How Engineering Undergraduates use Rich-Media Resources

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Abstract: 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 finds 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.
Keywords; Lecture podcast; Rich-media; Key concept videos; Lecture attendance

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1. 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 rich-media 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.

2. METHOD AND APPROACH

This study examined student use of the rich-media 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 and 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. Both cohorts were large (>200 students) and very diverse (~40% international students).

The rich-media 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.
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.
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. 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.
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.
3. Results from a written survey of students undertaken in April 2015. This survey provided self-reported statistical data on how students used the rich-media 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.
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.

Taken together these data sources provided a comprehensive set of information about student use of the rich-media resources being considered and enabled investigation of 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.

3. RESULTS

3.1. 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. 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 rich-media 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.
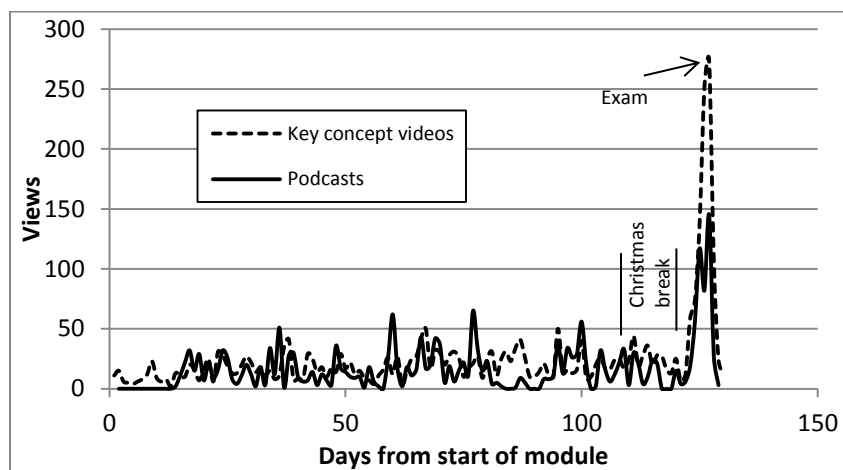

Figure 1 Video resource use vs. time for the Structures 1 module. Cohort size=198.

3.1. Reasons for Use

Having established that rich-media 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 rich-media 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 rich-media 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 rich-media resources, particularly lecture podcasts (54%), to compensate for missed lectures. However, Figure shows only 21% of students report being less likely to attend lectures as a result of rich-media 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 rich-media material was not provided. This is further evidence that any effect of rich-media material on lecture attendance is small overall.

There was a clear difference in how native and non-native English speakers used material as shown in Figure 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 rich-media 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.
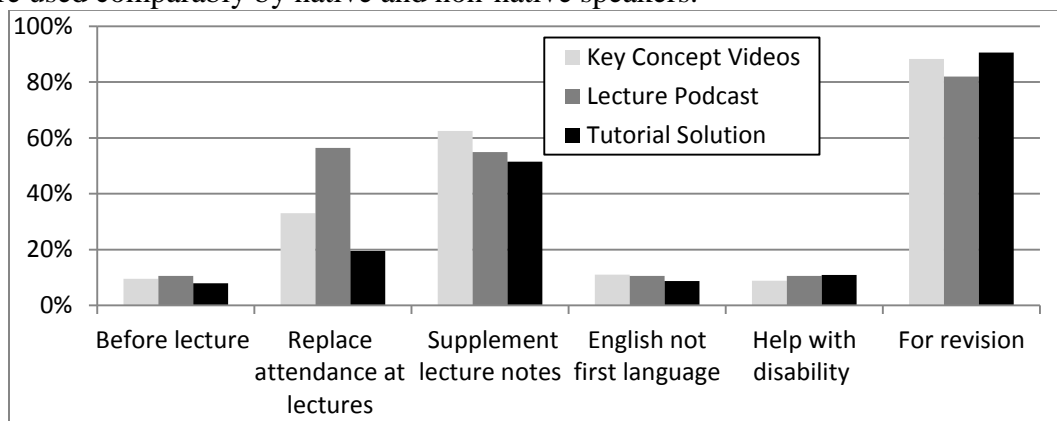

