

Enhancing Information Retrieval from Lecture Recordings

Principal's Teaching Award Scheme



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www.research.ed.ac.uk/portal/jhopgoo1

<http://www.research.ed.ac.uk/portal/dil>

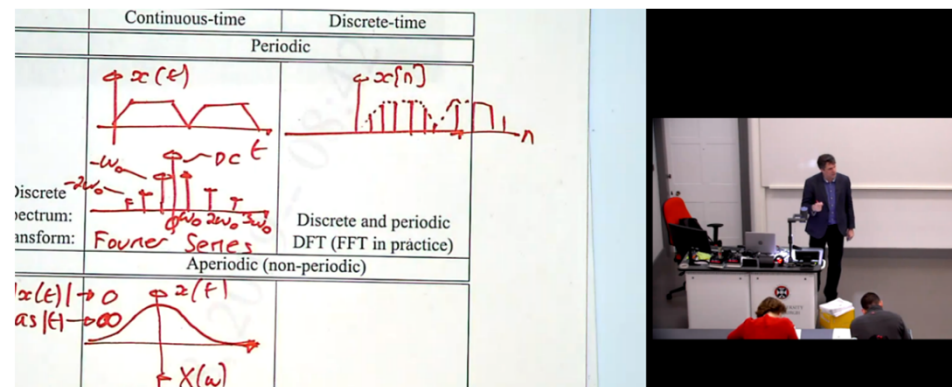
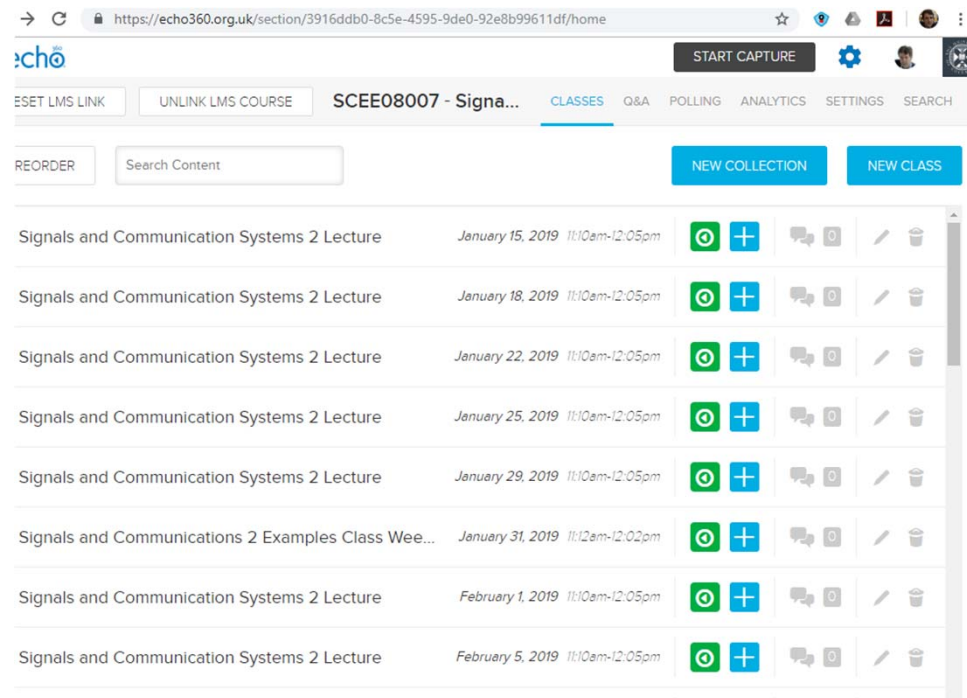


THE UNIVERSITY of EDINBURGH
School of Engineering

150
Celebrating engineering innovation
from 1864 - 2014... and onwards

Introduction

- University wide lecture recording project for past two years.
- What do students want from lecture recording?
- What is the ideal form for presenting online recordings?



Students' use of lecture videos

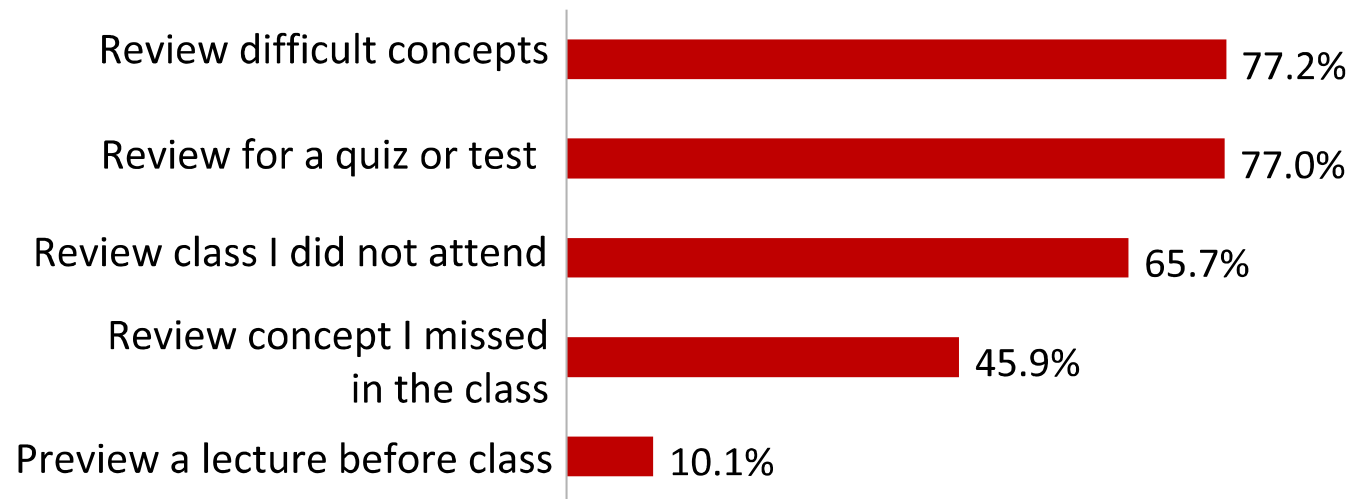


Fig. 13 Student-selected purpose of use ($N = 444$)

“I would view the lecture once, but pause it and replay it constantly, to write down extra notes that I might have missed during the first viewing. This was extremely helpful to be able to do this.”

