Imperial College London

Department of Mathematics

StudentShapers Project

Impact of the shift towards blended learning on student engagement with online resources

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1 Introduction

Student engagement has increasingly been positioned as a defining characteristic of high-quality teaching and learning in higher education. For example, [1] emphasises student engagement as a "key element of the development of learning communities in higher education". However, student engagement has admittedly many meanings, and following the distinguishment in [2], there are three broad objects of engagement:

1. Engagement to form individual understanding- which focuses on the ways in which student engagement can help students to improve their learning outcomes.

2. Engagement to form curricula- which focuses on the ways in which students can help to form the courses that they study in higher education.

3. Engagement to form communities- which focuses on the ways in which students can be involved in helping to shape the institutions and societies of which they are part.

Almost all educational institutions, including Imperial College London, are based predominantly on traditional learning techniques, that is, face to face lectures and problems classes perhaps supplemented by online resources. The sudden outbreak of COVID-19 has meant operating in the same manner is untenable and forced educators to switch to an online approach. This report investigates the benefits and weaknesses of a more blended approach towards learning, specifically within the Imperial College London Mathematics Department. It further analyses how the data pertaining to the usage of online resources compare throughout the last three academic years. This data contains the information regarding the online usage of 1104 Imperial College London Mathematics students, including Panopto lecture watch times, Blackboard access and Piazza usage. The results allow us to hypothesise the most efficient resources and teaching/learning methods in a more blended approach, and optimise our resources accordingly.

2 What is blended learning?

2.1 Traditional learning

We define traditional learning as an umbrella term covering any teaching strategy that includes only face-to-face interactions between teachers and students.

2.2 Blended learning

According to Friesen, blended learning "designates the range of possibilities presented by combining Internet and digital media with established classroom forms that require the physical co-presence of teacher and students" [3]. Note that the vast majority of teaching and learning taking place today is already 'blended' to some extent, i.e. through the use of online platforms such as institutional websites/-portals: Moodle, Google Classroom, Blackboard, or even something as simple and widely-adopted as email.

2.2.1 Blended learning techniques

A blended learning strategy consists of at least one offline component and at least one online component, hence all blended learning methods lie on a continuum between traditional learning and fully online learning.

The offline components include elements such as classroom teaching or lectures, distributable print media (e.g. books) and face-to-face tutoring. Examples of online components include video conferences, collaborative message boards, digital assessments, and student-directed online learning through digital content. [4]

These components can be combined in a variety of ways which lead to the blended learning methods that we see in use. Not all combinations will result in a successful blended learning strategy, and it is the carefully planned implementation and optimal mix of these components that can create a learning environment that is more productive than a traditional learning environment. [4]

3 Case studies on blended learning

Departments throughout Imperial have taken different approaches towards blended learning.

For example, the Aeronautics department, they created digital materials in Apple iBooks which guide students through a sequence of interactive animated problems, note-taking of theory, and finally, a summary video and self-assessment [5].

Case studies from the department of Medical Biosciences discuss fully online team-based learning experiences and running interactive online workshops with large cohorts. [6].

Within the Chemistry department, first-year Chemistry students take a lab consisting of workshops where students work through instructions provided in a Jupyter notebook, with support from demonstrators - provided in Microsoft Teams and in a Blackboard discussion forum during remote delivery [7].

As a result of COVID-19, all departments at Imperial College moved to fully online learning in March 2020. This carried on for the entirety of the 20-21 academic year, although there was a limited number of non-compulsory in-person sessions, such as problems classes, at the start of the academic year.

4 The benefits of blended learning

The literature suggests blended learning brings many benefits through combining the efficiency and flexibility of online learning with the social benefits of collaborative learning. These include: a more individualised learning experience through accommodating a variety of learning styles, improved academic achievement, more opportunities for "learner-to-learner" support, and the flexibility to study anytime and anywhere. [8] Namyssova et al [9] suggest a reason blended learning is preferred is that students are involved in active learning through the use of diverse learning approaches that require them to process and reflect on the given information and actively communicate with peers. Additionally, studies by Chyr et al [10] support that

"students' involvement, self-efficacy and self-directed learning" improved after taking a course that implemented "online academic help-seeking" and flipped learning (where materials are pre-studied then applied during the class).

With no need to commute and more flexibility, 52% of students felt less tired after class and 70% noticed an increased ability to plan 'free time'. [11]

5 The drawbacks of blended learning

However, according to Dumford and Miller, students who had more online classes rated their professors' teaching lower. Online learning interactions were described as lower quality, and there was a trend that students who took a larger proportion of online classes engaged in less collaboration [12].

Ishmuhametov and Kuzmenko [11] found that 48% of students they asked felt a "deficiency in communication with other students" and 44% noticed the lack of "live discussions with lecturers". Further, difficulty in concentrating during online lectures, inability to absorb material and procrastination were all reported as problems faced by a significant number of students.

6 Data Analysis

6.1 Panopto, Blackboard and Piazza

The data analysed in this report describes student usage of three online education platforms.

- Panopto- Panopto is a service used by most lecturers in the Department of Mathematics to record and manage video lectures. Students can view these recordings online. Under ordinary face-to-face circumstances Panopto is used to record the live lectures delivered on campus. In the 2020-2021 academic year and the end of the 2019-2020 academic year Panopto was used by lecturers to deliver prerecorded video lectures to students. [13]

- Blackboard (officially Blackboard Learn)- Blackboard is a virtual learning environment and learning management system used in most modules in the department of mathematics. It is typically used to upload module materials such as lecture notes, communicate with students via announcements and assess students via quizzes and coursework assignments which are submitted online. [14]

- Piazza- Piazza is a learning management system which functions as a forum for students to ask questions directed at instructors and/or other students. Questions can be asked anonymously and also answered by students anonymously. Instructors are able to endorse student answers and also answer questions themselves. Also, followup discussions can be initiated for each question. Various reactions (e.g. 'good question') can be given by students and instructors on questions, answers, and followups. Piazza also offers polls and live Q&A sessions. [15]

6.2 Data collected

Each student was given an anonymised ID number that remained the same throughout the three data sets. This was done by the Faculty of Natural Sciences EdTech Lab, who collated the data. The tables below show all the modules that we analysed data for, we selected all the core modules as well as several elective modules.

Year 1 Module list (* indicates old specification)				
Module Code	Module name	Blackboard data	Panopto data	Piazza data
MATH40001	Introduction to University Mathematics	✓	✓	✓
MATH40002	Analysis 1	✓	✓	✓
MATH40003	Linear Algebra and Groups	✓	✓	✓
MATH40004	Calculus and Applications	✓	✓	✓
MATH40005	Probability and Statistics	✓	✓	✓
MATH40006	Introduction to Computation	✓	✓	✓
MATH40007	An Introduction to Applied Mathematics	✓	✓	✓
MATH94002	Mathematical Computation*	✓	✓	
MATH94003	Foundations of Analysis*	✓	✓	
MATH94004	Geometry and Linear Algebra*	✓	✓	
MATH94009	Analysis 1*	✓	✓	
MATH94010	Algebra 1*	✓	✓	
MATH94012	Probability and Statistics 1*	✓	✓	

Year 2 Module list (* indicates old specification)				
Module Code	Module name	Blackboard data	Panopto data	Piazza data
MATH50001	Analysis 2	✓	✓	✓
MATH50003	Linear Algebra and Numerical Analysis	✓	✓	✓
MATH50004	Multi-variable Calculus and Differential Equations	✓	✓	✓
MATH50005	Groups and Rings	✓	✓	✓
MATH50006	Lebesgue Measure and Integration	✓	✓	✓
MATH50007	Network Science	✓	✓	
MATH50008	Partial Differential Equations in Action	✓	✓	✓
MATH50010	Probability for Statistics	✓	✓	✓
MATH50011	Statistical Modelling 1	✓	✓	✓
MATH95001	Differential Equations*	✓	✓	
MATH95002	Multivariable Calculus*	✓	✓	
MATH95003	Introduction to Numerical Analysis*	✓	✓	
MATH95005	Real Analysis*	✓	✓	
MATH95006	Algebra 2*	✓	✓	
MATH95011	Probability and Statistics 2*	✓	✓	

Year 3 and 4 Module list (all old data)				
Module Code	Module name	Blackboard data	Panopto data	Piazza data
MATH96011	Mathematics of Business & Economics	✓	✓	✓
MATH96046	Statistical Theory 1	✓	✓	✓
MATH96048	Survival Models and Actuarial Applications	✓	✓	✓
MATH96051	Statistical Modelling 2	✓	✓	✓
MATH96052	Applied Probability	✓	✓	
MATH96053	Time Series	✓	✓	
MATH96054	Stochastic Simulation	✓	✓	
MATH96067	Introduction to Statistical Learning	✓	✓	

To focus on Mathematics students we chose to exclude mathematical modules that were only offered to Joint Mathematics and Computer Science (JMC) students, such as MATH50012 Numerical Analysis for JMC. However, modules where both Mathematics and JMC students could take were included as Mathematics students made up the majority.

Some of the modules have two codes. For example, Calculus and Applications is referred to as both MATH40004 and MATH40011. The former is the code for Mathematics students and the latter is the code for JMC students taking that course. Some of the modules offered in year 3 and 4 have different codes depending on what year a student takes them. For simplicity, we opted to categorise modules by their Mathematics module code and their year 3 module codes.

Some modules such as MATH95006 and MATH40007 (Principles of Programming and Introduction to Applied Maths) were excluded because external sites were used to share resources and videos, leaving our data incomplete.

The Department of Mathematics has undergone a curriculum change through 19-21, hence data for year 1 and year 2 is a mix of old and new specification modules, whilst the data for year 3 and 4 is solely old specification modules. It should be noted that Piazza data is not available for all modules.

