-rich material predominantly in the revision period after all lectures had been completed and they confirmed that they are highly selective about the parts of the videos they watch. These findings and further analysis below suggest students value and use resources but in a selective and tactical manner.

## Reasons for Use

Having established that media-rich resources are used and valued by students, the next set of results provides insights in to how they were used. Figure 2 shows how students reported using each type of resource. Values approaching 90% for use as revision material correlate with the spike in usage data in Figure 1 around the exam period. It is clear students find the material highly valuable for revision of technical matter, particularly close to an exam. Various reasons were given for this in interviews and text responses including a feeling of receiving a “personal experience” or “private lesson” from using key-concept videos at home; finding the short, focussed nature of key-concept videos more engaging than lecture notes; and being able to stop and start tutorial solution videos while working on a problem. There was also a widespread feeling that lecture podcasts, while welcome, were less useful than shorter videos because there were too long and it was difficult to navigate to topics of interest.

Using the material as a general supplement for lectures and lecture notes is also widespread (Figure 2), particularly so with key concept videos. In interviews students reported using key-concept videos to clarify concepts that were not grasped in lectures and welcomed the ability to have a focussed explanation that could be replayed easily.

The effect of media-rich resources on lecture attendance has received attention in previous studies and is a somewhat contentious matter. Earlier studies have found a small but consistently negative effect on lecture attendance when media-rich material is provided. Saunders and Hutt (2014), when reviewing the literature, found reductions in lecture attendance of around 15% were typical. This finding is consistent with the results of the present study. Figure 2 shows that most students do use media-rich resources, particularly lecture podcasts (54%), to compensate for missed lectures. However, Figure 3 shows only 21% of students report being less likely to attend lectures as a result of media-rich resources being available, with 12% being more likely to attend. That is, while the

majority students use podcasts to catch-up on missed lectures, the availability of lecture podcasts themselves has only a small and mixed effect on attendance. Lecture attendance at the modules being studied was lightly monitored and was as high (60-70%), if not higher, than other modules delivered to the same cohort where media-rich material was not provided. This is further evidence that any effect of media-rich material on lecture attendance is small overall. That some students are more likely to attend lectures and some less likely as a result of media-rich material being available, suggests that the provision of the resources allows students to approach topics using a blend of material of their choosing.

The data suggests there was little difference in the use of material by age, gender or subject studied. By contrast, there was a clear difference in how native and non-native English speakers used material as shown in Figure 4. Non-native speakers were significantly more likely to watch podcasts and tutorial solutions multiple times. This suggests that students who may have difficulty following rapid, technical English on first hearing (as is required in traditional lectures and often in face-to-face tutorials) are able to use media-rich resources to compensate. This was not the case with key concept videos. These do not have a direct analogue in traditional teaching and it appears they are used comparably by native and non-native speakers.

## Devices Used

Recent developments in smartphones, tablets and computing generally mean that digital resources can now be accessed almost anywhere. If students are taking advantage of this freedom, it has implications for how media-rich resources should be developed because, for example, a podcast formatted for a large screen may be unusable on a small smartphone screen.

Figure 5 shows how students reported accessing the resources studied here. Because many students will use multiple devices, the percentages in this figure add up to more than 100. The breakdown of the number of views by type for Structures 1 key concept videos taken from YouTube Analytics are shown in Figure 6. Taken together these figures suggest that a wide variety of devices are used to access material but that currently desktop computers are still used most frequently. The data shows some variation between native and non-native English speakers, with tablets being more widely used by non-native speakers (46%) than native speakers (39%). Differences between genders, age and subject were insignificant.

## Viewing Behaviour

Data from YouTube analytics allowed viewing patterns of key concept videos and tutorial solution videos to be studied. Figure 7 and Figure 8 show the number of views of each segment of the videos as a percentage of initial viewers. An increase in the percentage through time indicates either that viewers skipped a section of video, or that they viewed sections more than once. The viewing patterns are very different for the two types of video. For the key concept videos there is a rapid loss of audience in the first few seconds, followed by a period of two to three minutes of gentle decline, then a further rapid loss at the end of the videos. In contrast the tutorial solution video curves are spikey, indicating repeated viewing of certain sections, although the initial rapid loss of viewers is still present.

By noting the timing of events in the videos and comparing them to the viewing pattern curves, it is possible to identify what makes viewers stop viewing or skip material. The annotations in Figure 9 and Figure 10, which are typical, show this for a key concept video and a tutorial solution video. Although in all cases there was a rapid drop in viewers in the first few seconds, it was noticeable that the rate of drop-off was much higher when either the video contained a few seconds of silence or started with a voice-over without a meaningful visual aspect. This implies that paying close attention to ensuring the initial few second of media-rich resources are meaningful will help gain and keep viewers' attention.

In short videos such as these it was also apparent that viewers were expecting concise and focussed information. Short asides (Figure 9) or slightly unclear passages in a video (Figure 10) were both consistently associated with loss of viewers. The spikiness in the viewing patterns of the tutorial videos is directly linked to viewers searching for information of specific questions or sub-questions within tutorials (Figure 10). This suggests that when making shorter media-rich resources, academics should focus on communicating clearly and concisely. This point was emphasised by the interview results where a common theme was students expressing a preference for the shorter format resources over lecture podcasts, which were seen as too long and discursive to be ideal.