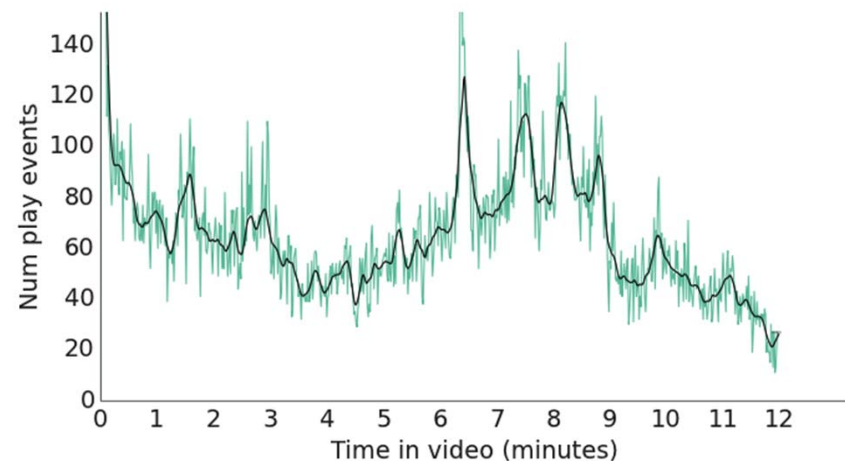
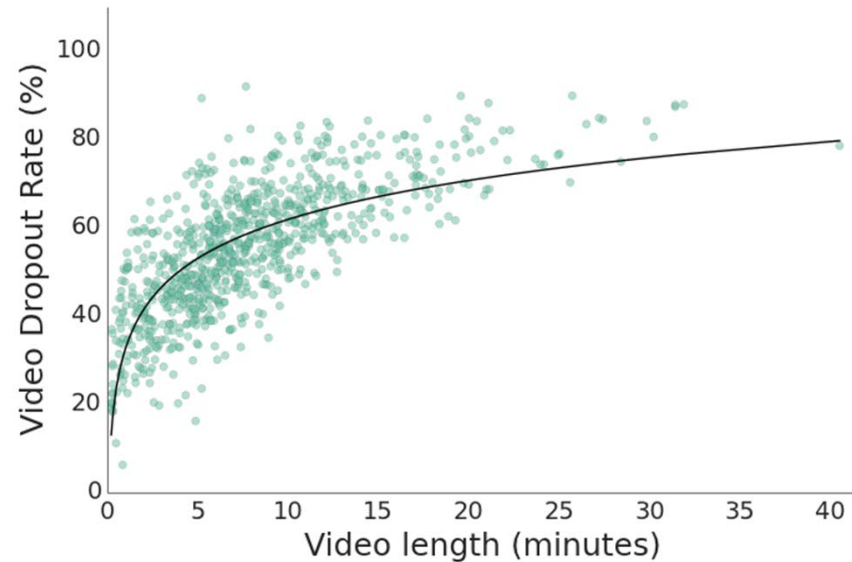
‘Indexed Captioned Searchable Videos: A Learning Companion for STEM Coursework’, T.Tuna et al., J. Sci. Educ. Technol. (2017) 26:82-99. DOI 10.1007/s10956-016-9653-1



User Behaviour

- In-video dropout.
- Watching and re-watching selected sections of a video.
 - Particularly true of recorded tutorials.
 - Also observed in lectures at transitions, and when key concepts are explained.
 - Non-visual explanations had the highest proportion of “peak” activity.

‘Understanding in-video dropouts and interaction peaks in online lecture videos’, J. Kim et al., Proceedings of the first ACM conference on Learning @ scale, L@S’14, pp 41-50. DOI 10.1145/2556325.2566237

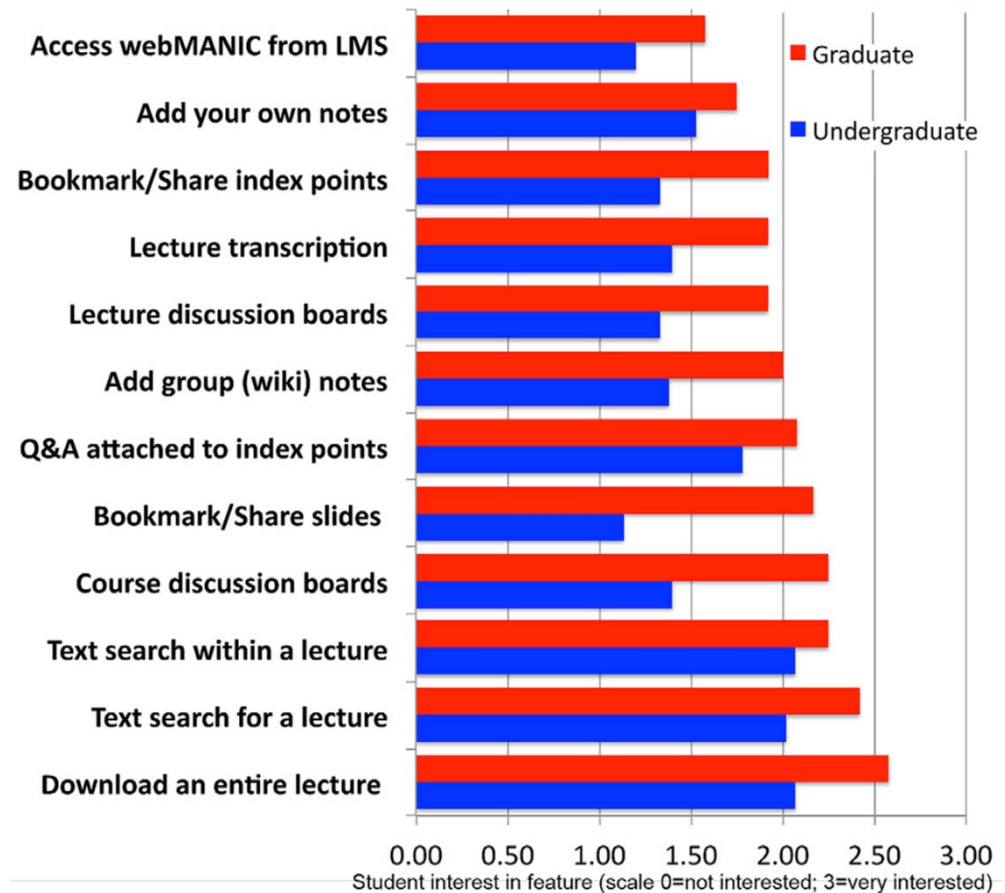


Features requested by students

“They were less interested in missing whiteboard content than in **easily navigating to material**.