6.2.1 Panopto data

Each datapoint corresponds to a particular student viewing a particular lecture video. These are identified by:

- The student's ID number
- The title of the module
- The year the student is currently in (Year 1, 2, 3, 4)
- The academic year the student took the module (2018-2019, 2019-2020, 2020-2021)
- Whether or not the student took the module for degree credit
- The title of the lecture video

The following fields of data were collected for each data point:

- Number of times the video was viewed and downloaded
- Number of minutes the student has spent on the video
- Percentage of the video viewed
- Date the video was last viewed

6.2.2 Blackboard data

Each data point corresponds to a particular student's activity on a particular module's Blackboard page. These are identified by:

- The student's ID number
- The title of the module
- The year the student is currently in (Year 1, 2, 3, 4)
- The academic year the student took the module (2018-2019, 2019-2020, 2020-2021)
- Whether or not the student took the module for degree credit

The following field of data was collected for each data point:

- Number of hours spent on the module's Blackboard page.

6.2.3 Piazza data

Each data point corresponds to a particular student's activity on a particular module's Piazza page. These are identified by:

- The student's ID number
- The title of the module
- The year the student is currently in (Year 1, 2, 3, 4)
- The academic year the student took the module (2018-2019, 2019-2020, 2020-2021)
- Whether or not the student took the module for degree credit

The following fields of data were collected for each data point:

- Number of days the student was online
- Number of posts written by the student
- Number of edits to posts made by the student

- Number of answers written by the student
- Number of edits to answers made by the student
- Number of followups written by the student
- Number of replies to followups written by the student
- Number of 'good question' reactions given by the student
- Number of 'thanks' reactions received on answers written by the student
- Number of 'helpful' reactions received on followups written by the student
- Number of posts viewed by the student
- Number of votes cast by the student in polls
- Number of 'upvote' reactions given by the student in live Q&As

6.3 Data Pre-processing

6.3.1 Data points removed

data points containing NaN values and data points from students not taking the module for degree credit were removed. After doing so, 96.86% of the Panopto data and 98.76% of the Blackboard data is retained. Furthermore, data points that have a covariate with a z-score less than -3 or greater than 3 were considered outliers and also removed. This left about 97% of the data.

6.3.2 Categorising last view dates (Panopto data)

The last view date was converted into a binary variable depending on whether it is during the 'term period' or 'revision period'. The 'term period' is defined as up to the last official day of the Spring term at Imperial that year, and the 'revision period' is defined as any time after the term period until the exam period. This helps us to determine which resources are commonly used during the exam revision period.

6.4 External Influences

Other factors to consider when comparing the data is that students resitting exams would use Blackboard and Panopto more over what we defined as the revision period, and this information is only wholly available for years prior to 2021. As well as this, the 2019-2020 cohort finished Spring term a week earlier than scheduled due to COVID-19. Many lecturers uploaded recorded videos for the missing week. Whilst some lecturers made that content optional, this still may influence our data as willing students would only be able to watch those lectures online.

6.5 Data

We now proceed by considering various plots pertaining to the previously described data.

6.5.1 Panopto data: by module

6.5.1.1 Compulsory/Elective split of average views per video per module Figures 1, 2, 3 show the average views for each module. Average views are defined as the average number of times a student clicks into a video for a module, in which we only include the videos that the student has clicked into at least once.

We can see in Figure 1 that the number of average views is generally between 1 and 2. MATH40006 had a low number of average views in both years. Since this was a computing course, students may have found it more useful to learn and revise by attempting practical exercises, rather than by re-watching videos. In 20-21, MATH40005 also had a low number of average views. This may be because the lecturers opted to split their lectures into several shorter videos, which students are more likely to finish in one go.

In Figure 2, we see that the majority of the modules have mean Average Views between 1.5 and 2. MATH50004 20-21 and MATH95006 19-20 are slightly lower than the rest. The average views for MATH50003 20-21 is quite high.

There is no data for MATH96052 18-19 and MATH96046 18-19 as they did not use Panopto, so in Figures 3 and 6, there are no data-points.

6.5.1.2 Compulsory/Elective split of the average percent completed of each video per module In Figures 4, 5, 6 we see the the modules from 20-21 (wording) have a much higher percent completed than the other years. Excluding this year, we can see moderate spread.

Considering figure 4. MATH40001 19-20 was the 'Introduction to Mathematics' module, an intensive module that all students take at the start of year 1. The low percent completed could be attributed to high attendance of lectures and fast pace of this module.

MATH94002 18-19 also had a very low percent completed. This could be because it is coursework only or non examinable content only, that is they have no summer exams.

Furthermore, looking at figure 5, The 20-21 year has significantly higher percent completed than the other years, and 19-20 has a small increase from 18-19. There are a lot of low outliers for MATH50004 20-21, which could be attributed to the supplementary introduction and summary videos provided that students may have not watched in favour of the main videos. MATH95001 18-19 is also a little low.

Looking at figure 6, we see that similar to figure 5 the 20-21 year has a much higher percent completed than other years. The 19-20 year is higher than the 18-19 year typically by a small amount, however this gap is considerable for MATH96054.

6.5.1.3 Compulsory/Elective split of Minutes Delivered by module Let us consider comparing the minutes delivered per person on Panopto between modules: (Figures 7, 8, 9).