## Conclusions

This study has presented a large-scale survey of student use of various media-rich teaching resources in technical undergraduate engineering modules. It is the first major study to examine this topic with a cohort of digital natives who use devices such as smartphones and tablets as a matter of course. A variety of insights into student behaviour and corresponding conclusions about developing and providing media-rich resources can be made:

First, the results show that students use and value rich-media resources. They access them for a variety of purposes, most notably to supplement other forms of teaching (such as lectures) and for revision. The data on when students access material suggests that having "virtual" contact with academics at times of their choosing is a major benefit of digital material. Groups such as non-native English speakers and students with disabilities derive particular benefits from having rich-media material available. The authors conclude that providing a range of rich-media resources as part of a blended suite of learning material is worthwhile and an effective method of teaching for technical subjects.

Second, concerns in some quarters (Bos et al., 2015; Chang, 2007) that media-rich resources reduce lecture attendance appear to be both overblown and misguided. The effects on lecture attendance of media-rich material are found to be small and also two-way – some students are more inclined to attend lectures if media-rich material is available. Moreover, a switch in viewpoint from seeing lectures as the core method of teaching, and non-attendance as indicative of student lack of engagement, to seeing lectures as simply one of several channels by which students engage with

course material removes concerns about reduced attendance. From this standpoint it makes no more sense to ask whether media-rich material affects lecture attendance than to ask whether lectures affect use of media-rich material. All channels in a blended-learning module should be of use to some students but it is unlikely that all will be valued by all students at all times. Overall student engagement and performance is the relevant factor, not the level of use of any particular channel.

Third, it is clear students access media-rich material from a variety of devices and software platforms. While a large majority of views come from desktop PCs, a significant minority come from tablets and smartphones, running a variety of software. Given global trends in the use of mobile technology, it seems likely that media-rich resources will be viewed from an increasingly wide range of devices. Practitioners should be mindful of these points when developing material and should ensure that the file formats used are universally readable and that material is useful on a variety of screen sizes.

Fourth, the results suggest ways in which high quality media-rich resources can be developed. There is strong evidence (Figure 1, Figure 7, Figure 8) that students use key concept videos and tutorial solution videos to obtain or check very specific information. This type of video should therefore be kept as short and focussed as possible. Key concept videos of more than five minutes are unlikely to be effective as viewer retention rapidly reduces beyond this time. Tutorial solution type videos can be longer because students will skip to the specific questions they are interested in, however, to aid students in locating the information they require rapidly, it may be beneficial to produce a number of short solution videos rather than longer ones containing several solutions.

The fact that viewers look for very specific information in media-rich material and therefore appreciate focussed, information-dense presentations, contrasts with what is expected in traditional lectures, where asides, examples, anecdotes and context are expected and beneficial as they provide an audience with relief from constantly receiving new concepts and information. This discrepancy results in difficulties when whole lectures are packaged as podcasts; a lecture designed for face to face delivery in a lecture theatre to a seated audience is not well-suited to viewing online because the information is too diffuse. Where automated lecture capture is available, there appears to be little reason not to use it, but the full educational benefits of media-rich material are most easily obtained from shorter, purpose-made productions centred on the explanation of single, specific concepts.

## References

Bos, N., Groeneveld, C., Van Bruggen, J., Brand-Gruwel, S., Bruggen, J., & Brand-Gruwel, S. (2015). The use of recorded lectures in education and the impact on lecture attendance and exam performance. *British Journal of Educational Technology*, n/a–n/a. doi:doi: 10.1111/bjet.12300

Chang, S. (2007). Academic perceptions of the use of Lectopia: A University of Melbourne example. *ICT Providing Choices for Learners and Learning Proceedings Ascilite Singapore 2007*, (2003), 135–144.

Copley, J. (2007). Audio and video podcasts of lectures for campus-based students: production and evaluation of student use. *Innovations in Education and Teaching International*, *44*(4), 387–399. doi:10.1080/14703290701602805

Davis, S., Connolly, A., & Linfield, E. (2009). Lecture capture: making the most of face-to-face learning. *Engineering Education*, *4*(2), 4–13.

Fried, C. B. (2008). In-class laptop use and its effects on student learning. *Computers & Education*, *50*(3), 906–914. doi:http://www.stanford.edu/dept/CTL/ClassroomLaptops/wikiupload/d/d9/In-class%2Blaptop%2Buse%2Band%2Bits%2Beffects%2Bon%2Bstudent%2Blearning.pdf

Garrison, D. R., & Kanuka, H. (2004). Blended learning: Uncovering its transformative potential in higher education. *The Internet and Higher Education*, *7*(2), 95–105. doi:10.1016/j.iheduc.2004.02.001

Gibson, A. (2015). EESC. Retrieved August 26, 2015, from https://www.youtube.com/channel/UCyVL_BL0Gw9PHGwhMRWvM7Q

Gillie, M. (2015). Structural Engineering Basics. Retrieved August 26, 2015, from https://www.youtube.com/user/structengineering

Google. (2015). Google Analytics - Mobile, Premium and Free Website Analytics – Google. Retrieved August 26, 2015, from http://www.google.com/analytics/

Holbrook, J., & Dupont, C. (2011). Making the Decision to Provide Enhanced Podcasts to Post-Secondary Science Students. *Journal of Science Education and Technology*, *20*(3), 233–245. doi:10.1007/s10956-010-9248-1

