CASE STUDY

Student Video Curation

Matthew Jones, School of Management, UCL, London, UK. Email: matthew.m.jones@ucl.ac.uk
Snezana Lawrence, Design Engineering and Mathematics, Middlesex University, London, UK. Email: s.lawrence@mdx.ac.uk
Brendan Masterson, Design Engineering and Mathematics, Middlesex University, London, UK. Email: b.masterson@mdx.ac.uk
Alison Megeney, Design Engineering and Mathematics, Middlesex University, London, UK. Email: a.megeney@mdx.ac.uk
Nicholas Sharples, Design Engineering and Mathematics, Middlesex University, London, UK. Email: n.sharples@mdx.ac.uk

Abstract

In the academic year 2020-21 Middlesex University maths students accessed all learning sessions remotely. Each of these interactive sessions was live-streamed, recorded and uploaded to our Virtual Learning Environment, providing hundreds of hours of recorded, unedited maths lectures for students to review. This case study reports on a project (partially funded by an IMA Education Grant) in which we invited undergraduates to reflect on their remote learning experiences and curate these video lectures. Students were asked to identify the most engaging, useful and interesting segments, and categorise and explain their choices in free-text comments to help us develop our approach to remote lectures and video resources. A total of 33 video clips were identified by students across levels 4 to 6 on our specialist BSc Mathematics and BSc Mathematics with Computing programmes. In this paper we will discuss our findings, illustrate with example clips, identify themes in the student choices, and conclude with tips to produce engaging content. We will also discuss applications of video curation as a social pedagogic tool for the current Generation Z students. We will argue that sharing how students interact with digital learning resources can help address the significant digital divide in education.

Keywords: Lecture capture, Student agency, Video curation, Student voice, Lecture evaluation.

1. Introduction and background

Video is increasingly used in university teaching. A recent systematic review on lecture capture (the “synchronized audio and visual recordings of live lectures, which students can download to view at their own leisure”) reports that at least 86% of UK universities used some form of lecture capture in 2017, up from 71% in 2016 (Lindsay and Evans, 2021). The COVID-19 pandemic has subsequently caused a wide-ranging and rapid adoption of lecture capture. A survey recently published by the Joint Information Systems Committee (JISC) (2022) of 33,726 students between November 2021 and April 2022 reports that 68% of students have accessed recorded lectures. Further, the survey reports only 42% of students would prefer to be taught “mainly on site” leaving universities to consider the appropriate blend of teaching modes for the future but suggesting that lecture capture will have a large role in this future provision.

Lindsay and Evans (2021) argue that a thorough discipline-specific investigation of effective lecture capture is urgent and undertook a review of the literature focusing on mathematics. They conclude there is some evidence suggesting lecture capture contributes to attrition in on-campus lecture attendance of around 23-30%, and also cite two studies, Zimmerman, Jokiaho and May (2013) and Yoon and Sneddon (2011), who observed 30% of students stating that they perceived lecture capture was a substitute for live attendance. Further, the review suggests that substituting live lectures with lecture capture is negatively associated with student attainment, while there is a positive association if lecture capture is used as a supplement to lectures. There are many discipline-specific reasons why mathematics students in particular may benefit from reviewing lecture recordings: traditionally maths students are expected to multitask in note-taking while engaging with the cognitive demands of understanding lecturers' arguments. Further, the hierarchical nature of mathematics requires that each lecture is understood before the next can be effectively accessed.

The JISC survey (2022) also reports 93% of students surveyed, regularly used a laptop for learning, but very few had access to peripheral devices to help with online learning (such as additional microphones or cameras). Further, for online learning, 51% of students had a poor internet connection, 15% were encumbered with data costs, 16% had no appropriate area to work, and 12% had no suitable device to engage with online learning. Even if students had equitable access to technology, there is a significant "digital divide" in how this technology is used: Generation Z students from lower income families spend more time online but are less likely to use the internet for learning and are less likely to develop digital skills compared to their peers from higher income family (Ipsos MORI, 2018). As universities increasingly use technology such as lecture capture in learning the digital divide could make education less equitable. Consequently, it is important that we close this divide by encouraging all students to develop the digital skills implicitly needed to excel in their courses.