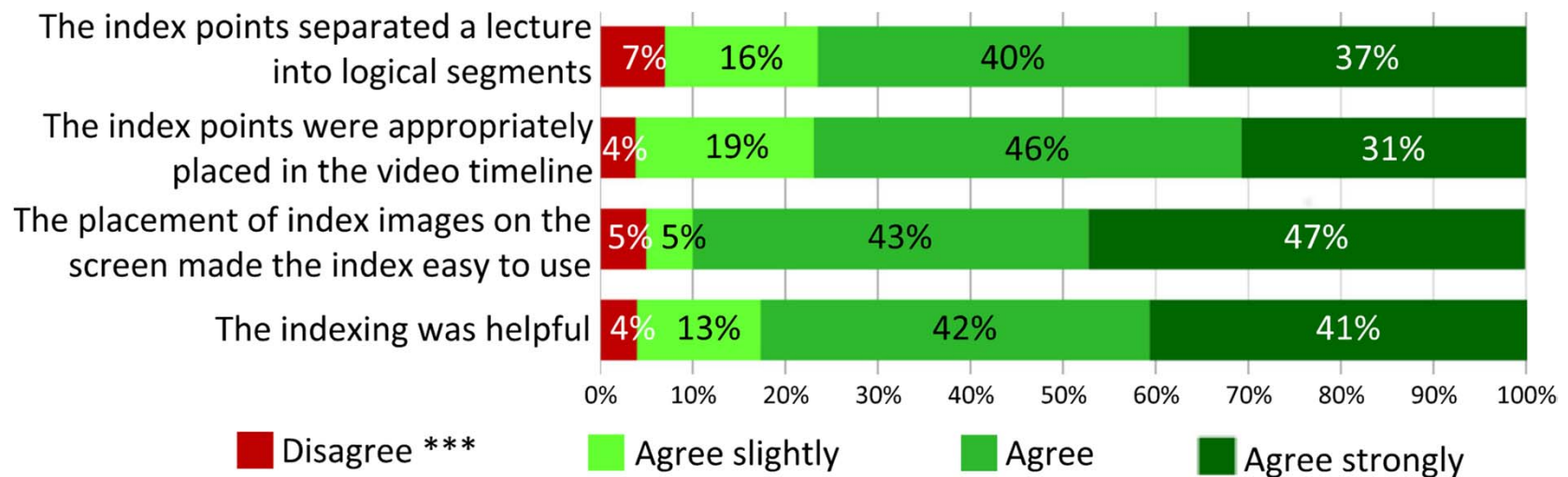
Their answers reinforced that **better search and navigation** was among the students’ highest priorities.”

‘Student Reactions to Classroom Lecture Capture’, P.E. Dickson et al, Proceedings of the 17th ACM annual conference on Innovation and technology in computer science education (ITiCSE’12), pp144-149, 2012, DOI 10.1145/2325296.2325334



Benefits of segmentation

- Reduces in-video dropout
- Simplifies finding content
- Improves retention in on-line format

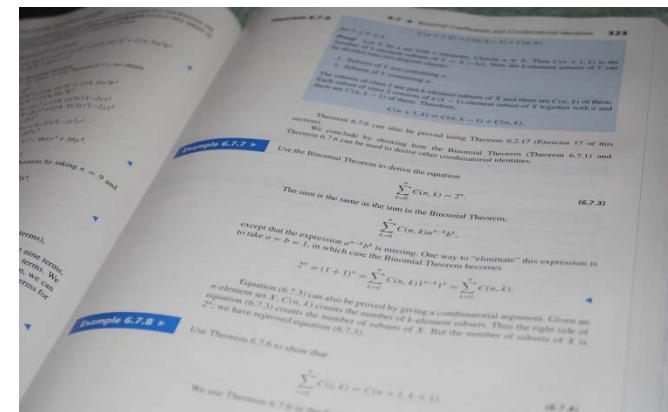
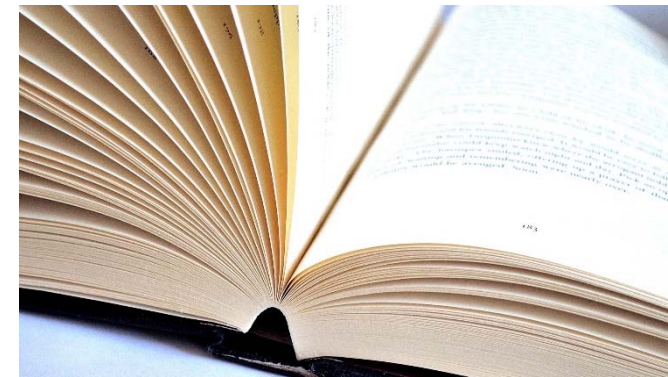


'Indexed Captioned Searchable Videos: A Learning Companion for STEM Coursework', T.Tuna et al., J. Sci. Educ. Tehcnol. (2017) 26:82-99. DOI 10.1007/s10956-016-9653-1



The Ideal Lecture Recording?