Kazlauskas, A., & Robinson, K. (2012). Podcasts are not for everyone. *British Journal of Educational Technology*, *43*(2), 321–330. doi:10.1111/j.1467-8535.2010.01164.x

Leadbeater, W., Shuttleworth, T., Couperthwaite, J., & Nightingale, K. P. (2013). Evaluating the use and impact of lecture recording in undergraduates: Evidence for distinct approaches by different groups of students. *Computers and Education*, *61*(1), 185–192. doi:10.1016/j.compedu.2012.09.011

Margaryan, A., Littlejohn, A., & Vojt, G. (2011). Are digital natives a myth or reality? University students' use of digital technologies. *Computers & Education*, *56*(2), 429–440. doi:10.1016/j.compedu.2010.09.004

Meyer, J., & Land, R. (2013). *Overcoming Barriers to Student Understanding: Threshold Concepts and Troublesome Knowledge*. Routledge.

Mikropoulos, T. A., & Natsis, A. (2011). Educational virtual environments: A ten-year review of empirical research (1999–2009). *Computers & Education*, *56*(3), 769–780. doi:10.1016/j.compedu.2010.10.020

Nguyen, L. L. L. T., Barton, S. S. M., & Nguyen, L. L. L. T. (2015). iPads in higher education—Hype and hope. *British Journal of Educational Technology*, *46*(1), 190–203. doi:10.1111/bjet.12137

Parson, V., Reddy, P., Wood, J., & Senior, C. (2009). Generation: Undergraduate Attitudes, Experiences and Understanding of Vodcast and Podcast Use. *Learning, Media and Technology*, *34*(3), 215–228. doi:10.1080/17439880903141497

Pearce, K., & Scutter, S. (2010). Podcasting of health sciences lectures: Benefits for students from a non-English speaking background. *Australasian Journal of Educational Technology*, *26*(7), 1028–1041.

Prensky, M. (2001). Digital natives, digital immigrants. *On the Horizon*, *9*(5), 1–6.

Risko, E. F., Buchanan, D., Medimorec, S., & Kingstone, A. (2013). Everyday attention: Mind wandering and computer use during lectures. *Computers and Education*, *68*, 275–283. doi:10.1016/j.compedu.2013.05.001

Saunders, F. C., & Hutt, I. (2014). Enhancing large-class teaching: a systematic comparison of rich-media materials. *Higher Education Research & Development*, 1–18. doi:10.1080/07294360.2014.911261

University of Manchester. (2015). My Podcasts (The University of Manchester). Retrieved August 26, 2015, from http://www.mypodcasts.manchester.ac.uk/

Van Zanten, R., Somogyi, S., & Curro, G. (2012). Purpose and preference in educational podcasting. *British Journal of Educational Technology*, *43*(1), 130–138. doi:10.1111/j.1467-8535.2010.01153.x

Walls, S. M., Kucsera, J. V., Walker, J. D., Acee, T. W., McVaugh, N. K., & Robinson, D. H. (2010). Podcasting in education: Are students as ready and eager as we think they are? *Computers and Education*, *54*(2), 371–378. doi:10.1016/j.compedu.2009.08.018

YouTube. (2015). YouTube Analytics basics - YouTube Help. Retrieved August 26, 2015, from https://support.google.com/youtube/answer/1714323?hl=en-GB