1.1. Partial recording of lectures

Middlesex University mathematics staff have been integrating lecture capture into their provision since 2016. This began as videoing key sections in *Mathematical Analysis* lectures where staff made short recordings of what they regarded to be the key sections of the lectures. In this compulsory second year undergraduate module, specialist mathematics students are expected to understand quite technical proofs before being able to themselves prove related but previously unseen results in analysis. As students are still developing their proof writing abilities, we were motivated to make a strong distinction between the formal statements of the proof and the narrative that explains the strategy and construction of the proof. In a lecture this narration is typically verbal while the formal statements are written, meaning that students will only hear the narration once and may be more concerned with transcribing this narration than engaging with it. Our solution was to point a video camera at the whiteboard during these key sections and upload the resulting videos to our Virtual Learning Environment (VLE) so that students could access the narration at leisure and engage without the pressure of transcription.

Although there were significant technical limitations in the audio quality, legibility of the whiteboard and length of the videos these initial experiments were very popular with students. In an end-of-module questionnaire completed by 7 out of 12 students on the course 4 out of 7 currently accessed the videos at least monthly, while 6 out of 7 intended to access the videos at least monthly in the future (for revision, for example). Further, 5 out of 7 students highly rated the usefulness of the videos, and 3 out of 7 credited the videos as a significant contributor to their mastering of the course. Notably, 6 out of 7 students wanted video recordings to be introduced to their other modules.

The distinction between formal proof and narration is increasingly prevalent in modern mathematical education materials. For example, Jones, Megeney and Sharples (2021a) describe using handwritten digital ink to provide "pedagogic commentary" annotations to typeset mathematics. The textbook market is similarly developing as universities are adopting "long-form" textbooks such as Cummings (2019a), which contain sections such as "Scratch work", "Proof idea" and "Pre-proof trick" before beginning a formal proof, compared to the traditional textbooks “with terse proofs of those results and not much else” that Cummings wittily characterises as “sage on the page” (Cummings 2019b).

1.2. Recording entire lectures

From 2018 Middlesex University mathematics staff were able to produce high-quality video recordings of live lectures thanks to an investment in tablets and styluses for staff (see figures 1,3 and 4 of Jones, Megeney and Sharples, 2021a). This meant that all the lectured content, questions, and critical conversations were captured and could be reviewed by students. These videos were between one and three hours in length and were unedited and uncurated other than being organised by module and week on the VLE. There was no noticeable drop in attendance (one student reported “The recordings are very useful, even though I attend the lectures”) and our VLE statistics showed that on average each student accessed each video 3 times following the lecture (see Jones, Megeney and Sharples, 2021b). Students’ attitudes towards the videos were highly favourable, for example reporting “My favourite thing about the teaching at Middlesex is… the video recording of lectures for our modules” and “All the explanations are on the video, you can really see what the lecturers are doing” (see Jones and Sharples, 2020) and module evaluation surveys made it clear that maths students wanted similar videos for all their modules.

Staff adopted the practice of video lectures at different paces. Universal adoption followed the introduction of the Technology Enhanced Learning thresholds in 2019, a university policy designed to “provide a consistent inclusive student experience” that required each learning session to be “captured in a way that allows students to independently meet the learning outcomes”. At the onset of the COVID-19 pandemic and the resulting lockdowns, maths staff were adept at using iPads to present and record lectures and simply had to connect the iPads to online meeting sessions at home rather than projectors on campus. As this was a relatively seamless shift (other than student access to devices, which was resolved through an iPad loan scheme – see Jones, Megeney and Sharples, 2021a) we opted to deliver the entire 2020-21 academic year remotely, and still deliver around 25% of lectures online in the 2022-23 academic year.

Universities have largely completed the technical elements of adopting lecture capture and more research on what constitutes effective lecturing in this format is needed. This research must include student perceptions, as there is often a gap between lecturer and student perceptions of effectiveness. For example, modern pedagogic approaches leave students “unconvinced as to whether flipped lectures are better for learning” (Novak, Kensington-Miller and Evans, 2017), while perceptions about the quality of mathematical explanation are “largely consistent” across lecturers and undergraduates (Evans, Mejia-Ramos and Inglis, 2022). In this case study we make inroads in understanding student perceptions of lecture capture.