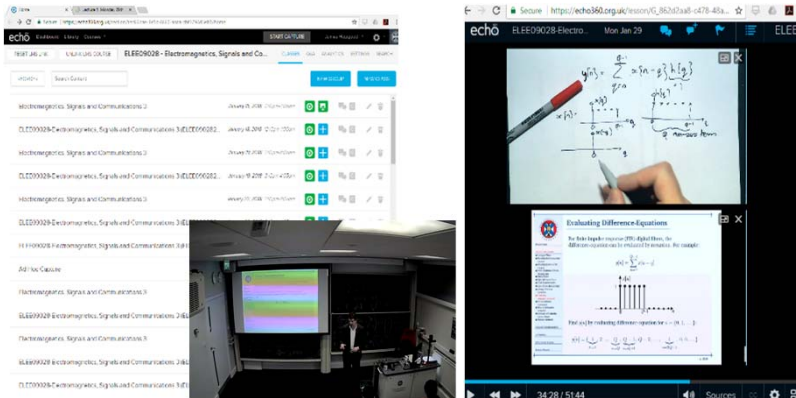
- “A versatile learning resource comparable to a textbook.”
- Ability to navigate large volumes of lecture recordings.
 - Efficient information retrieval.
 - Key-points, highlighting.
 - Topical lecture themes.
 - Transcription for indexing and accessibility.
 - “Chalkboard” summaries.
- Minimise in-video “drop-out” and enhance engagement.
- Integrate note-taking.



Media Hopper Replay vs the Competition

Media Hopper Replay (MHR)

- 50 minutes duration for a typical lecture.
- Search limited: index by date/capture time, and title (if edited).
- Timeline preview for searching/playback x2.



What's the Competition?

- YouTube lectures, duration typically 5 to 13 minutes.
- Presented as part of a focused “Channel” with meta-enhanced context.
- Information found easily and quickly by a Search.
- Often “Branded”.
- Easy to leave comments, and “Timestamps”.
- Some services correlate video with slides.



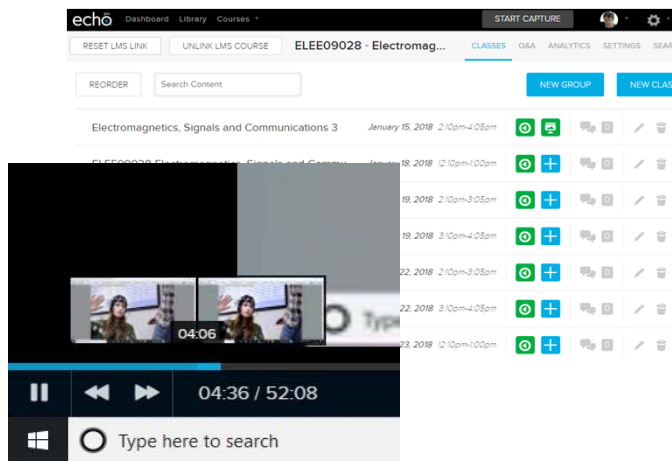
How to Achieve the Gold Standard

- Manually segment 50 minute lectures into shorter video segments based on topic (using video editing software).
- Write searchable text summaries (based on lecture notes?).
- Semi-automated caption/subtitle generation.
- Manually add meta-data linking video segments, time-stamps, lecture notes, external reading materials.
- Enhance chalk/marker-board and visualiser captures (crop/contrast, using image processing software etc).
- **Unlikely any Academic Staff member would do this regularly!**



PTAS Project: Enhancing Information Retrieval by Improving Content Organisation

- Nevertheless, is it worth it?
- The literature says yes, but we tried this to verify!
- With Student help!



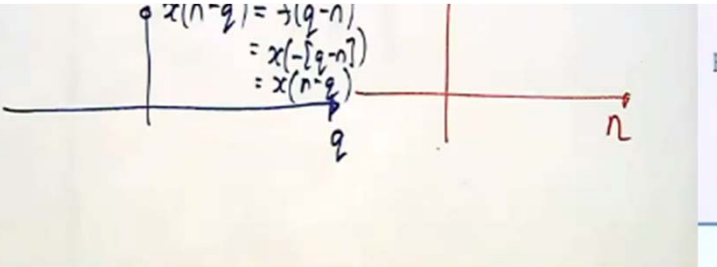
“We hypothesis the ability to retrieve information quickly from a video will increase engagement.”

- Segmented lecture into ~10 x 5 minute video “highlights”.
- Student-created summaries describing content.
- Added meta data for search indexes (Keywords).
- Timestamped important content.



Summaries and Timestamps for Full Lectures

<https://media.ed.ac.uk/channel/ELEE09027%2BSignals%2Band%2BCommunications%2B3/88532151>



$$x(n-q) = x(q-n)$$
$$= x(-[q-n])$$
$$= x(n-q)$$

Lecture 5, Monday 29th January 2018, "Digital Filter Evaluating the Convolution Summation".
From James Hopgood A week ago

Details **Share**

Summary

1. Showing how one can use MATLAB for investigating the workings and properties of a digital filter.
2. Showing how to solve the Convolution summation (giving the output of a digital filter) in a different way.

Topic/ sub-topic (times are slightly offset due to video editing)

@00:36: Review the digital filters: the different equations and block diagram which describes them

@1:10: Using an example to explain the implementation in software.

@6:17: Showing how MATLAB can be used to investigate the digital filter. How it worked with an example

@7:23: In MATLAB, explains how to pass the signal through a digital filter, combining with an example

@14:37: Using an audio signal as the sample, passing it through a digital filter.

@16:08: Explaining the meaning of the plots generated by the MATLAB.

@22:21: Listening to the impulse response!

- **Concise summaries of full lecture written by students**

- **Timestamps for material**

EXAMPLE: Summary

Showing how one can use MATLAB for investigating the workings and properties of a digital filter, ...

Topic/ sub-topic:

@00:36: Review the digital filters: the different equations and block diagram which describes them

@1:10: Using an example to explain the implementation in software.



Short Lecture Capsules

<https://media.ed.ac.uk/channel/SCEE08007%2BSignals%2Band%2BCommunications%2B2%2B-%2B2017-2018/86439321>

The screenshot displays the Media Hopper Create channel for SCEE08007 Signals and Communications 2 - 2017-2018. The interface includes a search bar, navigation tabs (Home, How to use Media Hopper, Creative Commons, All Channels), and a list of lecture capsules. The video player shows a slide titled "Relationship between Trig and Complex" with mathematical equations and text. The slide content includes: "The relationship can be further simplified by defining", "Using the relationship, we can write as", and "Using the relationship, we can write as". The video player also shows a progress bar and various controls.