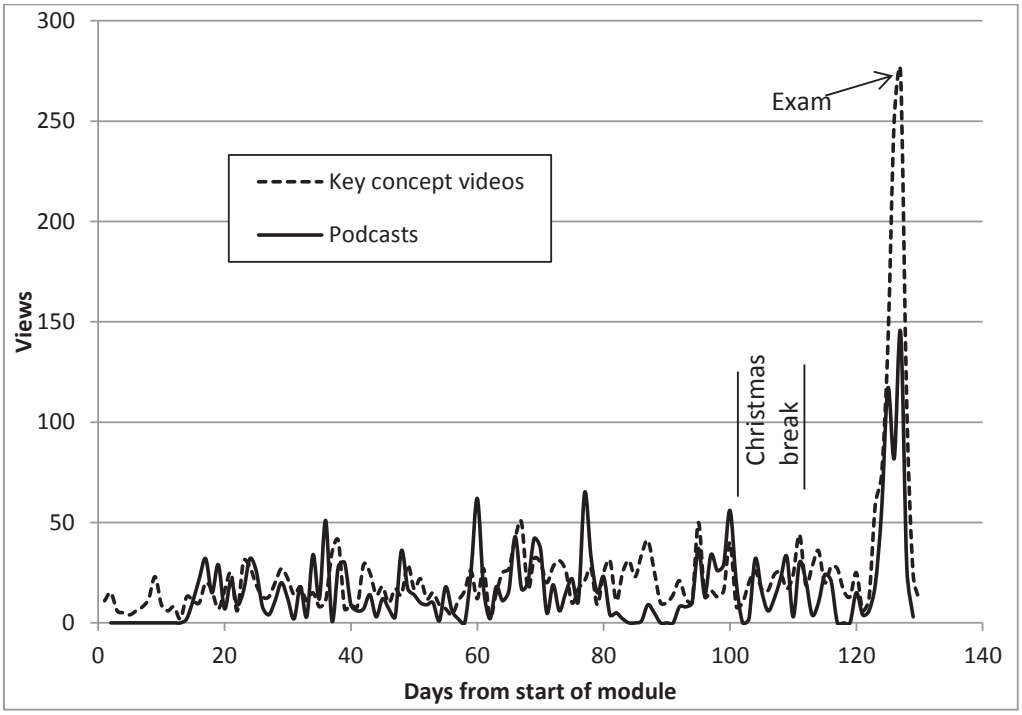


**Figure 1 Use of video resources against days from the start of the Structures 1 module. Cohort size=198.**

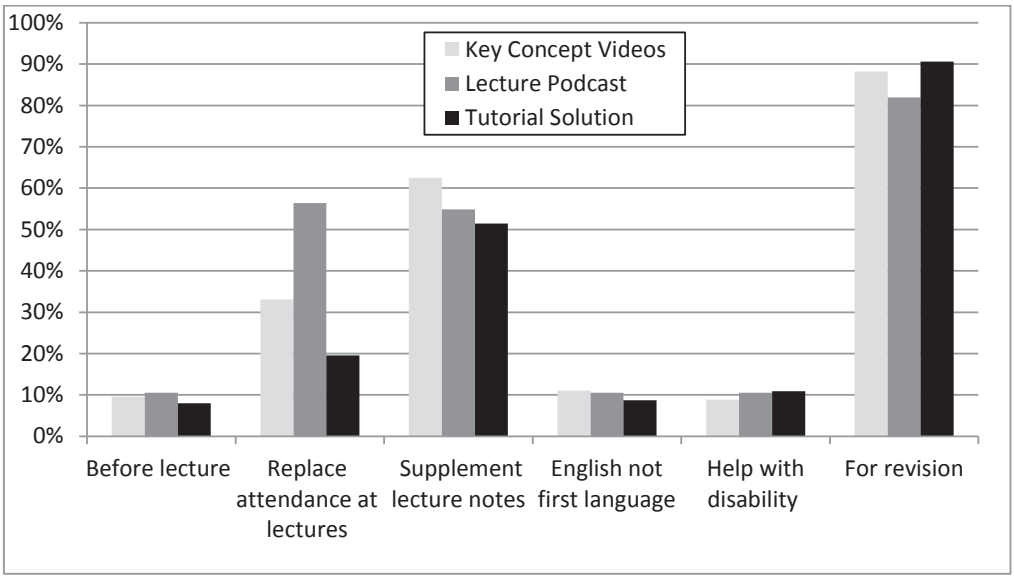


**Figure 2 Questionnaire data (n=141) on how students used the three types of media-rich resource studied.**

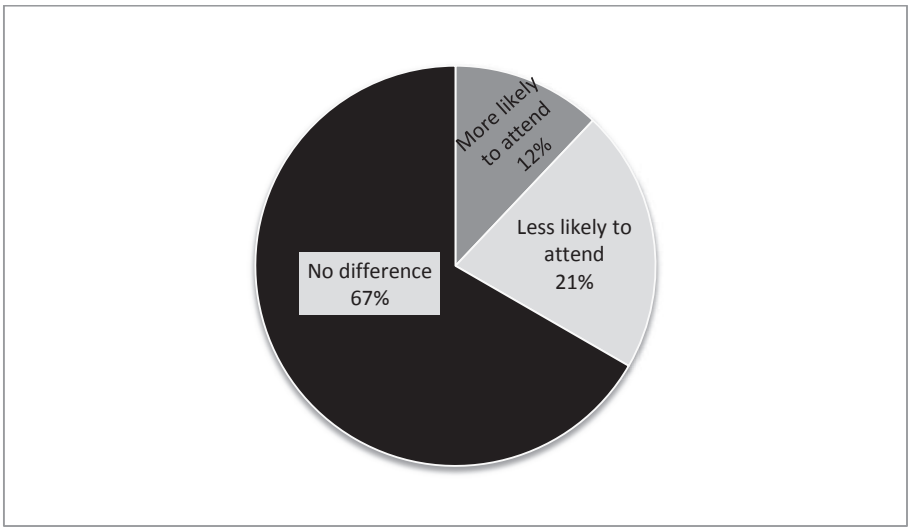


**Figure 3 Questionnaire data (n=141) on the effect of media-rich resources on lecture attendance.**

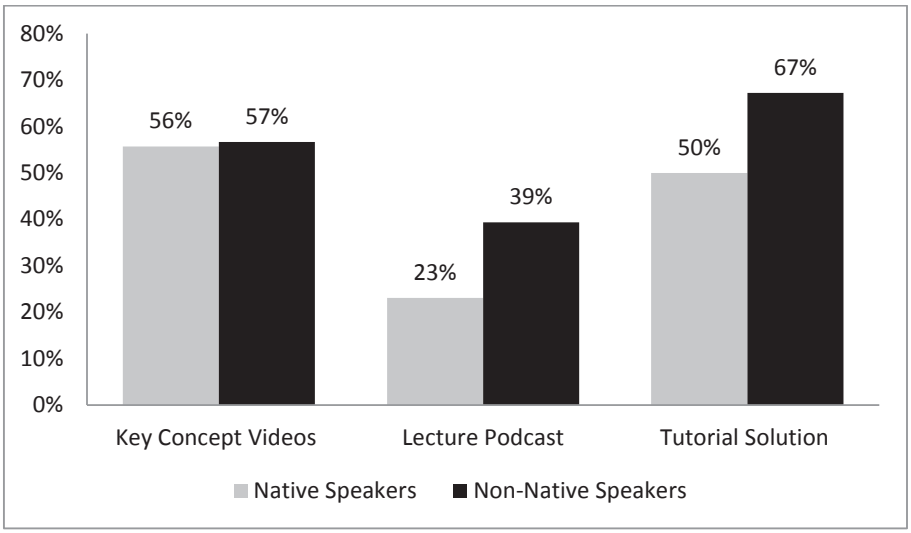