2. Methods

In the academic year 2020-21 Middlesex University maths students accessed all learning sessions remotely. Each of these interactive sessions was live-streamed, recorded and uploaded to our VLE providing around 1400 hours of video. We invited undergraduates to reflect on their remote learning experiences and curate these video lectures to find the most engaging, interesting and useful segments and to explain their choices. Thanks to funding from an IMA Education Grant, we were able to offer students £13.71 per hour of video curation. We recruited six undergraduates from our BSc Mathematics and BSc Mathematics and Computing programmes; one first year (OfQual Level 4), four second years (OfQual level 5) and one third year (OfQual level 6).

Student curators would meet online via the Zoom platform for scheduled video curation sessions. An initial session trained students on the curation process: curators would access the video lecture archive (hosted on the university's MDXPlay video platform and the VLE) and either from their memories of lectures or simply by searching would identify relevant clips of the whole lecture video. Curators would then fill in a webform to identify the clip, choose a category, and write some sentences to explain their choice.

Curators were instructed to "find the best, most interesting, most useful video clips to help us develop our teaching", and were told to look out for video clips that

- helped you get knowledge of the syllabus;
- had a style that worked well for you;
- helped you understand a difficult concept;
- helped you become "unstuck";
- had particularly interesting content;
- were particularly engaging;
- were good lecturing;
- or had other notable features.

This work was done individually within a Zoom "breakout room" shared with the other curators to allow for discussion. A supervising lecturer remained in the main Zoom room to offer support if necessary but to avoid interference only entered the breakout room when requested to do so by the curators. Beginning in June 2020, at the end of the academic year, curators met on 5 separate occasions.

3. Results, thematic analysis and discussion

A total of 33 video clips (5/21/7 clips at each of OfQual levels 4/5/6) were identified across a range of undergraduate modules. These modules are all 30 credit, 12-week compulsory modules except for the 15-credit, 12-week optional module *Combinatorics*. All these modules were delivered as 3 hours of live recorded lectures per week. However, to respond to staff unavailability many modules replaced one week of live lectures with pre-recorded content. Except for a single clip from *Groups and Rings* all the clips were chosen from live recorded lectures rather than pre-recorded videos.

The shortest clip selected was 10 seconds long (a mnemonic for remembering the difference between permutations and combinations) and the longest was 14 minutes (a worked example of job allocations as an application of combinatorics). The median length was 5 minutes 15 seconds (see Figure 1).

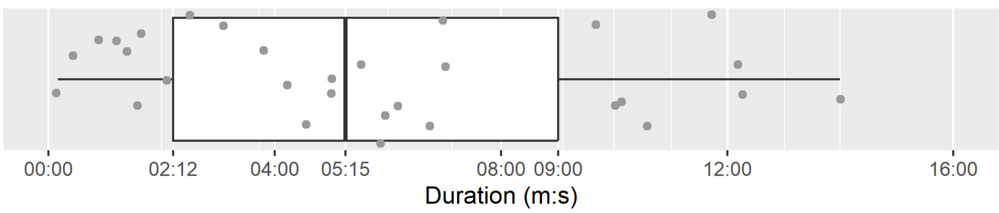

Figure 1: Distribution of chosen clip length (data is jittered in the vertical direction to prevent over plotting).

Curators categorised the clips into pre-defined categories and provided free-text comments for each clip. We identified the following six themes from the free-text responses: Examples, Explanation, Recap/Overview, Student-Led, Visualisations, and Technology (see Table 2). Where we have the appropriate permissions, the clips have been collated by theme into six short videos of approximately 25 minutes each (Sharples, 2022). We relate the emergent themes to the pre-defined categories in Figure 3, where it is evident that very engaging lectures tended to be student-led, and that lectures in styles that worked well or helped students become ‘unstuck’ covered a wide variety of themes.