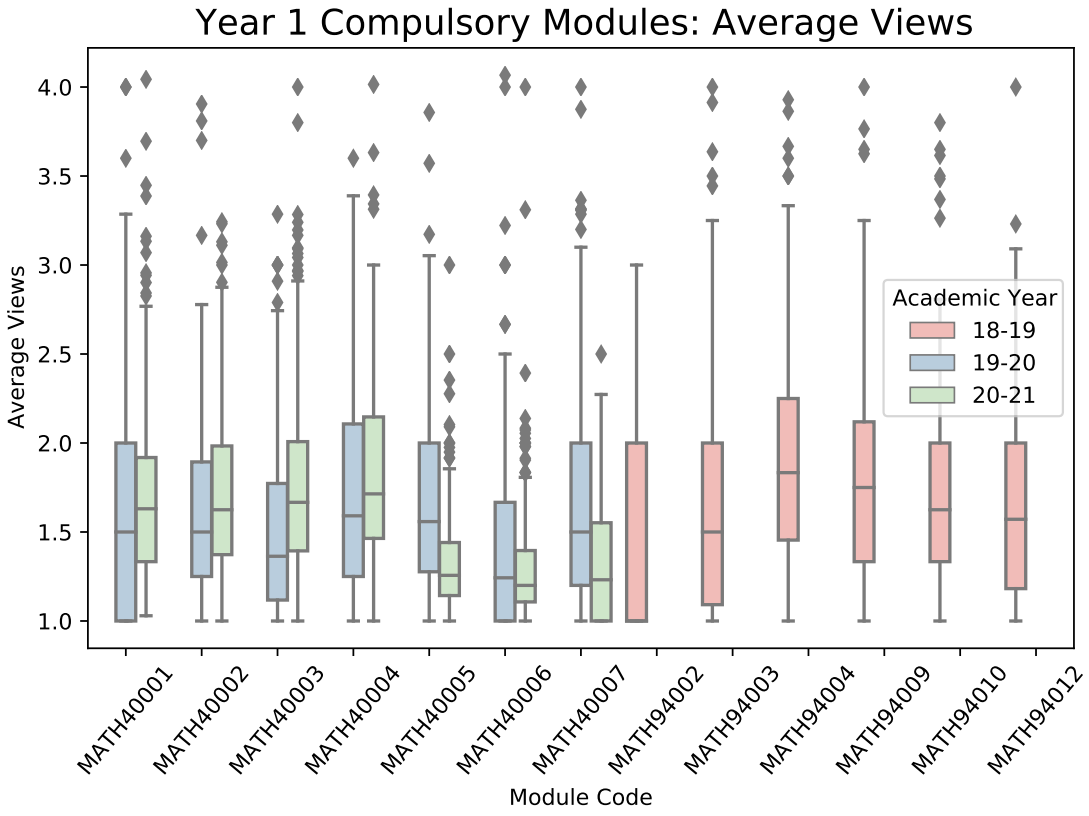

Figure 1: Year 1 compulsory modules by average views per video

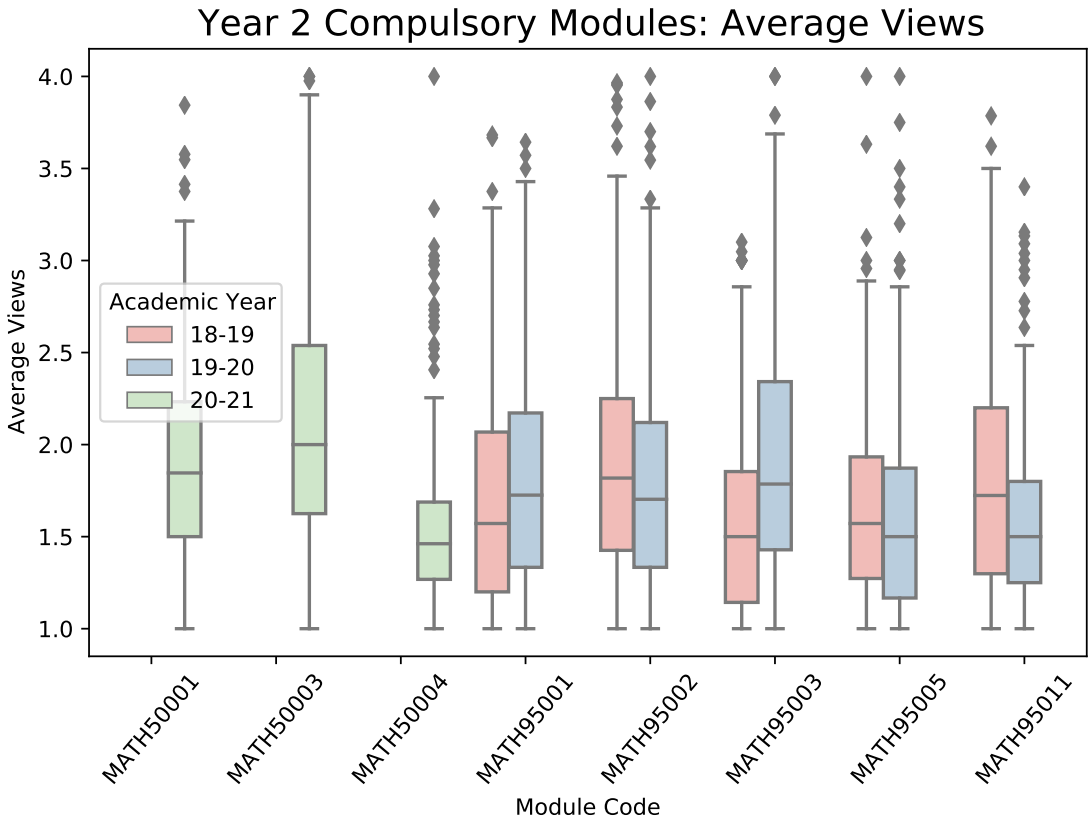

Figure 2: Year 2 compulsory modules by average views per video

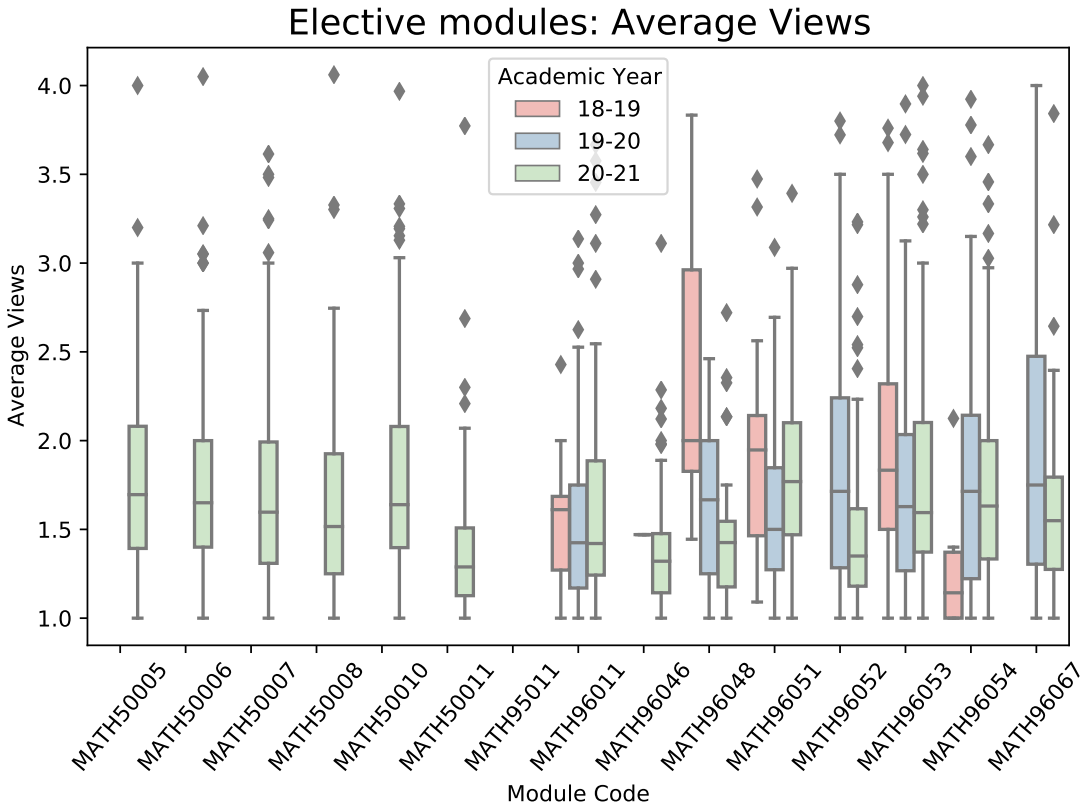

Figure 3: Elective modules by average views per video

One should be careful before interpreting usage patterns between modules; naturally there will be a difference in length of recordings due to lecturer preference (the minutes of lectures they deliver, how many minutes they upload to Panopto etc.). This is further exacerbated in the 20-21 academic year (and the end of the 19-20 year) where lectures were prerecorded hence there were far fewer time restrictions. Therefore overall there is a large diversity in the minutes delivered per module.

Figure 7 contains boxplots pertaining to the compulsory year 1 modules. The afore mentioned discrepancy can be seen in particular with the below modules:

- MATH40007, 20-21
- MATH94002, 18-19
- MATH40006, 19-20
- MATH40001, 19-20
- MATH40003, 20-21

In general there is a large range of data - there is a large range between the watch times of individuals. The exception being MATH94002, 18-19 which is a computational module where minimal emphasis was placed on Panopto.

Similarly Figure 8 shows the year 2 compulsory modules. There is again a large range of minutes delivered within the modules. Most modules have a similar spread of minutes delivered with the exception of:

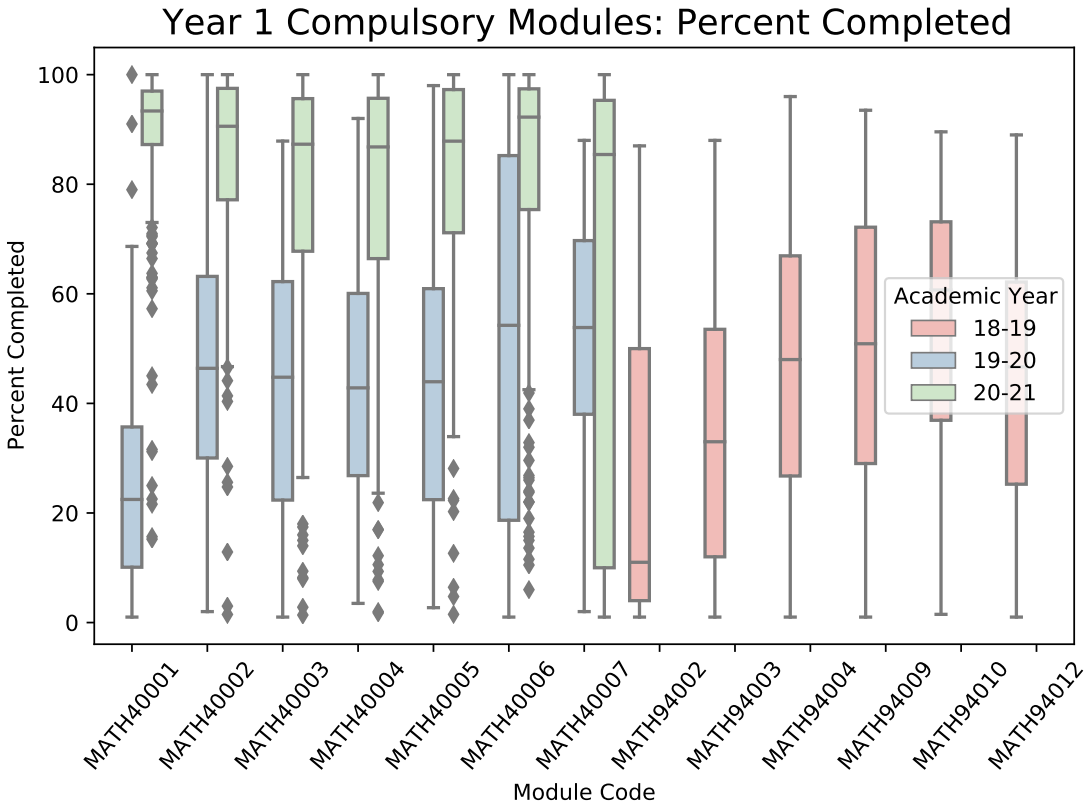

Figure 4: Year 1 compulsory modules by average percent completed

- MATH50001, 20-21
- MATH50003, 20-21
- MATH50004, 20-21

this is due to these modules containing more content (due to the refore of modules) than most others and so naturally are longer.

Figure 9 shows the minutes delivered for all elective modules. The vast disparity between the modules is down to the previously mentioned reasons. Further, it should be noted in the 18-19 academic year MATH96052, MATH96046 did not use Panopto - explaining their lack of data.

Comparing figures 7, 8,9 we can see that very broadly the minutes delivered has increased drastically in the 20-21 Academic year (this is explored further in 13).

6.5.1.4 Compulsory/Elective split of Proportion of last views during term time Now let us compare the proportion of last views during term time between modules:

It should be noted that when considering the last view time, we should expect that modules without end of year exams to have a large (≈ 1) proportion of videos viewed in the term time. This is because there is clearly little motivation for students to watch Panopto Lectures relating to non-assessed or already assessed material in the revision period.