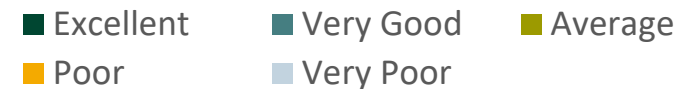
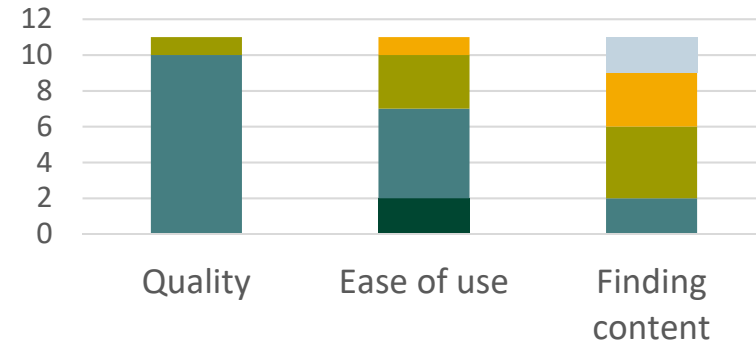
- Students created ~5 min length Lecture Capsules by editing full lecture – segmented as the students saw fit.
- Student-written summary of lecture capsules, list of keywords
- Built a “Channel” in Media Hopper Create (searchable).



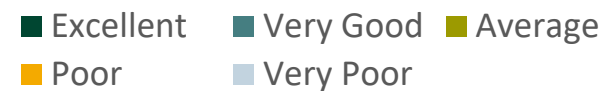
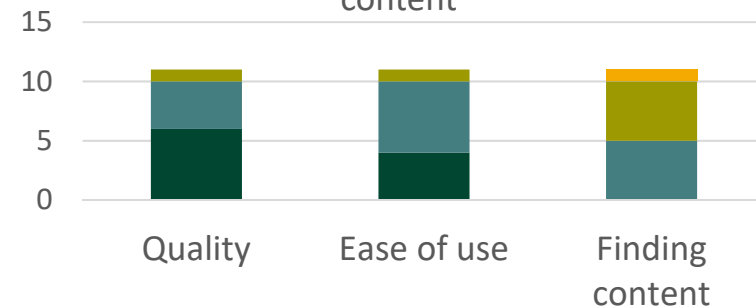
Perception of Enhanced Content

- Questionnaire evaluated appeal of enhanced content.
- Students with access to enhanced content found it to be a significant improvement
 - Perception of Media Hopper Replay declines when compared with enhanced functionality.
- While students found the enhanced content to be of benefit, they do not like to change platforms.
- Encouraging Student Feedback through Questionnaire “Comments”

REPLAY perception for students with ENHANCED content available



REPLAY perception without ENHANCED content



Technological Solutions

Can we automate this?

- Yes! Well, sort of ... active research topic!

Techniques include:

- Automatic key-frame recognition
- Automatic speech recognition
- Emotion recognition and Acoustic Emphasis
- Word-frequency for segmentation
- Crowd-sourced captioning

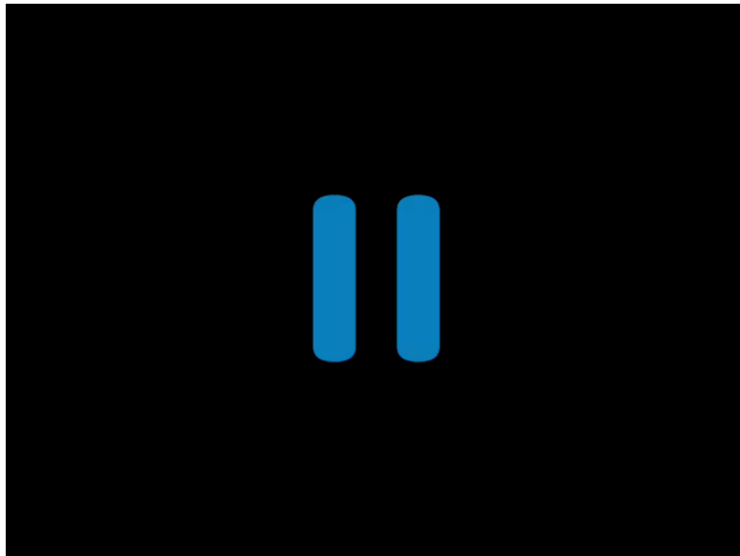
The screenshot shows a video player interface for a lecture video. The video is titled "Lecture 6 Part 2: Relationship between Trig and Complex - Working through Notes" and is from James Hoggood, uploaded 3 weeks ago. The video content includes a slide titled "Relationship between Trig and Complex" with the following text: "The relationship can be further simplified by defining $X_n = A_n - jB_n$ for all n ". Another slide titled "Relationship between Coefficients" states: "There is a simple relationship between the complex and algebraic Fourier series coefficients: $X_n = \begin{cases} A_n - jB_n & \text{for } n > 0 \\ A_0 & \text{for } n = 0 \\ A_{-n} + jB_{-n} & \text{for } n < 0 \end{cases}$ ". The video player interface includes a search bar, navigation controls, and a list of video parts on the left side.



Technological Solutions: PTAS Project

Can we automate this?

- Two current joint Engineering and Informatics enthusiastic to develop “Automation Tools for Instructor-Led Segmentation and Indexing Markup”.



Worldwide University Projects

University of Houston
Taufun Tuna et. Al (PhD thesis)
R. Long, T. Tuna and J. Subhlok,
"Lecture Video Analytics as an
Instructional Resource," 2018 IEEE
Frontiers in Education Conference,
2018, pp. 1-7. doi:
10.1109/FIE.2018.865900

Hasso Plattner Institute, Germany
X. Che, H. Yang and C. Meinel,
"Automatic Online Lecture
Highlighting Based on Multimedia
Analysis," IEEE Transactions on
Learning Technologies, vol. 11, no.
1, pp. 27-40, 2018.
doi: 10.1109/TLT.2017.2716372

Biology - Human Physiology - lecture19_1106

Main Video Playback

Inspiration

Major muscles are the diaphragm and the external intercostal muscles

- Stimulation of the phrenic nerve causes the diaphragm to pull down on the thoracic cavity, vertically enlarging the cavity
- Intercostals contract forcing the ribs & sternum up and outward
- Result:** Drop in pressure in the lungs (due to increased volume) of ~1 mm Hg which allows air to move down its gradient until there is no longer a gradient
- Deep inspiration requires accessory inspiratory muscles which further enlarges the thoracic cavity and the lungs are far apart. The thoracic cage want to be way