**Figure 4 Questionnaire results showing the percentage of students who watched material more than once for native English speakers (n=79) and non-native speakers (n=62).**

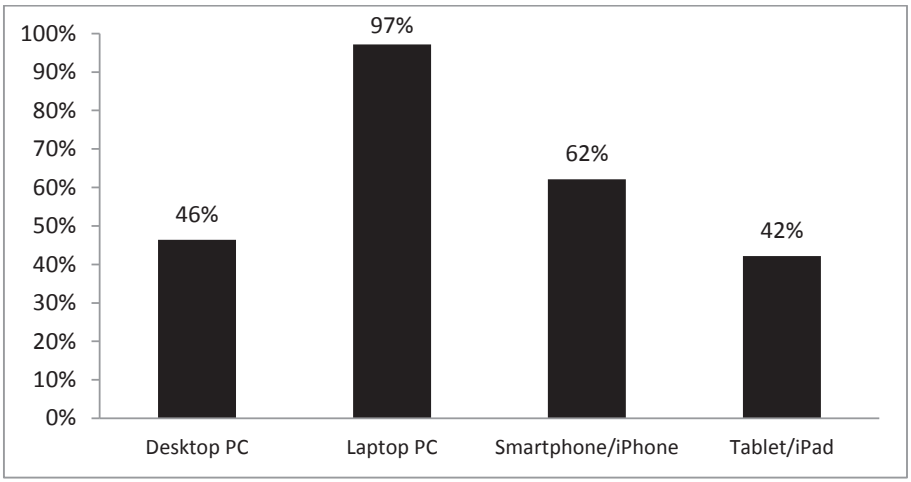


**Figure 5 Questionnaire results about the devices used to access media-rich material (n=141)**

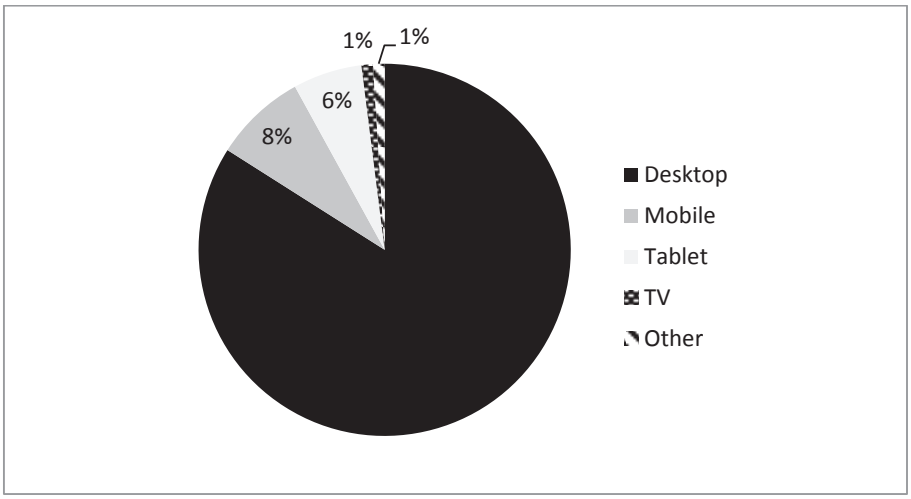


**Figure 6 YouTube analytics data on the devices used to access the key-concept videos associated with the Structures 1 module (n=3224).**