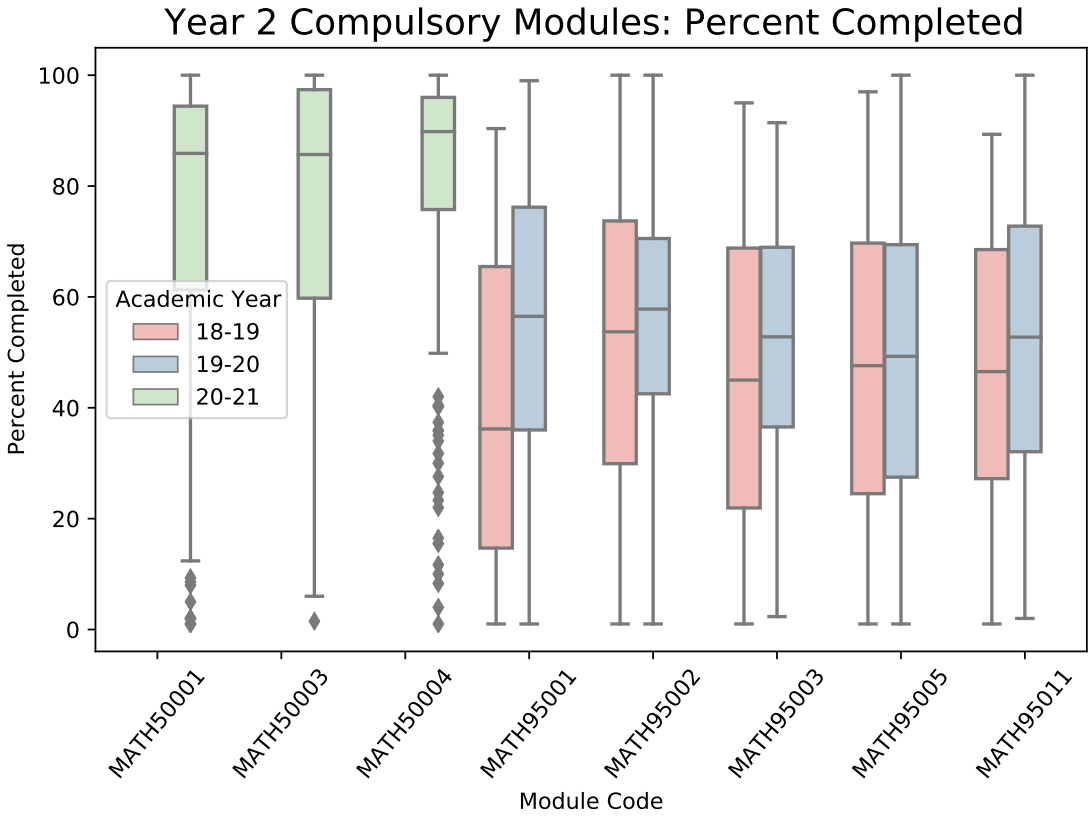

Figure 5: Year 2 compulsory modules by average percent completed

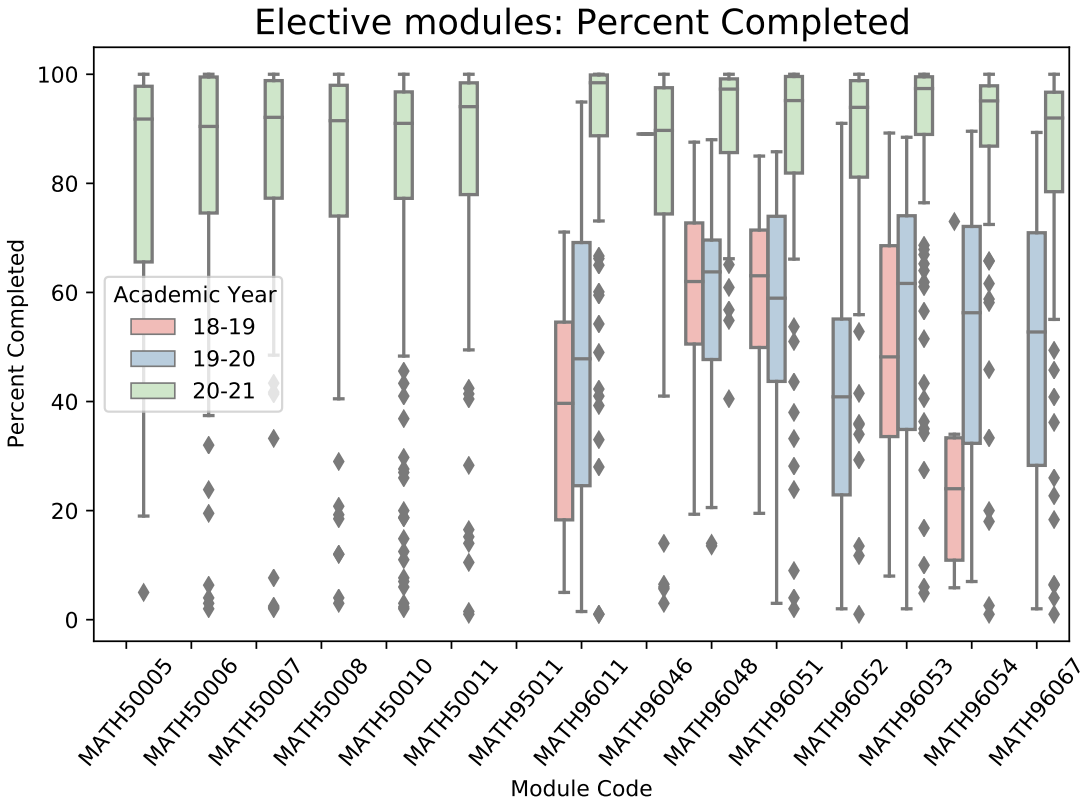

Figure 6: Elective modules by average percent completed

Looking at Figure 10, most modules have a wide spread of individuals last watching a lectures in term time/ revision period, with the median generally skewed to towards last viewing in term time.

The below modules are an exception to this, being almost exclusively viewed in term time:

- MATH40006, 19-20 and 20-21
- MATH40001, 19-20 and 20-21
- MATH94002, 18-19

This is because these modules constitute coursework only or non examinable content only, that is they have no summer exams.

Now let us look at year 2 compulsory modules (Figure 11). Similarly to as with the compulsory year 1 modules there is a variety- between individuals watching in term time and in the revision period with the median towards the term time period. This is likely down to the difference in study styles do to students.

Surprisingly

- MATH50003, 20-21

Has almost every view within the term time.

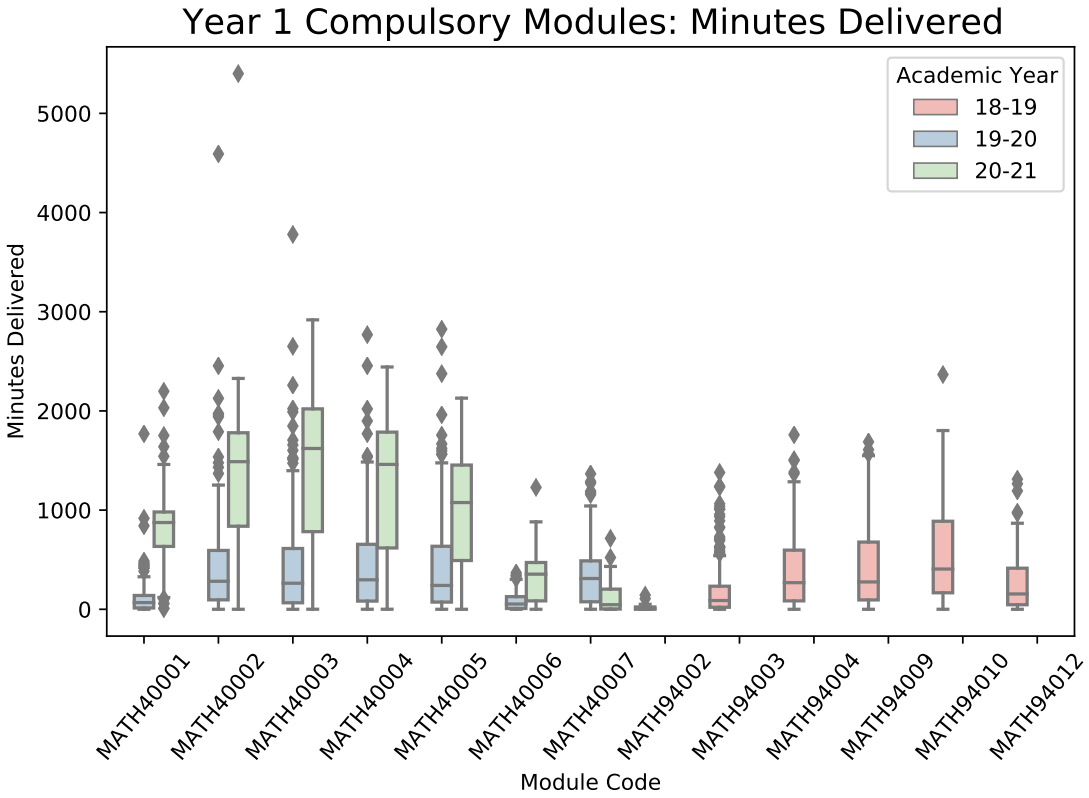

Figure 7: Year 1 compulsory modules by Minutes Delivered

Figure 12 of the elective modules, draws a similar conclusion as to Figures 10, 11. There are some modules that are viewed predominantly in the revision period. This is likely because elective modules are mainly year 3 modules, which provides a heavier workload, including term 2 coursework modules, whereby students can find themselves behind and therefore having to catch up on modules in the revision period.

6.5.2 Panopto data: overview

Figures 13 to 16 provide more general overviews of the Panopto data.

In all the subplots of Figure 13, the violin from academic years 18-19 and 19-20 follow similar shapes, while in the 20-21 academic year, there was a decrease in the average number of views per video, and an increase in 'percent completed', 'minutes delivered' and proportion of videos last viewed in term time.

There were significantly more minutes of lectures delivered per module per person in 20-21 than 18-19 and 19-20. Since lectures were also delivered in-person in 18-19 and 19-20, the Panopto lecture videos may have been viewed more as 'supplementary' material, compared to 20-21, when Panopto was the only source of lectures available. The increase may also be due to a curriculum change that meant modules worth 5 ECTS made up a larger proportion of data in 18-19 and 19-20 than in 20-21.

A hypothesis for the remaining three covariates may be as follows: students may have previously used Panopto videos as revision material rather than learning

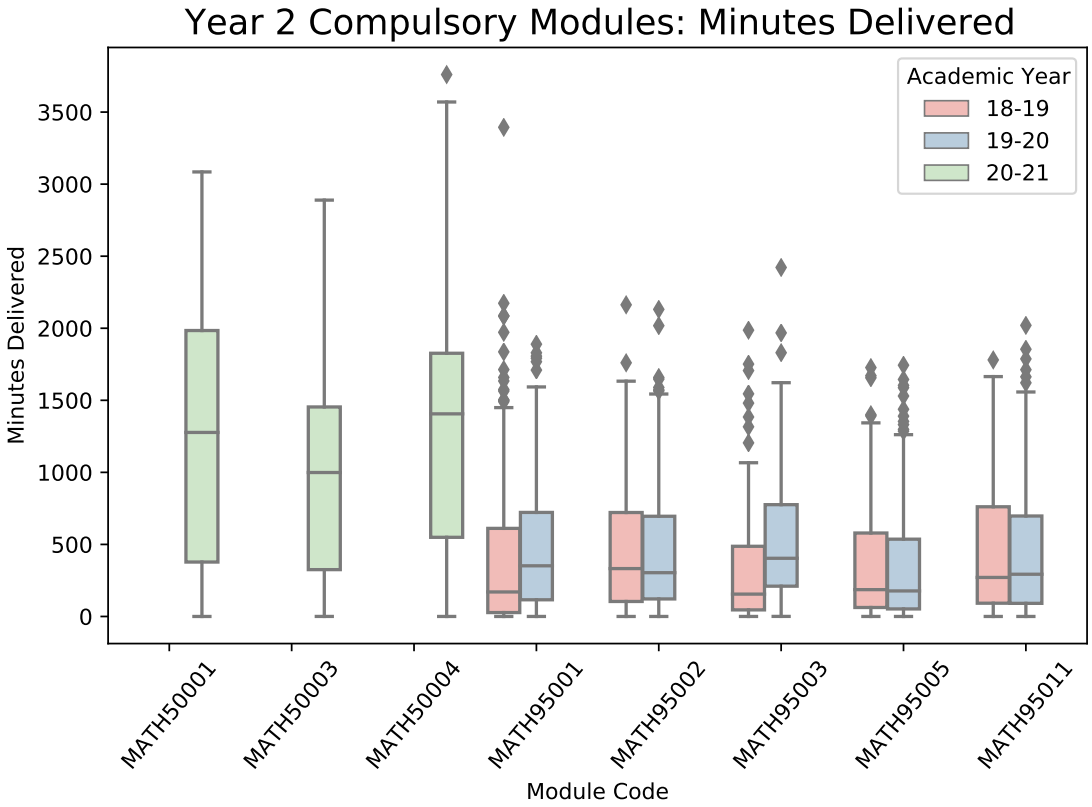

Figure 8: Year 2 compulsory modules by Minutes Delivered

content. This would lead to a lower percent completion and higher average view count as students click through the videos to get an idea of what they are about, rather than watching it in full

Figure 14 shows the number of hours students spend on a module in blackboard and Panopto, weighted by ECTS. The first plot includes points 1.5 times the interquartile range above the third and below the first quartile while the second plot does not.