Transcript

10:21 and who wants to be the thoracic cage? I need another

10:25 female, come on. Look. Hold you you're in the space. Come up

10:31 to my left, nice and lovely. And she likes to be way over here

10:36 who's going to be my thoracic cage? Now notice the thoracic cage

10:44 and the lungs are far apart. The thoracic cage want to be way

10:51 over here, your lungs want to be way over here. This is your body

10:54 and that's what's going on. During development that happens but then

10:59 we develop that pleural sac. Remember the pleural sac? it sits in between them and it's attached to so I need a pleural sac

11:05 usually a very strong male who wants that role. Come on somebody comes up here

11:16 we're going to try to break him. Now,

Speed 1x

Keyword Search Box

Search: insp

Download: Video Audio

Index Panel

0:1 4:59 10:7 17:49 23:27 28:37 33:33 39:29

Search Results Indexed video segments with keyword match

insp(3) insp(3) insp(2) insp(1) insp(8)

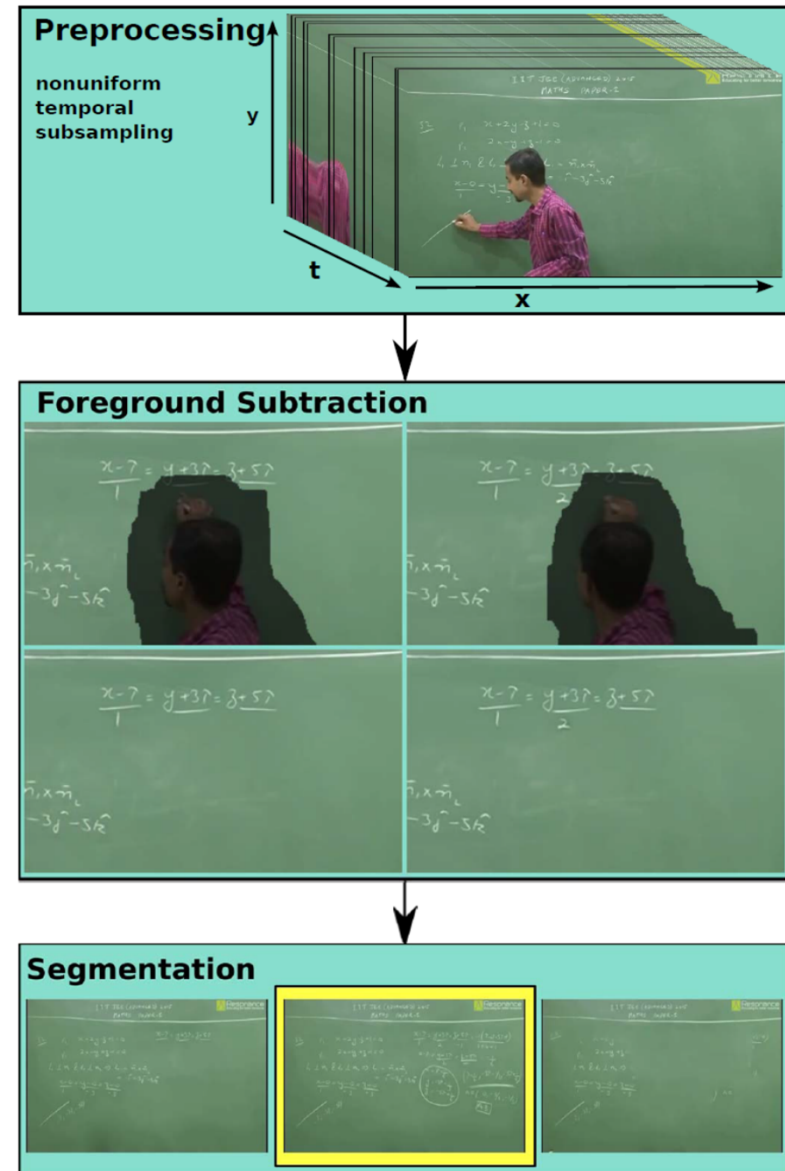
inspiration(2) inspiratory(1)

<http://videopoints.uh.edu/>



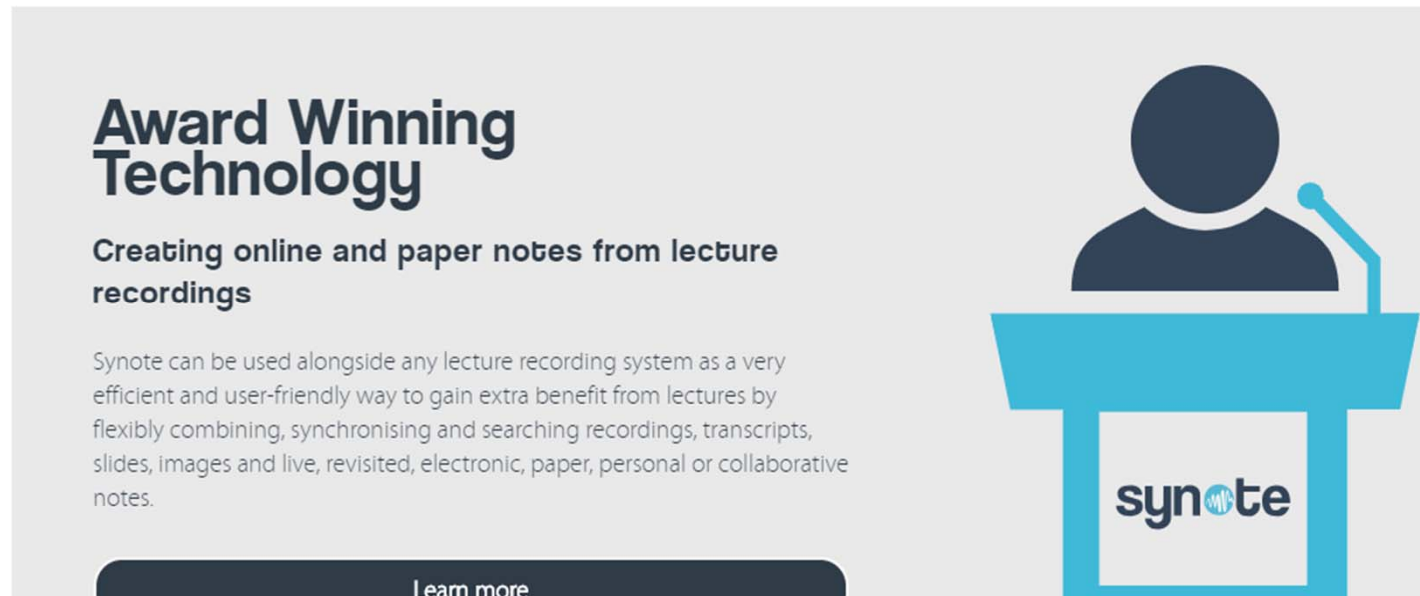
Image Processing for Chalkboard Summaries