Table 2: Number of clips as categorised by emergent themes

Emergent Theme	Number of clips
Explanation	8
Technology	7
Student-led	6
Examples	5
Recap/Overview	5
Visualisation	2

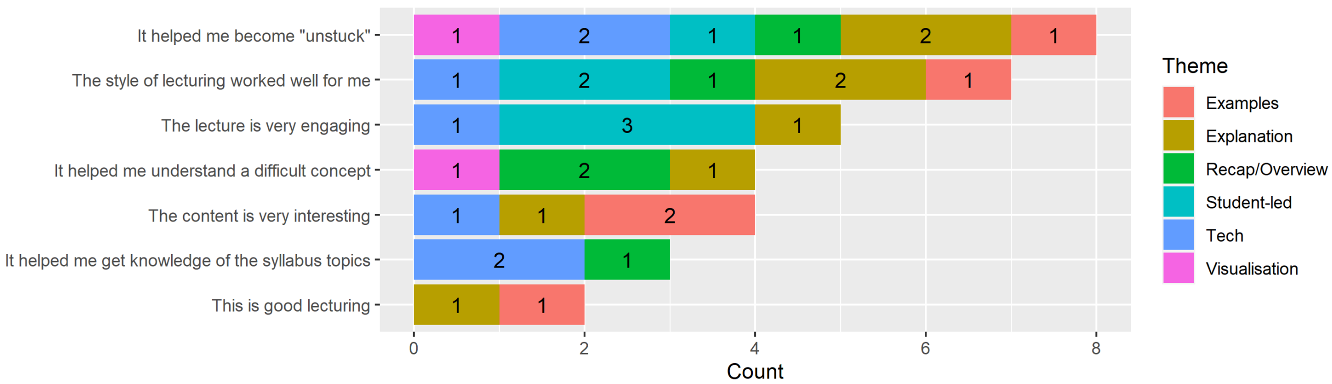

Figure 3: Student’s categorisation of chosen video clips (y-axis) with themes identified from the free-text responses (colours).

Curators chose video clips from throughout the academic year (see Figure 4) with a notable spike in weeks 3 and 13. This is perhaps reflective of week 13 lectures which, as the first lectures after the Christmas break, tend to focus on the review of previous material and overview of forthcoming lectures with motivating examples (see below). Further, the week 3 spike contains a cluster of clips in the “student-led” theme (3 out of the 5 clips): by this time in the year students typically have the pre-requisite knowledge to lead elements of the lectures.

We now discuss each theme in turn. It should be emphasised that curators were not specifically asked about the online, remote or recorded aspects of their lectures. The pre-determined categories were chosen to encourage curators to consider the lecture content rather than the mode of delivery or ability to review. In fact, there was only one comment referring to online delivery (see section 3.2), and the only comments about retrospective viewing concerned written materials rather than video recordings (see section 3.6).

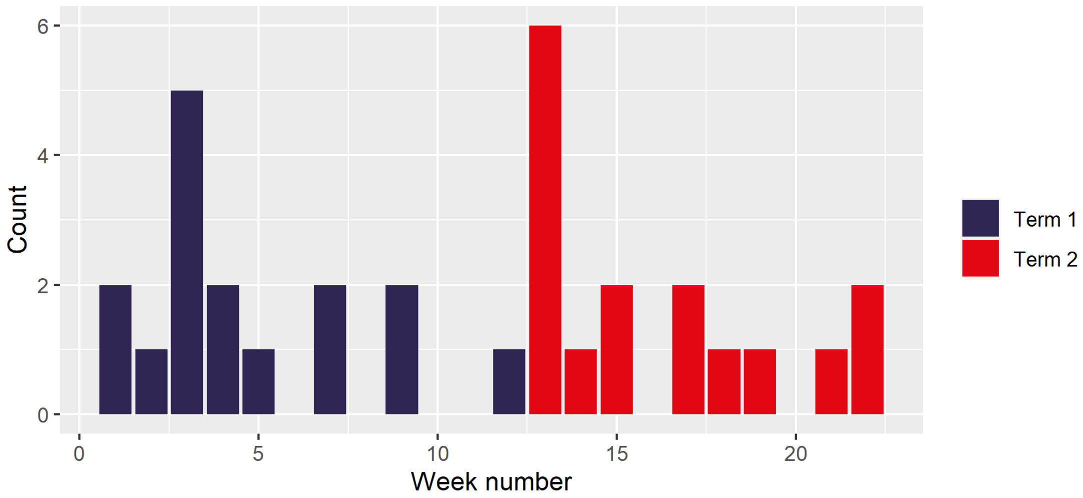

Figure 4: Distribution of clips chosen by teaching week.