Students used blackboard significantly more in 19-20 and 20-21 than in 18-19, which could be due to an increased focus on using online resources and assessment approaches.

The violin plots in Figure 15 group the data in Figure 13 by compulsory and elective modules. One trend across all three academic years is that students are more likely to watch a Panopto video for an elective module during the 'revision period' than a compulsory module. Students may have been catching up on lectures during the revision period due to taking other electives with a large coursework component.

Figure 16 shows that one trend across all three academic years is that students are more likely to use the Panopto lecture videos during the 'revision period' as they progress into higher years. This may be due to the increasing number of elective modules (see Figure 15) in higher years. There also tends to be more minutes of lecture videos delivered for compulsory modules than electives. This may be because electives are more likely to have specialised content that is not delivered through

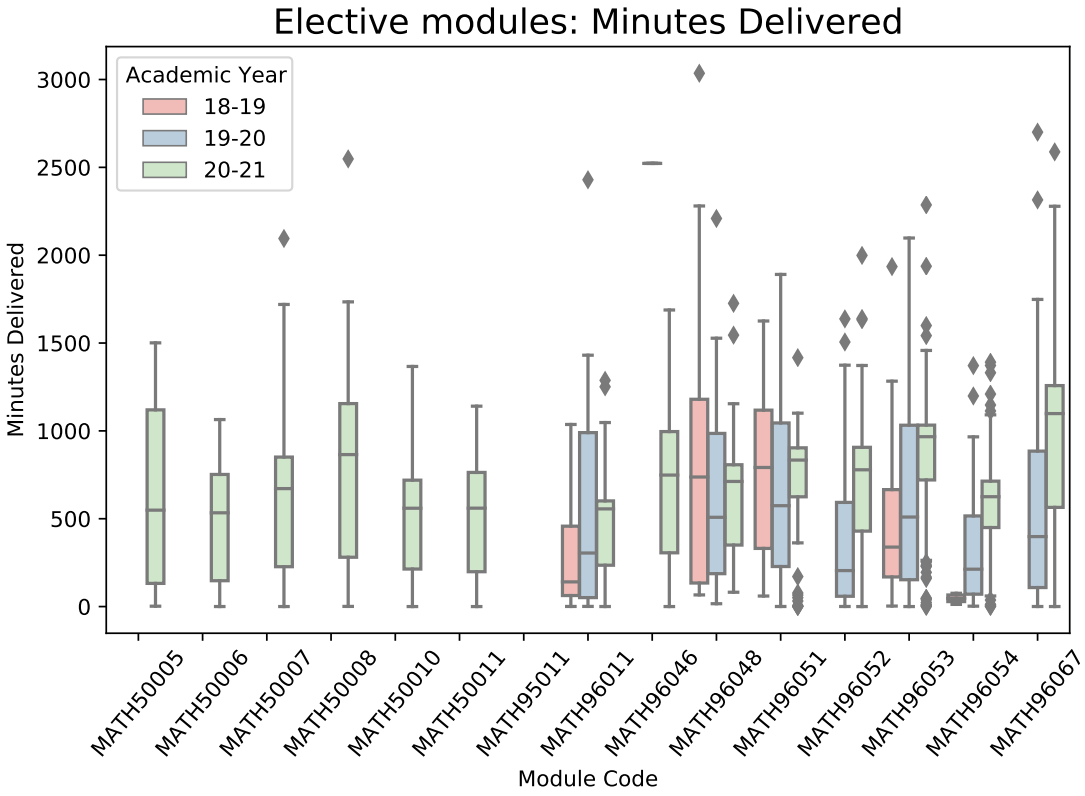

Figure 9: Elective modules by Minutes Delivered

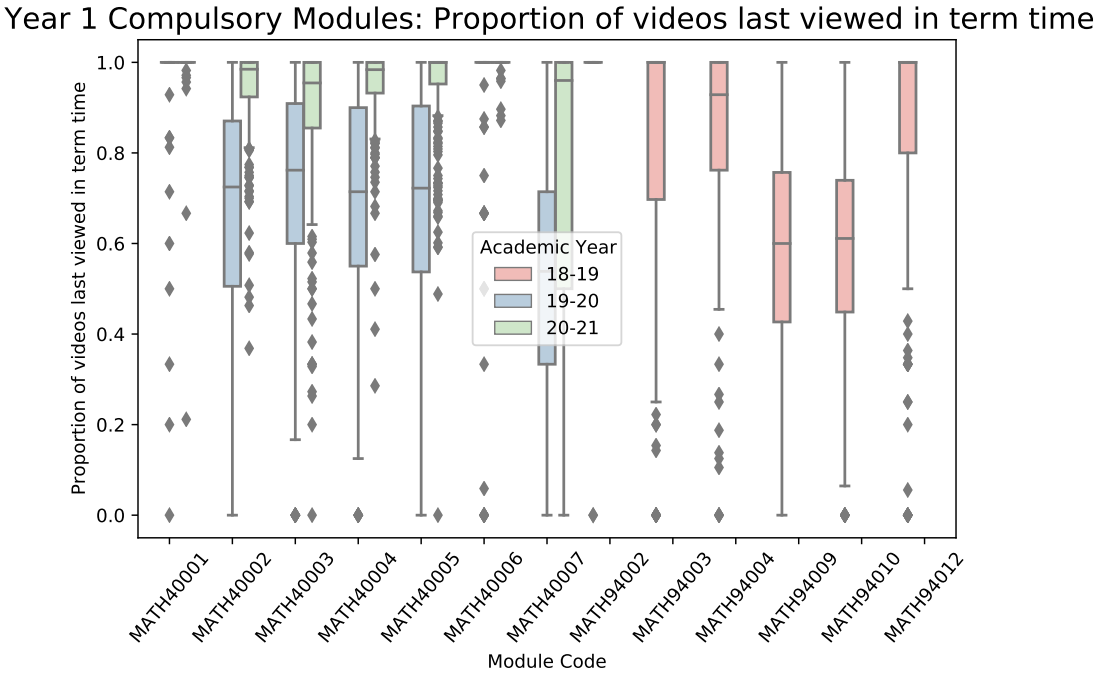

Figure 10: Year 1 compulsory modules by proportion of videos last viewed during term time

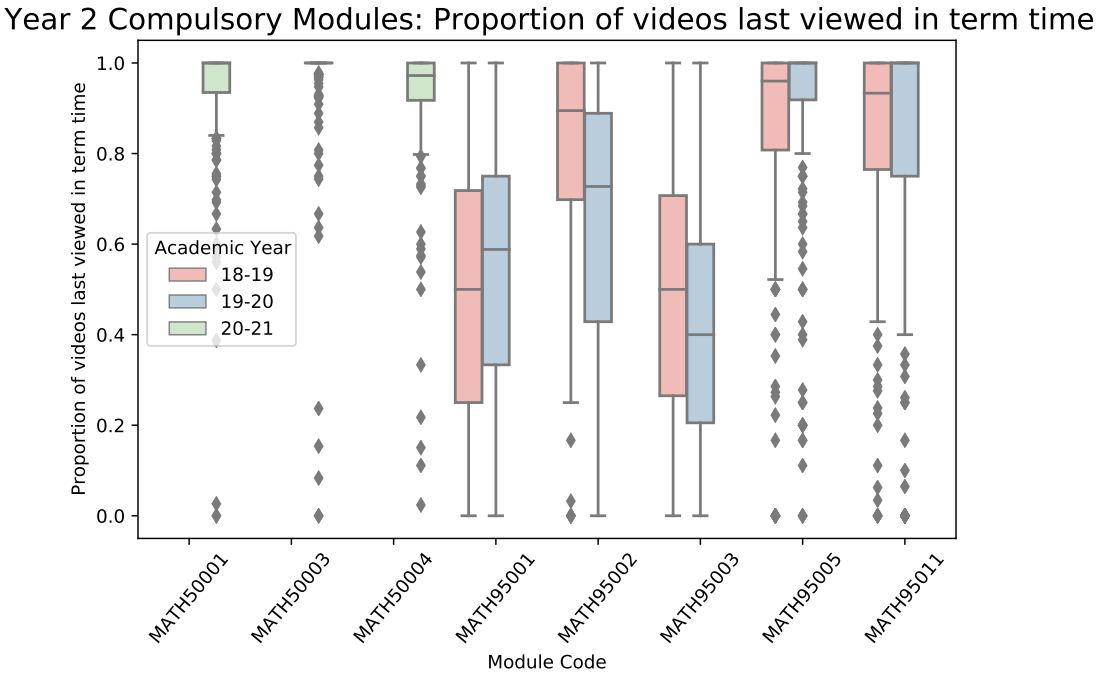

Figure 11: Year 2 compulsory modules by proportion of videos last viewed during term time