- Occlusions from lecturer.
- Non-linear flow of material.
- Foreground subtraction and segmentation for chalkboard “notepads”.
- Important for STEM subjects.



Technological Solutions

- University of Southampton: SyncNote
 - Speech recognition based.
 - Crowd-sourced fixes to transcription errors.
 - Lecture notes uploaded and aligned.




Award Winning Technology

Creating online and paper notes from lecture recordings

Synote can be used alongside any lecture recording system as a very efficient and user-friendly way to gain extra benefit from lectures by flexibly combining, synchronising and searching recordings, transcripts, slides, images and live, revisited, electronic, paper, personal or collaborative notes.

[Learn more](#)

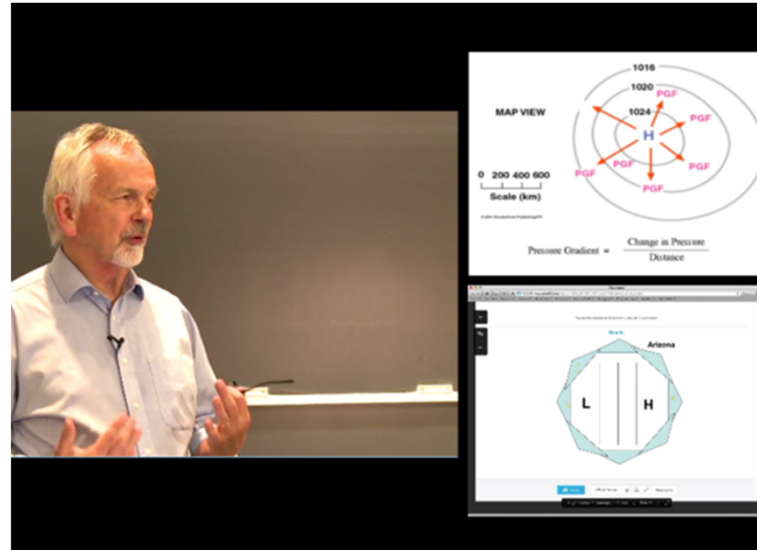


synote



Captioning (Supported by MHR)

- Improves accessibility.
- Allows video to be watched in quiet spaces.
- Stimulates dual channel processing through verbal and visual stimulus.
- Increases clarity where the lecturer and class languages are not the same.
- Enables further language learning (esp technical terms).
- Supports better searching of video content.



In the atmosphere.

And understand that, we have enumerated the fact that there are three forces that

actually cause **wind** directions and **wind** speed and

we're gonna be able to determine what the **wind** speed is anywhere and

what the **wind** direction is anywhere by knowing those three forces.

The three forces we are interested in first of all,

our the first force is pressure gradient force.

The pressure gradient force is a force that always acts towards low pressure.

Always acts towards lower pressure no matter where you are on Earth.

There's high pressure in one spot and low pressure in another spot.



Captioning (Supported by MHR)

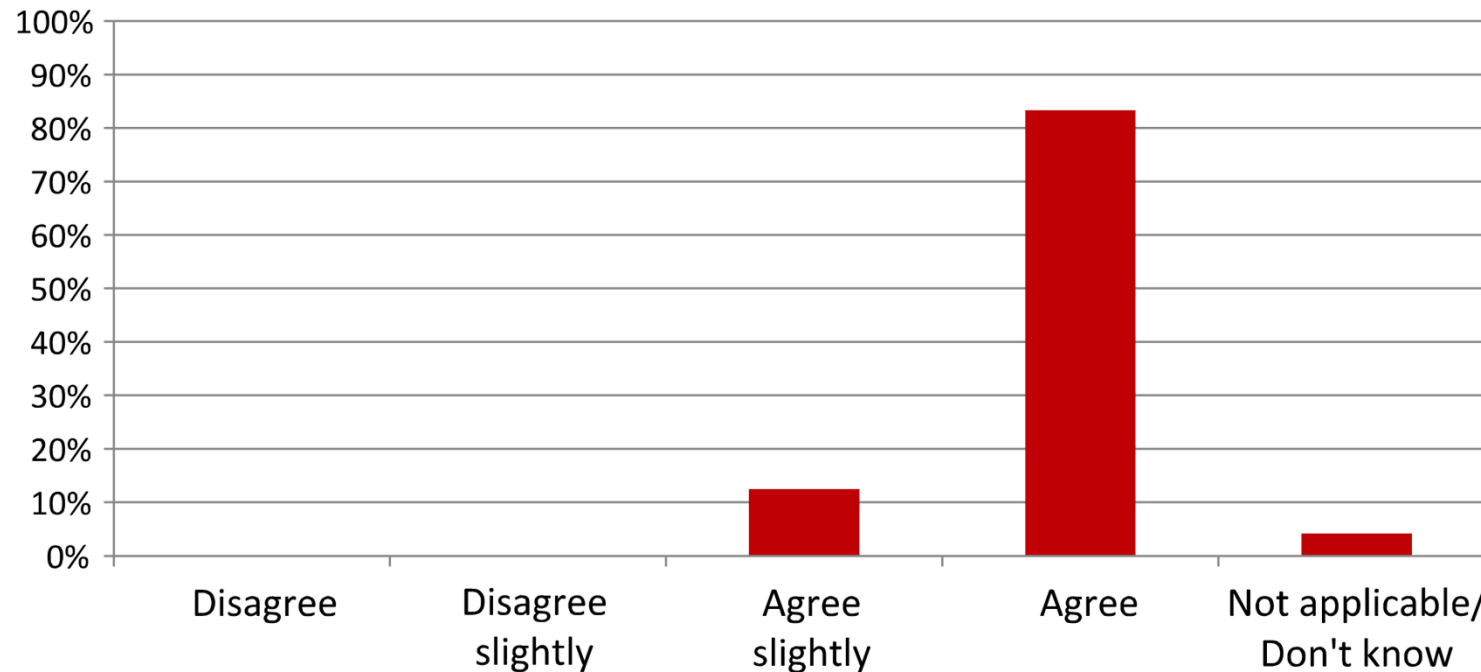


Fig. 6. Question: The videos with captions/transcript (text given for spoken sentences) are preferable than videos without them. Please express the strength of your agreement.