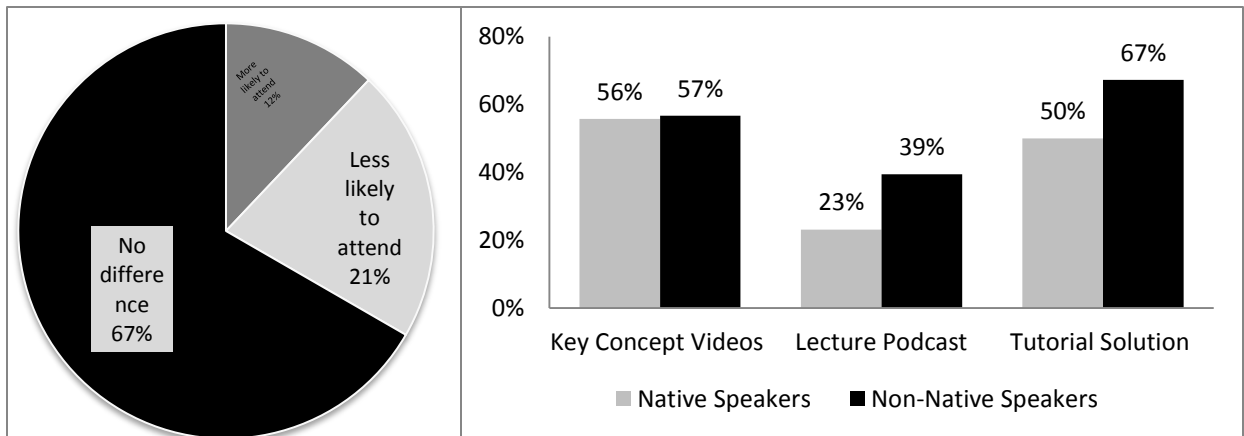**Figure 2 Questionnaire data (n=141) on how students used three types of rich-media resource.**

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).