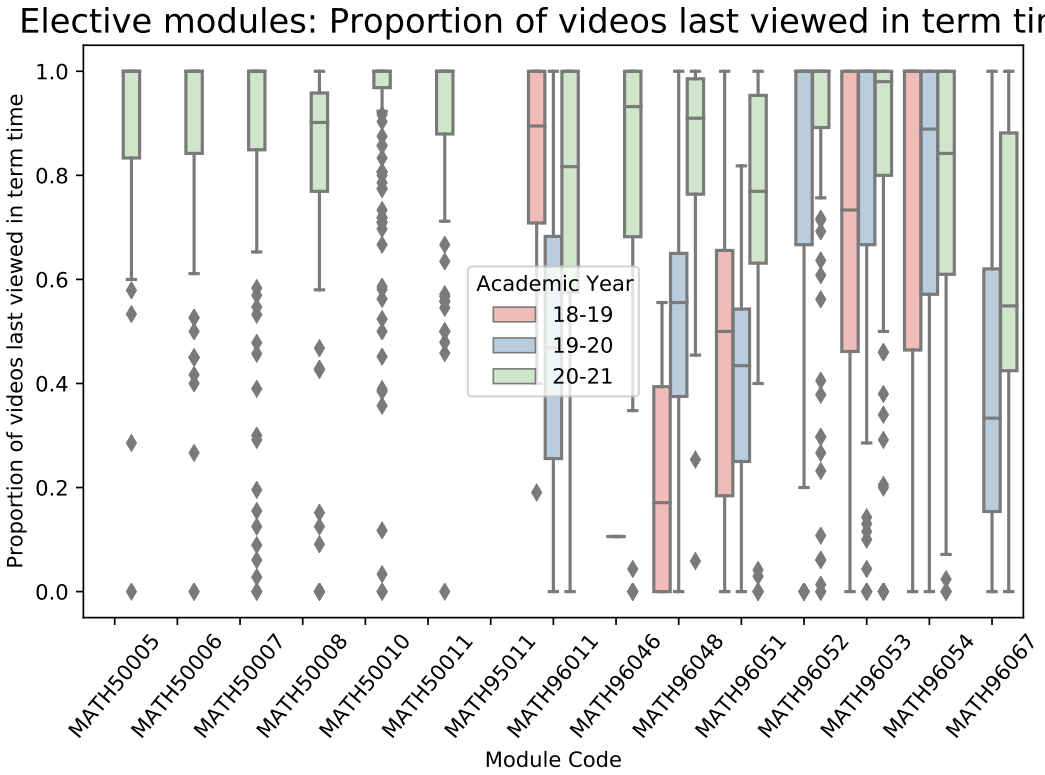

Figure 12: Elective modules by proportion of videos last viewed during term time

lectures, such as a practical computing component.

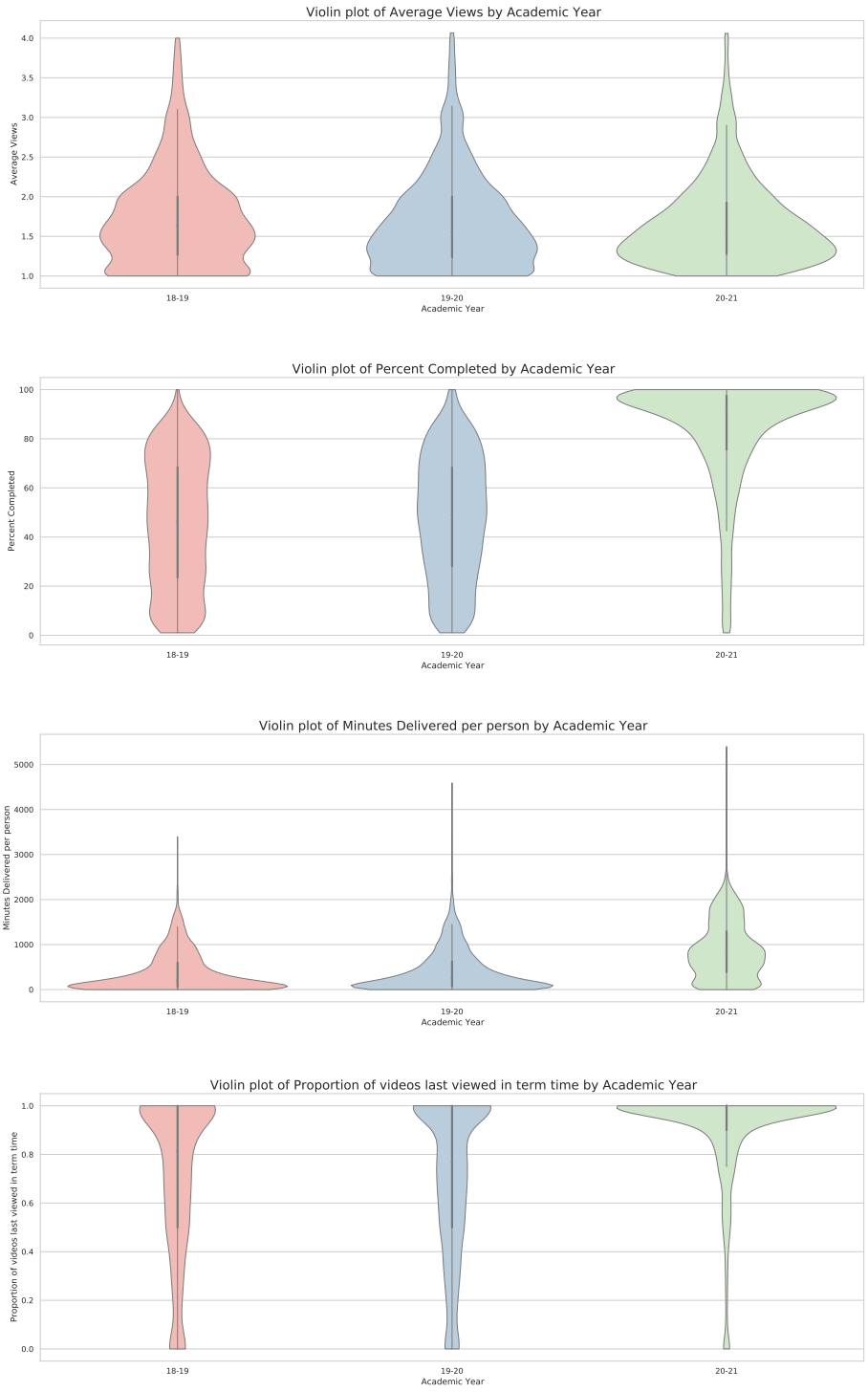

Figure 13: Violin plots of Panopto data

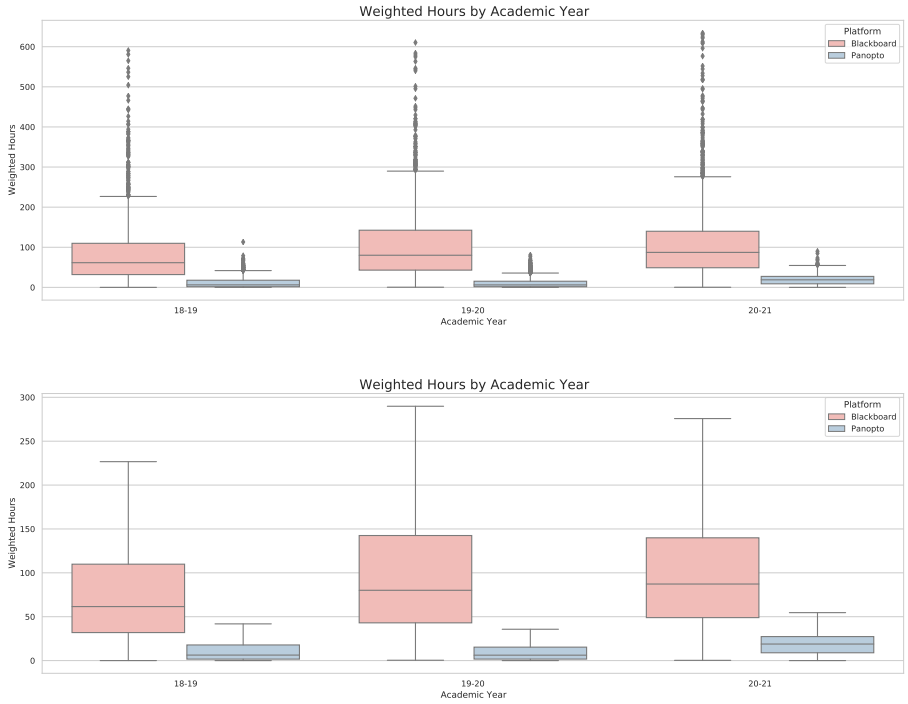

Figure 14: Hours in Blackboard and Panopto, weighted by ECTs

6.5.3 Blackboard

Figures 17 to 22 provide a module-by-module breakdown of the number of hours students spend in Blackboard.

Figure 17 shows that students spend roughly half the time on modules that are worth 5 ECTS compared to modules that are worth 10 ECTS, with the exception of MATH40001 (Introduction to University Mathematics). This may be because students are particularly motivated for the first course of their university studies, or by the pass mark for the module being higher at 50% (compared to 40% in all other modules). Comparing the same modules in 19-20 and 20-21, students seem to spend more hours on Blackboard in 19-20. This may be due to the 19-20 data including the additional hours resit students spend revising on blackboard over the summer holiday. Additionally, in 20-21, students may have chosen to spend some of their 'online learning' time on other newly offered platforms, such has piazza and online office hours, rather than on blackboard.

Figure 18 shows that a lot more time was spent on Blackboard in the academic year 20-21 than 18-19 and 19-20. There is a small increase from 18-19 to 19-20.

Compared to Figure 19, we can see that students spent around 1.5 times more hours on Blackboard on compulsory modules (worth 10 ECTS) than elective modules (worth 5 ECTS).