Captioning (Supported by MHR)

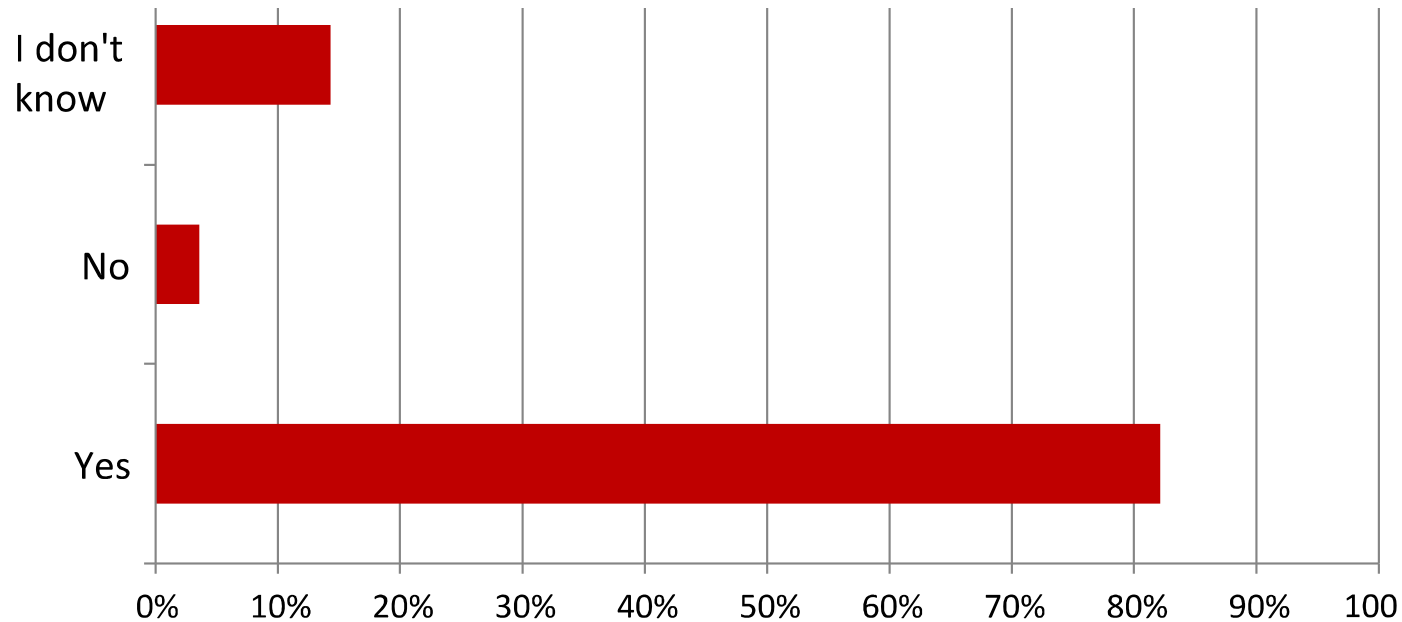


Fig. 13. Question: Would you be interested in working with other students to correct captions for your class lectures using this caption editor if you receive some incentive (for example academic credit)?



Takeaways (Conclusions)

- Reviewed academic studies on how lecture recording material is used and consumed.
- YouTube content: short, focused, part of a meta-enhanced *channel* with descriptions, user comments, and recommendations.
- PTAS project showed content segmentation and indexing is desirable from UoE students.
- Reinforces results found in the literature.
- Benefits for accessibility.
- Commercial solutions available for some features, though not others.
- Very rich academic literature in high-profile journals.



Enhancing Engagement with Media Hopper Replay – A Comparative Study

Effective Use of Lecture Recordings

Lecture recording offers new opportunities for students to interact with material taught in classes. Uptake depends upon several factors such as the ease of accessing specific content within a recording, and familiarity with the software. Many Media Hopper Replay (MHR) recordings will typically consist of basic recordings of 50 minute lectures, with no support to search the content, or retrieve specific information quickly.

This six-month study will explore the benefits of identifying content within a MHR recording, and the effect of demonstrations of advanced MHR capabilities on student uptake. The outputs will be applied in future courses to encourage more active use of MHR by students, supporting better engagement with course material, and improving the student experience.

Demonstrating Advanced Capabilities

- We hypothesise that a demonstration can have significant impact on the use of an advanced technology within teaching.

We will assess the effect of demonstrations from staff on using MHR on student engagement. The rationale for this approach is based on the observation that many technology users do not read documentation and instead learn through direct interaction, expectation of functionality, or observation of peers' usage.

We will evaluate engagement when using basic tools, compared to engagement when using advanced features such as taking notes, Q&A discussions, flagging confusion, and student bookmarking.

Enhancing Information Retrieval

- We hypothesise the ability to retrieve information quickly from a video will increase engagement.

Fast information retrieval is possible when a video is well-indexed with a comprehensive description. Finding specific content in a set of MHR recordings after an event is not a simple task unless staff have uploaded lecture notes in advance, and students make notes in MHR during the lecture. However, where it is not possible to upload notes in advance due to creating content interactively in class, or where students do not have a suitable device, the notes functionality is of little benefit.

This study will investigate:

1. whether engagement with MHR is greater when videos have additional meta-data such as lecture summaries and indexed "key-frames";
2. how short "lecture capsules" engage and are used by students.