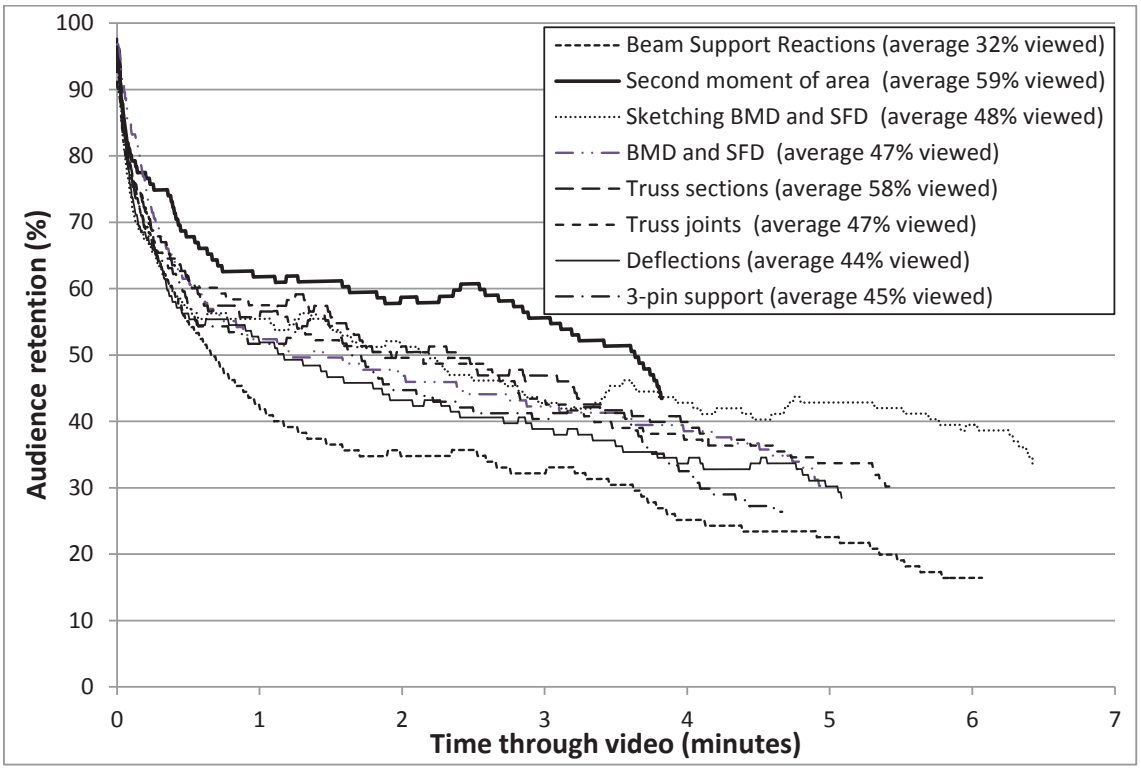


**Figure 7 Viewer retention data from YouTube analytics for the Structures 1 key-concept videos. The average percentage viewed and subject of each video is indicated.**

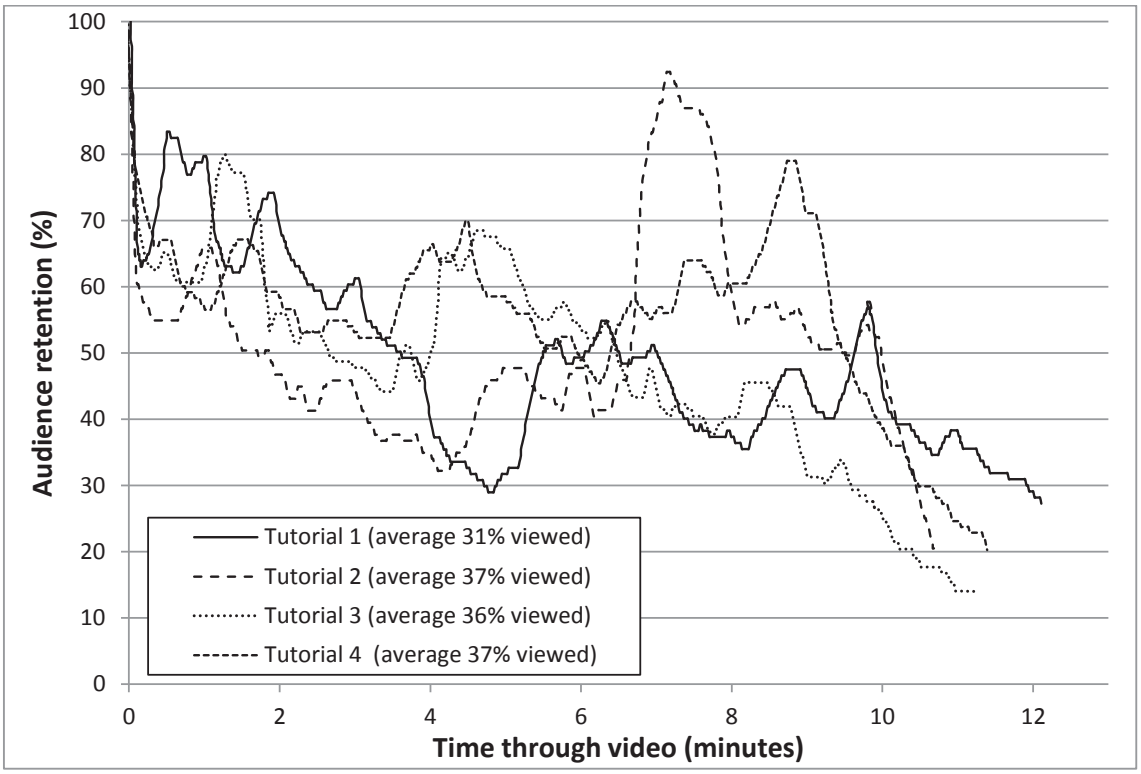


**Figure 8 Viewer retention data from YouTube analytics for the EESC tutorial-solution videos. The average percentage viewed is indicated.**