Looking at Figure 19, most modules have a wide spread of hours spent on Blackboard. Students in the 18-19 academic year tended to spend less time on Blackboard than in 19-20 and 20-21, likely due to the shift to blended/remote learning in these latter years. However, for some modules, students spent more time on Blackboard

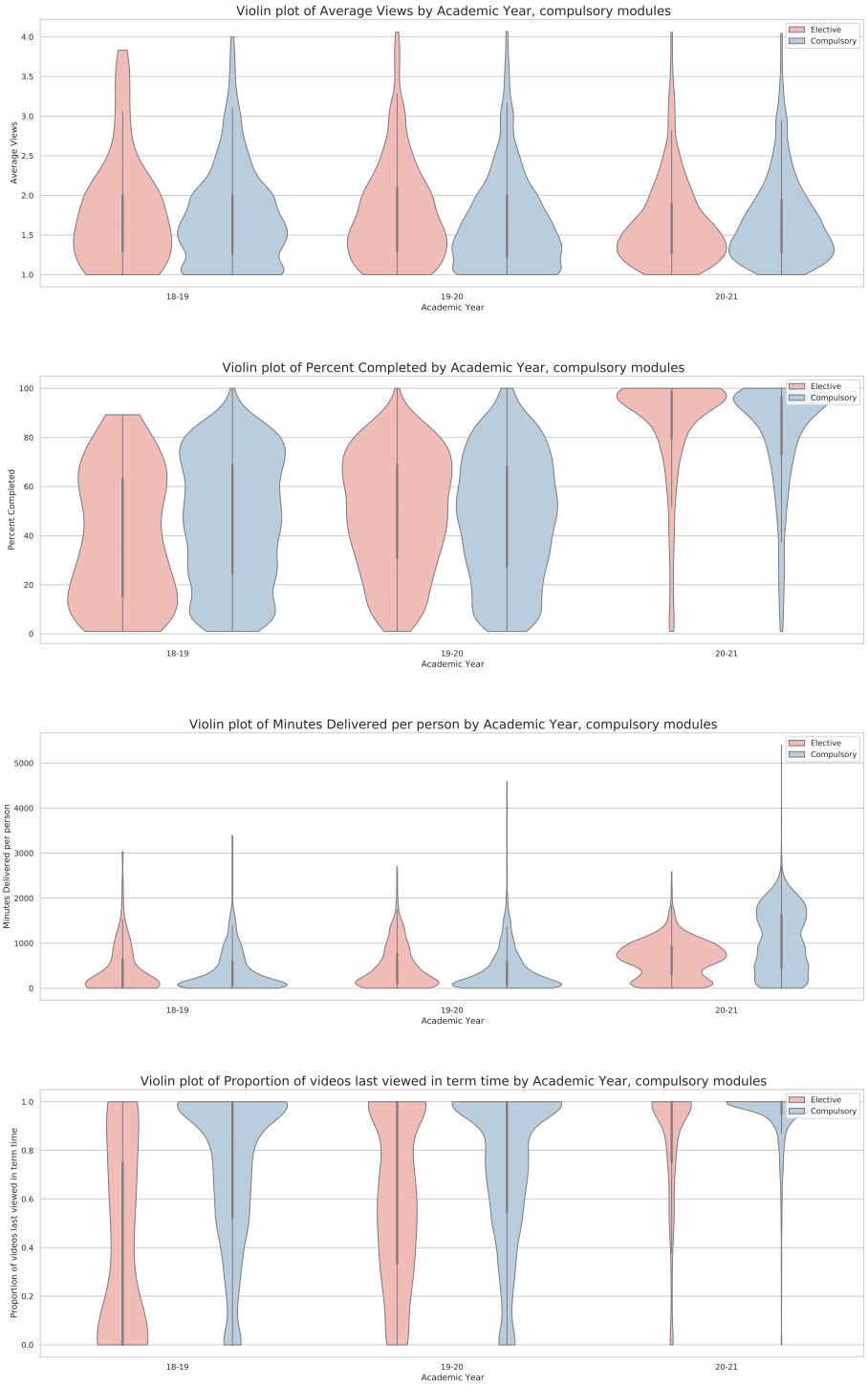

Figure 15: Violin plots of Panopto data split by academic year and elective/compulsory modules

in 19-20 than in 20-21. This could be due to the wider variety of online resources made available in 20-21.

In Figure 20, we can see that the number of hours spent on Blackboard was

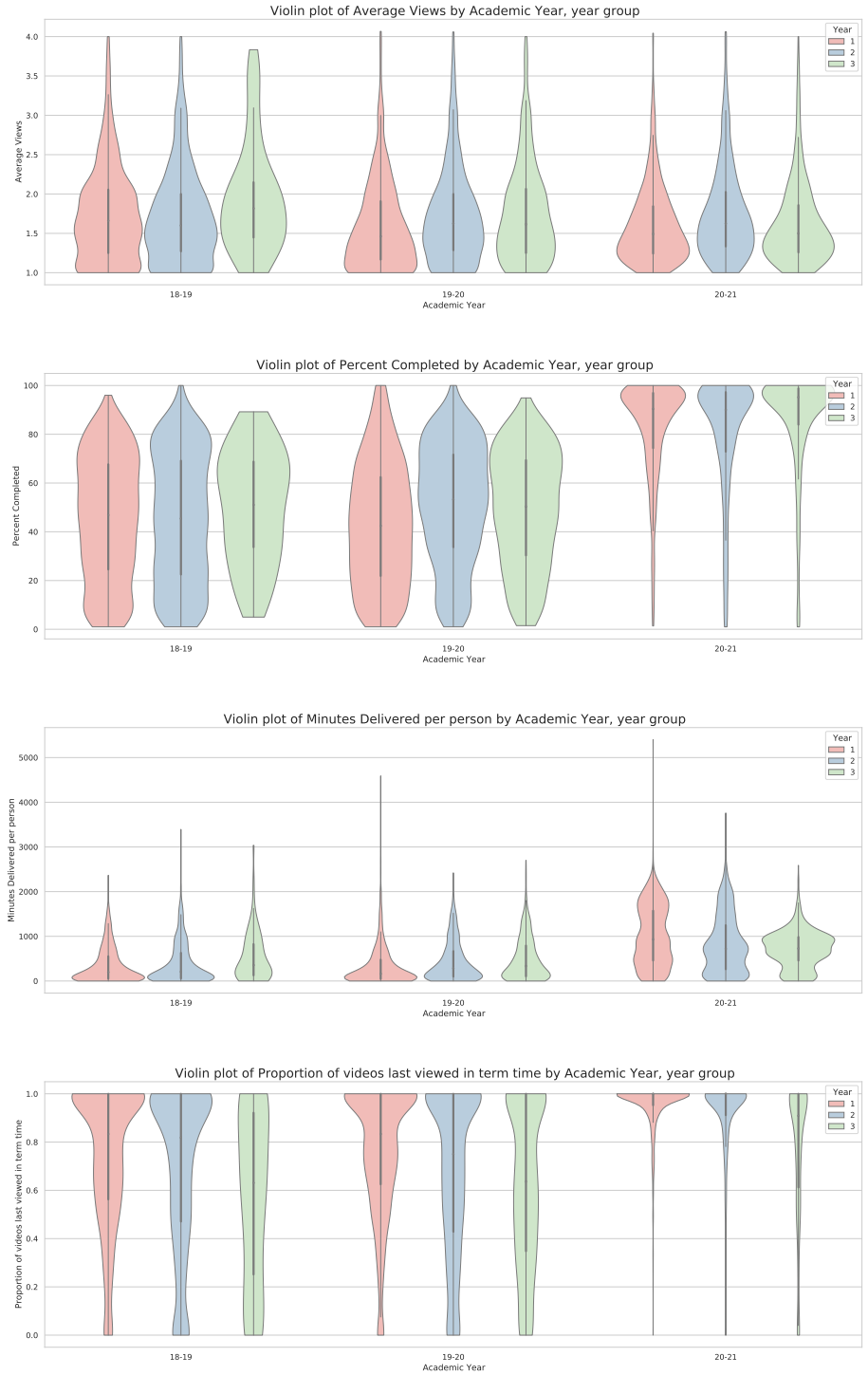

Figure 16: Violin plots of Panopto data split by academic year and year group

slightly higher in the 19-20 academic year than in 18-19 and higher still in the 20-21 academic year. The small increase from 18-19 to 19-20 can likely be attributed to the shift from in-person to remote learning in March of 2020. The further and larger increase from 19-20 to 20-21 can be attributed to the fully remote/online learning

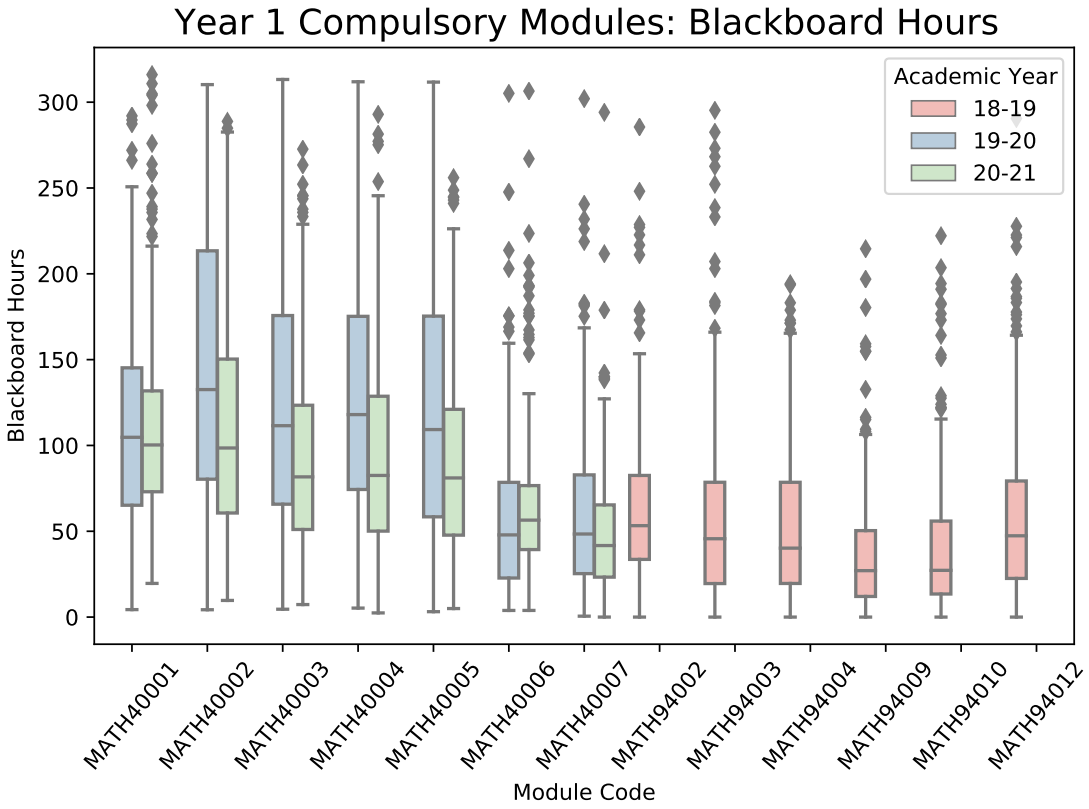

Figure 17: Year 1 compulsory modules by hours on Blackboard

taking place in the 20-21 academic year (compared to only a few months in the 19-20 academic year).