3.1. Viewing Behaviour

Data from YouTube analytics allowed viewing patterns of key concept videos and tutorial solution videos to be studied. Figure 3 and Figure 4 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 5 and Figure 6, 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 rich-media 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 5) or slightly unclear passages in a video (Figure 6) 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 6). This suggests that when making shorter rich-media 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.
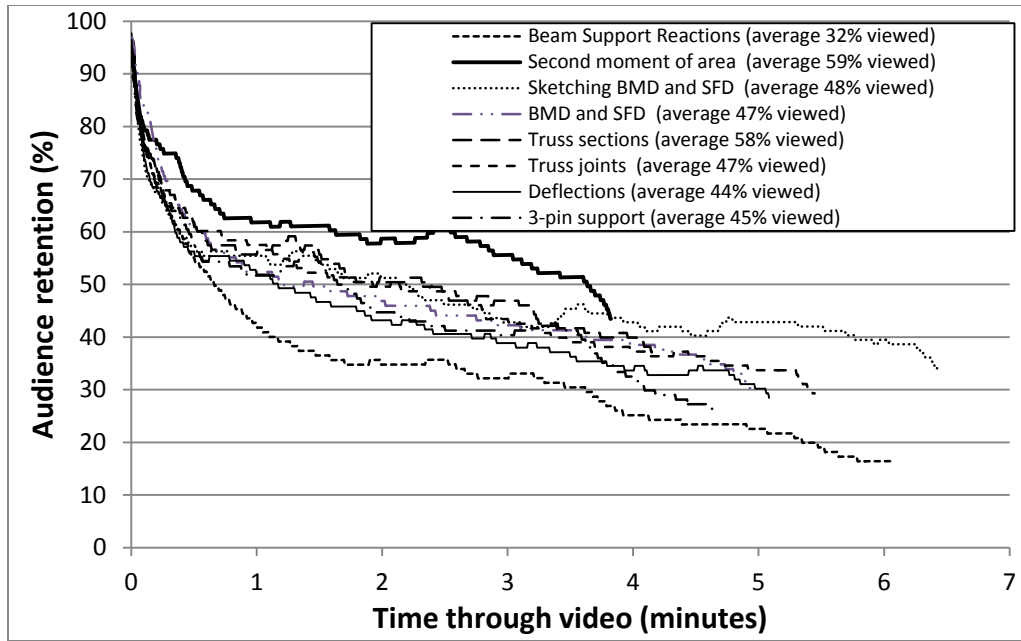
Figure 3 Viewer retention data from YouTube analytics for the Structures 1 key-concept videos. The average percentage viewed and subject of each video is indicated.
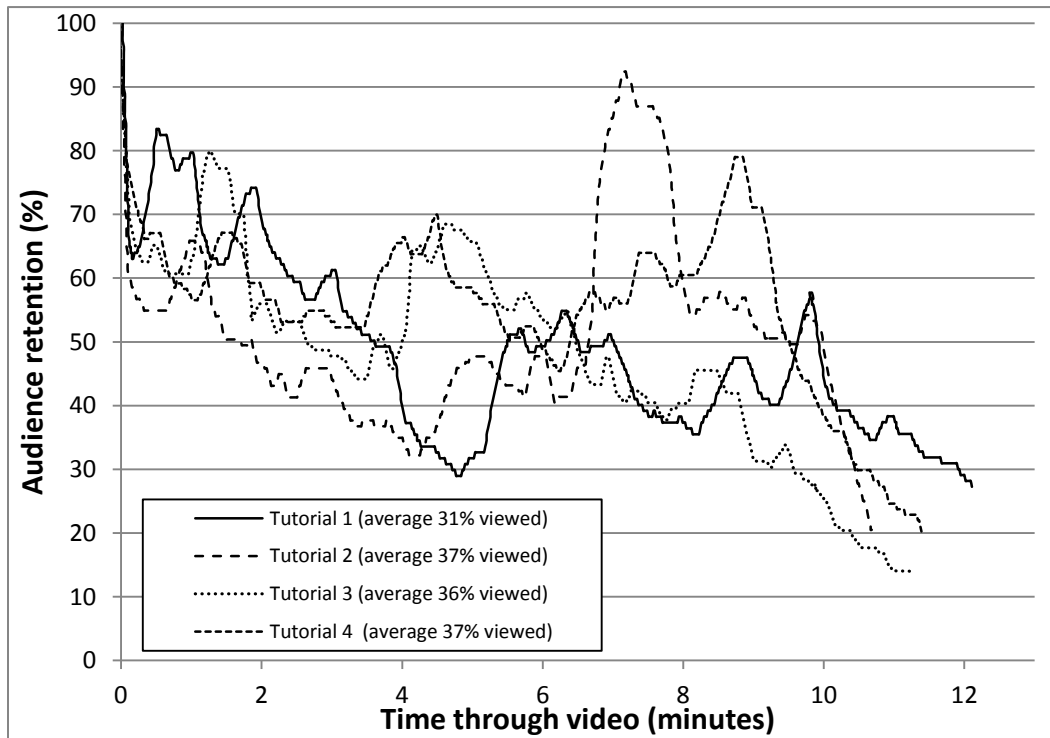