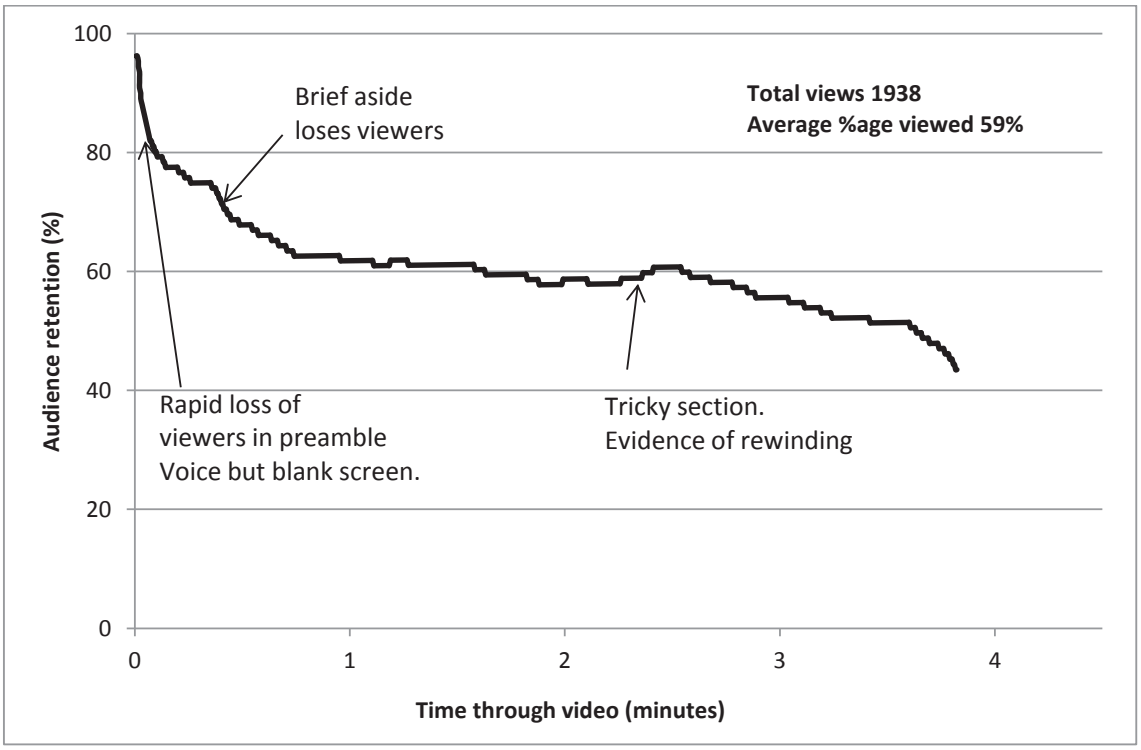


**Figure 9 Annotation of a key-concept video timeline showing key features that affect viewers' behaviour. This plot is typical.**

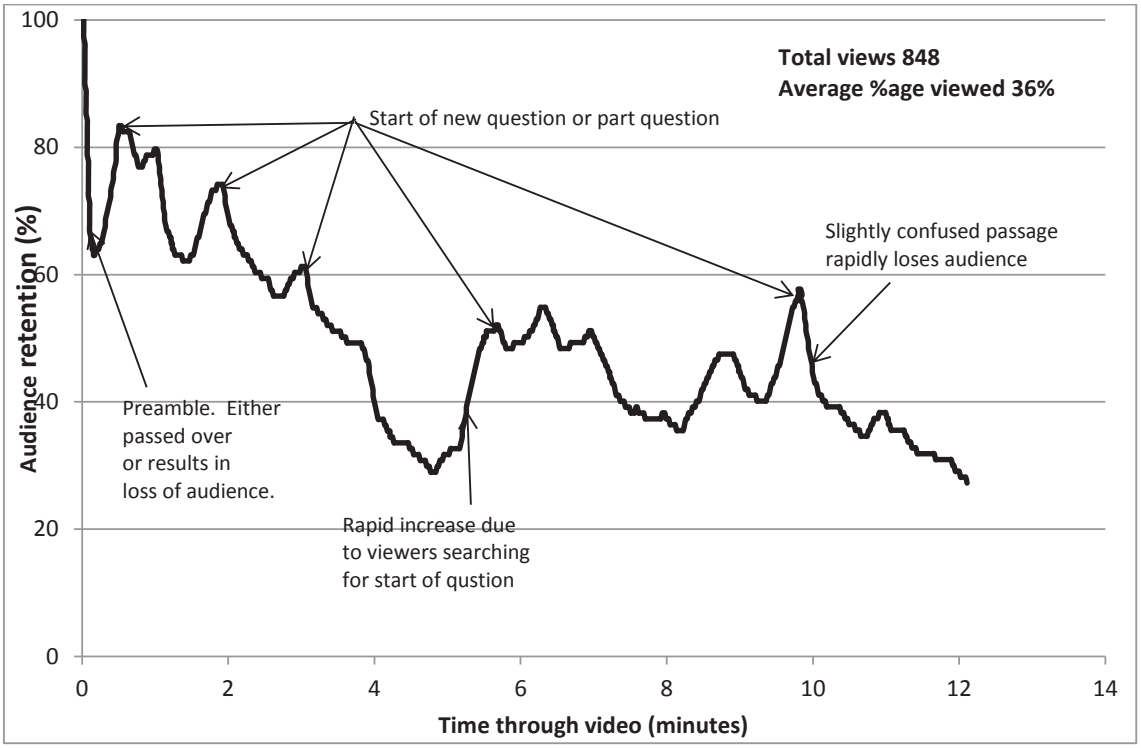


**Figure 10 Annotation of a tutorial solution video timeline showing key features that affect viewers' behaviour. This plot is typical.**

## Appendix A

### Video E-learning Material Questionnaire

Please take a few moments to complete this questionnaire on the video e-learning material supplied with the Electrical Energy Supply and Circuits 1 unit and the Structures 1 unit. The information obtained from this questionnaire will be used only to evaluate, develop and disseminate the use of future e-learning material. It will not affect the treatment of the participant by the School of Mechanical, Aerospace and Civil Engineering. All information disclosed by the participant is and will remain anonymous. For more information, please contact Dr Martin Gillie (martin.gillie@manchester.ac.uk).