3.1. Examples

Five of the clips were grouped as “worked examples”. These were a step-by-step implementation of an algorithm (*Discrete Maths and Geometry* - level 5); parametrisation in the complex plane (*Real and Complex Analysis* - level 6); normal subgroups (*Groups and Rings* - level 5); and two combinatoric applications (*Combinatorics* - level 6). From the comments one student particularly valued the visual showing of the lecturer’s thought process.

From Figure 3 we see that examples could have very interesting content but were not regarded as engaging. This may be because examples tend to be discrete, minimal, exemplar applications of theory which may be interesting but are often presented passively.

3.2. Explanation

Eight of the clips were grouped as “good explanation”, making this the largest theme. Further, from Figure 3 we see that this theme appears in nearly all the student-selected categories for inclusion, reinforcing the idea that good explanations are fundamental in teaching mathematics. The chosen clips were applications of Lagrange’s Theorem to cyclic groups, and exploring the group of symmetries of a triangle (*Groups and Rings* - level 5); real-life applications of discrete maths, and analysing the complexity of determining graph connectivity (*Discrete Maths and Geometry* - level 5); how to manipulate generating functions *(Combinatorics* – level 6*);* proving properties of divisors (*Logic and Structures* – level 4); counting permutations and combinations (*Data and Information – level 4)*; and an intuitive explanation of vector spaces (*Vectors and Matrices* – level 4).

Notably, one student remarked that being online they were hesitant to unmute to ask questions about small details as “sometimes it feels like a nuisance”. This style of slow, detailed explanation of every step, with the lecturers’ thought process outline was identified as a helpful style of good lecturing. One student also remarked that explicit links between topics helped them understand ideas that they found hard previously. Another student remarked that the real-life applications of discrete mathematics were the “biggest reason I did well in this module”.

3.3. Recap/Overview

Five of the clips were grouped as "recap and/or overview" where students had indicated that either the topics were being revisited or an overview of coming lectures was given. These were an overview of abstract analysis, a recap of set theory, and a review of open and closed balls in the discrete metric (*Mathematical Analysis* – level 5); recap of properties of prime numbers (*Advanced Algebra* – level 6); and a recap of sampling methods (*Data and Information* – level 4). Clips identified with this theme were taken from lectures within the first four weeks of each term.

Notably, one student remarked that the links between the abstraction of analysis and the abstraction of group theory was valuable. Another student remarked that the mnemonic device of "permutation begins with a 'p' and the position matters" was valuable. Finally, a student commented that the repetition in a clip (finding closed balls in the discrete metric with various radii) was helpful.

3.4. Student-led

Six of the clips were grouped as "student-led", where either the lecturer is primarily responding to student questions or supervising student activities. These were students applying Dykstra's algorithm on a shared virtual whiteboard (*Discrete Maths and Geometry* – level 5); lecturer sharing and providing commentary on a student's work on sequences (*Mathematical Analysis* – level 5); line-by-line diagnostic of a student's LaTeX submission (*Problem Solving Methods* – level 5); students listing elements of symmetry groups and calculating orders, working through homework questions on basic groups, and students finding inverses of group elements (*Groups and Rings* – level 5). We see from Figure 3 a strong relationship between "very engaging" and "student-led" clips of lectures. Students seem most engaged when a peer is leading the session, or when peer's work is being discussed.

The comments suggest that working primarily from students' written submissions, using shared virtual whiteboards or scribing for individuals/groups of students is an effective way of running a video lecture. Students comment that lecturers were "able to instantly spot our mistakes and explain what we had missed" even saying "I found this more useful than even being in-person as the lecturer was able to watch our every line." Similarly, with a LaTeX assignment "screen sharing this way was a more efficient way of [debugging code]". Interestingly, the students making these comments were not those whose work was being discussed in these clips. The more collaborative examples were in fact scribed by the lecture but described as "great because it was very engaging with the students" and is "more memorable and useful" when "the whole class was contributing to find a solution". A student remarked that working from a peer's submission "allowed us to gain confidence in our work and also fill in any holes in our understanding".