Figure 4 Viewer retention data from YouTube analytics for the EESC tutorial-solution videos. The average percentage viewed is indicated.
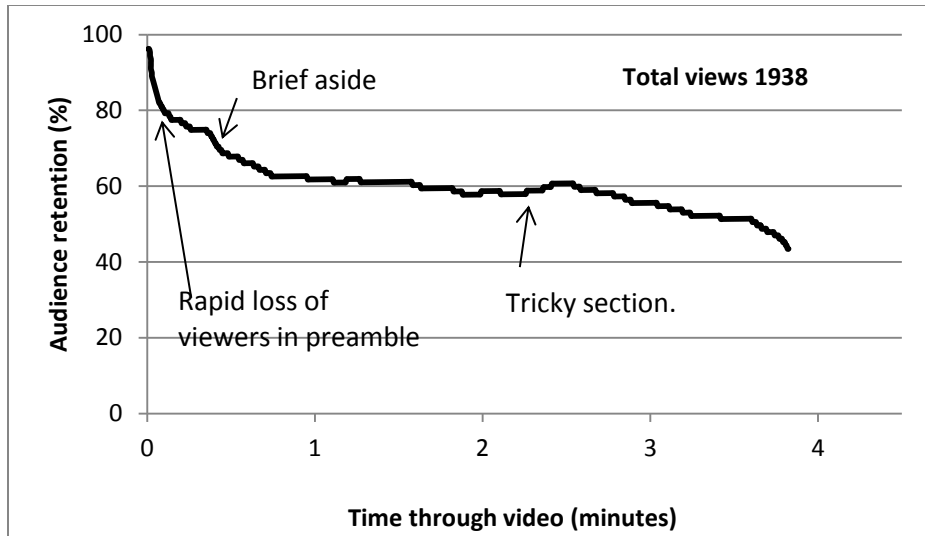
Figure 5 Annotation of a key-concept video timeline showing key features that affect viewers' behaviour. This plot is typical.
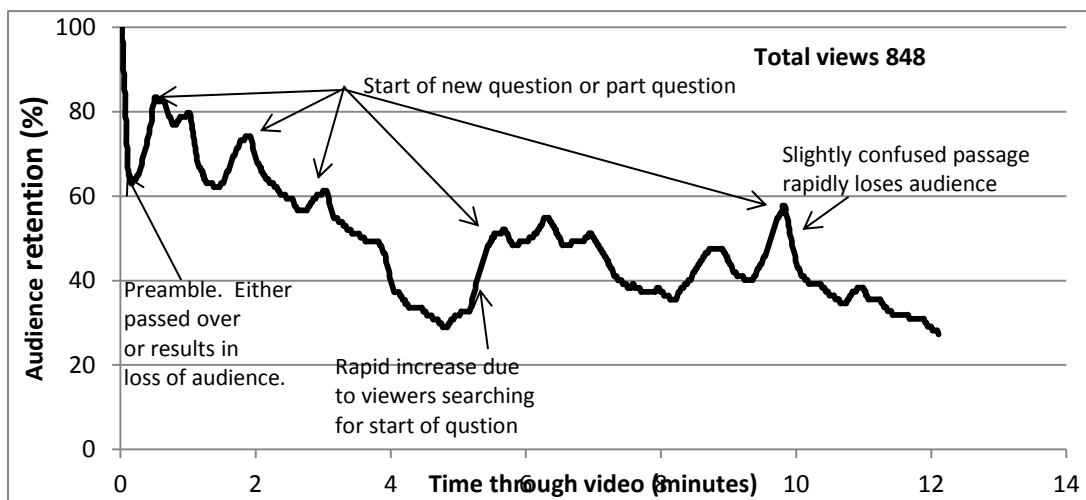

Figure 6 Annotation of a tutorial solution video timeline showing key features that affect viewers' behaviour. This plot is typical.

3. CONCLUSIONS

This study has presented a large-scale survey of student use of various rich-media teaching resources in technical undergraduate engineering modules. A variety of insights into student behaviour and corresponding conclusions about developing and providing rich-media 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 (Chang 2007; Bos et al. 2015) that rich-media resources reduce lecture attendance appear to be both overblown and misguided. The effects on lecture attendance of rich-media material are found to be small and also two-way – some students are more inclined to attend lectures if rich-media material is available.

Third, it is clear students access rich-media 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 rich-media resources will be viewed from an increasingly wide range of devices.

Fourth, the results suggest ways in which high quality rich-media resources can be developed. There is strong evidence (Figure 1, Figure 3, Figure 4) 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. Tutorial solution type videos can be longer because students will skip to the specific questions they are interested.

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