**SECTION A – General Questions**

1. **Gender** Male ☐ Female ☐
2. **Age** <22 ☐ 22-35 ☐ >35 ☐
3. **Which subject are you studying?** Civil ☐ Aero ☐ Mech ☐
4. **Is English your first language?** Yes ☐ No ☐
5. **How would you describe your familiarity with computing and internet technology?**

☐ Excellent ☐ Good ☐ Average ☐ Poor ☐ Very Poor

6. **Prior to starting your degree at Manchester, did you view educational video material on-line?**
   Yes ☐ No ☐
7. **Do you use any of the following devices to view e-learning video resources?** *(Please tick all that apply.)*
   Desktop PC ☐ Laptop PC ☐ Smartphone/iPhone ☐ Tablet/iPad ☐
8. **How does the availability of video resources affect your attendance at lectures?**
   More likely to attend ☐ Less likely to attend ☐ No difference ☐
9. **How do you think a greater range of video resources would affect your attendance at lectures?**
   More likely to attend ☐ Less likely to attend ☐ No difference ☐

**SECTION B – Key Concept Videos**

1. **On average how many times did you watch (or watch part of) each key concept video?**

☐ Less than once ☐ Once ☐ Twice ☐ Three times ☐ More than 3

2. **For what purposes did you use the key concept videos?** *(please tick all that apply)*
   - Before lectures for preparation ☐
   - To replace attendance at lectures ☐
   - After lectures to supplement lecture notes ☐

After lectures as English is not my first language ☐
After lectures to help with a disability ☐
After lectures for revision and preparation for assessment ☐

3. **The key concept videos aided or added to my understanding of the topics they covered.**

☐ Strongly Agree ☐ Agree ☐ Neither Agree nor Disagree ☐ Disagree ☐ Strongly disagree

**SECTION C – Full lecture podcasts**

1. **On average how many times did you watch (or watch part of) each lecture podcast?**

☐ Less than once ☐ Once ☐ Twice ☐ Three times ☐ More than 3

2. **For what purposes did you use the lecture podcasts?** *(please tick all that apply)*

Before lectures for preparation ☐
To replace attendance at lectures ☐
After lectures to supplement lecture notes ☐
After lectures as English is not my first language ☐
After lectures to help with a disability ☐
After lectures for revision and preparation for assessment ☐

3. **The lecture podcasts aided or added to my understanding of the topics they covered.**

☐ Strongly Agree ☐ Agree ☐ Neither Agree nor Disagree ☐ Disagree ☐ Strongly disagree

**SECTION D – Video tutorial solutions**

1. **On average how many times did you watch (or watch part of) each video tutorial solution?**

☐ Less than once ☐ Once ☐ Twice ☐ Three times ☐ More than 3

2. **For what purposes did you use the video tutorial solutions?** *(please tick all that apply)*

Before lectures for preparation ☐
To replace attendance at lectures ☐
After lectures to supplement lecture notes ☐
After lectures as English is not my first language ☐
After lectures to help with a disability ☐
After lectures for revision and preparation for assessment ☐

3. **The video tutorial solutions aided or added to my understanding of the topics they covered.**

☐ Strongly Agree ☐ Agree ☐ Neither Agree nor Disagree ☐ Disagree ☐ Strongly disagree

**Do you have any other comments on the video e-learning material provided?**

# Appendix B

**Section 1**

Aim: *what forms are most used and most useful. When, where , why and how often students accessed the material.*

Duration: *20 minutes*

- Which multimedia tools did you use?
- Which one did you prefer and why?
- What did you use it for?
- (revision, fill in gaps of knowledge, lecture preparation, English not first language, to replace attendance to lecture?)
- In what way were the tools useful, give examples?
- How did you access the tools?
- When did you access the tools? And how often?
- How did the multimedia tools compare in terms of usefulness with face to face lectures, printed slides/notes?

**Section 2**

**Aim:** *feedback on the techniques and content of the following tools*

Duration: *20 minutes*

| | |
|---|---|
| **Electrical Energy, Supply & Circuits** | Lecture podcasts<br>Key Concepts – Audio Visual Support<br>Tutorials video solutions<br>Exam paper solutions<br>Dynamic Behaviour of Engineering Systems 1: Change takes time |
| **Structures** | Video examples<br>Lecture podcasts |

Request comments on :

- Length/ duration
- Production techniques
- Content
- Would you use it again?
- Would like to see it used for other subjects? Give examples of subjects?

**Section 3**

**Aim:** *Possible improvements to existing methods.*

Duration: *20 minutes*

Brain storm, then discuss the following questions

- How might we improve existing resources?
- How might we encourage more students to use the tools?
- What other tools could be adopted in teaching?