3.5. Visualisation

Two of the clips were grouped as having visualisations that the students found noteworthy. These included a visualisation of Riemann integration (*Real and Complex Analysis* – level 6); and a visualisation of automorphisms (*Discrete Maths and Geometry* – level 5). Interestingly, these chosen visualisations were hand-drawn by lecturers in real-time during the live lectures. In comparison students didn't remark on the other high-quality pre-prepared graphics, including the frequent use of Tikz and Desmos resources in these or other modules. Figure 3 shows that visualisations are valued in helping students understand difficult concepts and to become "unstuck".

3.6. Technology

Seven of the clips were grouped as having a "high tech" approach, perhaps using specialist software or more advanced features of the universal iPad provision for maths undergraduates. These were the use of Geogebra graphing and augmented reality to explore multivariable calculus (*Real and Complex Analysis* – level 6); the use of shared persistent virtual whiteboards as a replacement for lecture notes (*Mathematical Analysis,* and *Discrete Maths and Geometry* – level 5); the provision of "phone-sized" notes, and demonstrations of using the RStudio Integrated Developer Environment (IDE) (*Problem Solving Methods* – level 5). From Figure 3 we see that "high tech" elements of lectures are valued by students for a variety of different reasons, which supports the importance of technology enhanced learning for mathematics.

The comments about the persistent virtual whiteboards (Miro boards) were very positive. Students wrote "the Miro board… was helpful to look back on afterwards, a system like this … is really useful", and "the Miro board… is great… I could look back on it for reference and notes, which made revision easier". However, it seems important to students that they are given the opportunity and support to adapt to these new technologies: one student wrote that the lecturer "referring back to the Miro boards for definitions instead of the notes made me more comfortable with using the Miro board".

Other formats of lecture notes, such as the "phone-sized" notes (produced from a LaTeX class file that renders 9:16 aspect ratio documents) were noted by one student as making "revising more accessible for me and allowed me to revise in more unconventional places".

Finally, the demonstrations of writing R code were well received, particularly the techniques on using the IDE rather than the code-writing itself. Students commented that the video "showing how you can find all details about a command [was] extremely helpful every time I forgot something" and that "this was needed because we hadn't used R since the first semester."

These student observations suggest that lecture capture may also give valuable, unintended technology demonstrations (such as with the Miro software, and use of the RStudio IDE detailed above), which may help address the divide in digital skills documented by Ipsos MORI. A "technology enhanced" lecture may (inadvertently) contain the set-up and use of multiple pieces of software, adjusting settings, locating and logging in to resources, file management, searching the internet and troubleshooting. By recording and involving students in this authentic use of digital skills we provide exemplars of the digital skills students required to excel in a modern, blended mathematics degree.

On returning to campus Middlesex University mathematics staff further incorporated technology into face-to-face lectures. Most lectures are audio and video recorded in their entirety and later made available to students on the VLE. This has been achieved through retaining iPads as the primary tool of delivering lectures in a face-to-face setting (Jones, Megeney and Sharples, 2021a). Many staff also use Miro boards to deliver material through importing slides and/or digital ink and organising into sections (perhaps non-linearly). Lectures involve navigating these virtual collaborative whiteboards, adding commentary through digital ink or pasted computer output, setting students tasks in dedicated collaborative sections of these virtual boards, and providing real-time feedback. Multiple students can work on the boards in real-time, and even upload existing work (e.g., photographs of paper documents) for immediate feedback and class discussion. Some students prefer to work individually on paper but are gently encouraged to contribute work after they receive individual feedback during the session.

4. Conclusions

Having the opportunity to revisit their online lectures has enabled students to give a critical appraisal of the elements that they have found particularly useful for their learning. We summarise our findings with the following suggestions:

1) Slow, highly detailed explanation that include the lecturer's thought processes are desirable. Students can be particularly reluctant to interrupt online or recorded sessions to ask questions.
2) Virtual whiteboards with notes and a record of the lecture commentary are desirable as a single source for the module content. But students should be trained in the use of these technologies.
3) Visual aids are perhaps more memorable and useful if they are constructed in real-time rather than as high-quality pre-prepared graphics.
4) Repetition of key ideas may still be important, even for recorded lectures.
5) Student-led elements of lectures are highly appreciated whether working together on virtual whiteboards or providing commentary on students submitted work. Students find these discussions helpful even if it is not their work being discussed!
6) Students appreciate recaps and overviews that provide links between modules and wider areas of mathematics.
7) Videos of lecturers' incidental use of technology can be used as exemplars for the discipline-specific digital skills we need to encourage students to develop in order to excel.

Finally, the video curation exercise itself could be a useful way of getting students to engage with lecture capture, and a further study could investigate this. Students could collaboratively curate lecture videos by adding communal bookmarks, comments and questions on sections if such functions are available on the VLE. Ipsos MORI (2018) also comment on the potential negative effects of social media use by generation Z students, but perhaps creating an explicitly academic, productive social media environment built on video lectures could show some benefits.

5. References

Evans, T., Mejía-Ramos, J.P. and Inglis, M., 2022. Do mathematicians and undergraduates agree about explanation quality?. *Educ. Stud. Math.* 111, pp. 445–467. https://doi.org/10.1007/s10649-022-10164-2

Cummings, J. 2019a. *Real Analysis: A Long-Form Mathematics Textbook.* 1+ε edition. CreateSpace Independent Publishing Platform.

Cummings, J. 2019b. Real Analysis Book. [online]. Available at: https://longformmath.com/analysis-home [Accessed 30 November 2020].

Ipsos MORI, 2018. *Ipsos Thinks: Beyond Binary: The lives and choices of Generation Z.* [online] Available at: https://www.ipsos.com/ipsos-mori/en-uk/ipsos-thinks-beyond-binary-lives-and-choices-generation-z [Accessed 30 November 2022].

Joint Information Systems Committee (JISC), 2022. *Student digital insights survey 2021/22: higher education findings*. [online]. Available at: https://www.jisc.ac.uk/reports/student-digital-experience-insights-survey-2021-22-higher-education-findings [Accessed 30 November 2022]

Jones, M., Megeney, A. and Sharples, N., 2021a. Engaging with Maths Online – teaching mathematics collaboratively and inclusively through a pandemic and beyond, *MSOR Connections* 20(1). pp. 74-83.

Jones, M., Megeney, A. and Sharples, N., 2021b. Digital pedagogy in a world of digital poverty: The Middlesex iPad project. In: AdvanceHE Curriculum Symposium 2021. Available at: https://www.advance-he.ac.uk/knowledge-hub/curriculum-symposium-2021-post-pandemic-curriculum

Jones, M. and Sharples, N., 2020. Video recording lectures: blending the quarantine. In: Teaching and Learning Mathematics Online (TALMO) Workshop: Student Engagement and Interaction. Available at: http://talmo.uk/daysei.html

Lindsay, E. and Evans, T., 2021. The use of lecture capture in university mathematics education: a systematic review of the research literature. *Math Ed Res J (2021).* https://doi.org/10.1007/s13394-021-00369-8

Novak, J., Kensington-Miller, B., and Evans, T., 2017. Flip or flop? Students' perceptions of a flipped lecture in mathematics. *International Journal of Mathematical Education in Science and Technology 48(5), pp. 647-658. https://doi.org/10.1080/0020739X.2016.1267810*

Sharples, N., 2022. Student video curation. [online video playlist]. Available at: https://www.youtube.com/playlist?list=PLY4Kh5I7CS1ohLYtogHNNmvfyeSzhVhSF [Accessed 30 November 2022]

Yoon, C. and Sneddon, J., 2011. Student perceptions of effective use of tablet PC recorded lectures in undergraduate mathematics courses. *International Journal of Mathematical Education in Science and Technology, 42*(6), pp. 425–445. https://doi.org/10.1080/0020739X.2010.543165

Zimmermann, M., Jokiaho, A. and May, B., 2013. Lecture recordings in higher mathematics education: Use and impact on academic performance. *Journal of Information Technology and Application in Education*, 2(4), pp. 150–156. https://doi.org/10.14355/jitae.2013.0204.04