As we might expect, Figure 21 shows that students spend more time on Blackboard pages for their compulsory modules than on the pages for their elective modules. It is also worth noting that time spent on Blackboard for both compulsory and elective modules increased from 19-20 to 20-21. The increase from 18-19 to 19-20 seems to be due to an increase in time spent on Blackboard only for compulsory modules.

Figure 22 shows that year 1 students spent more time on Blackboard than year 2 and year 3 students in all three academic years, perhaps because extra time spent on Blackboard is less useful for the more complex modules taught in later years. The time spent on Blackboard for all three year groups increased from 19-20 to 20-21. The overall increase in time spent on Blackboard from 18-19 to 19-20, however, seems to be only as a result of year 1 students spending more time on the platform.

From these three violin plots (Figures 20, 21, 22), we can gather that student engagement with Blackboard has increased over the last two academic years. Of course, this can largely be attributed to the increasing proportion of material delivered online due to COVID-19.

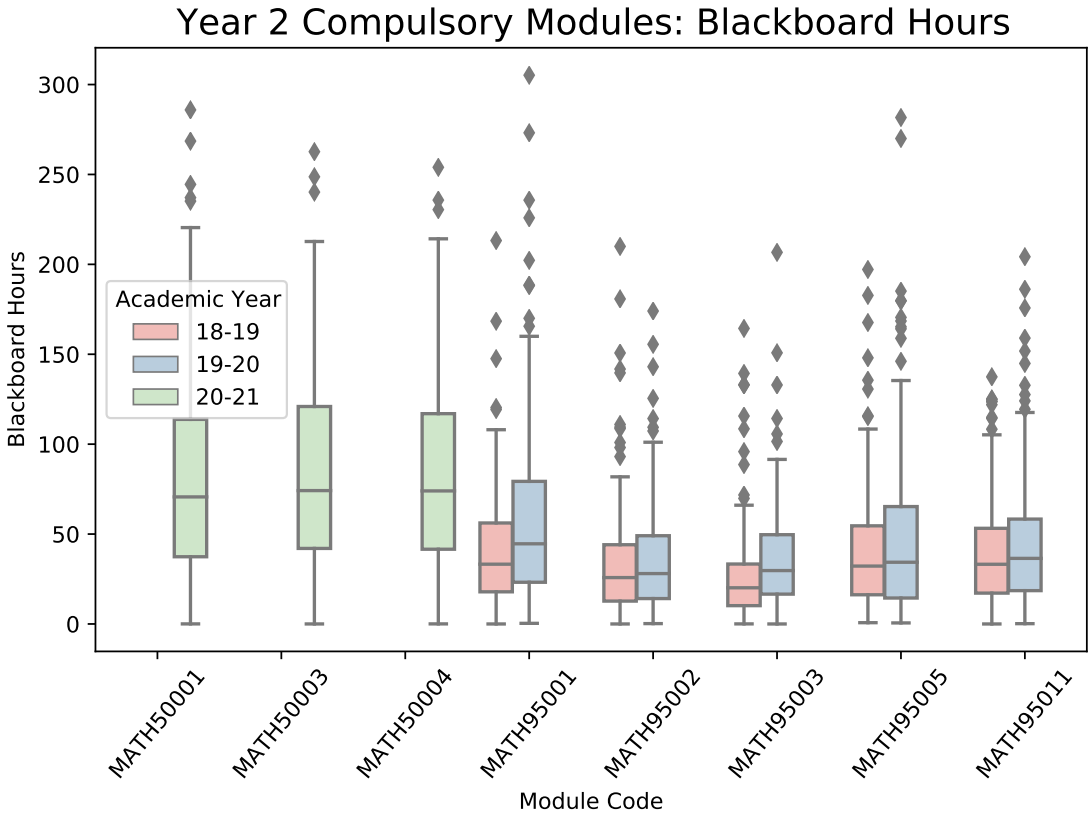

Figure 18: Year 2 compulsory modules by hours on Blackboard

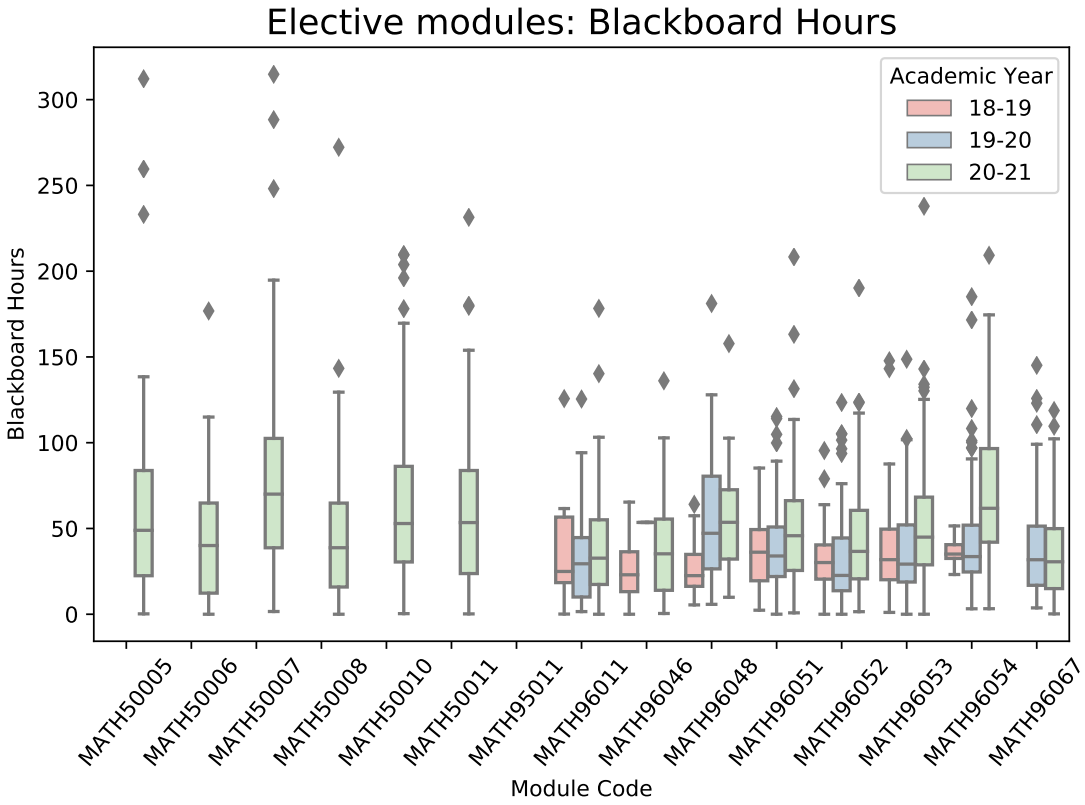

Figure 19: Elective modules by hours on Blackboard

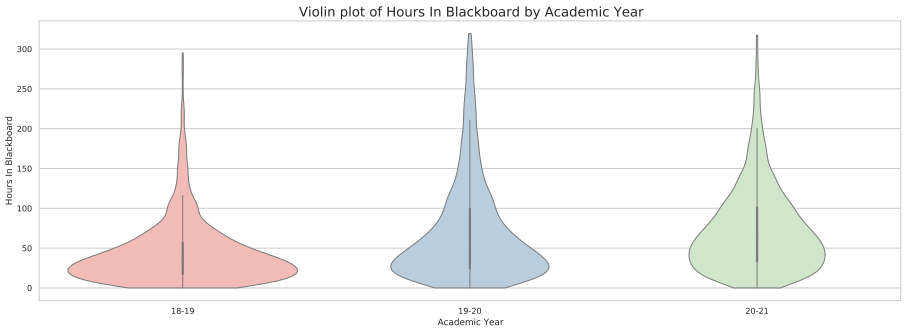

Figure 20: Violin plots of hours spent on Blackboard pages split by academic year

6.5.4 Piazza

Figure 23 shows violin plots of four fields of data for Piazza split by year group. The first plot shows that the vast majority of students in all three year groups do not answer many questions on the platform. Most answers given by students can be attributed to a very small number of individuals. We can see in the second plot that the usage of Piazza by students is relatively similar between year groups when looking at days online. The third plot, however, shows that the range of posts viewed is highest in year 1 and lowest in year 3. The median number of posts viewed is similar for all year groups. Interestingly though, the fourth plot suggests that year

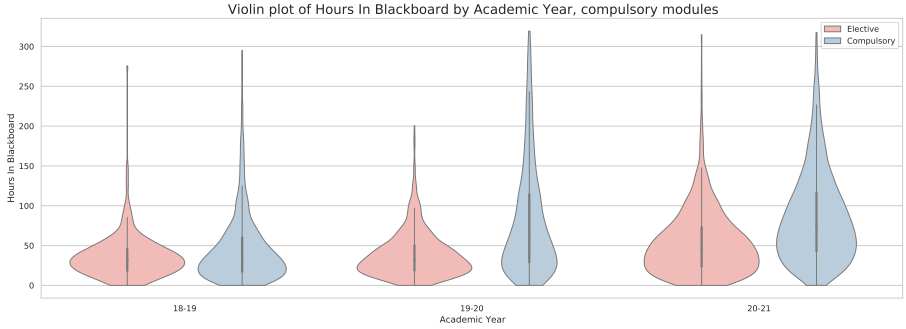

Figure 21: Violin plots of hours spent on Blackboard pages split by academic year and elective/compulsory modules

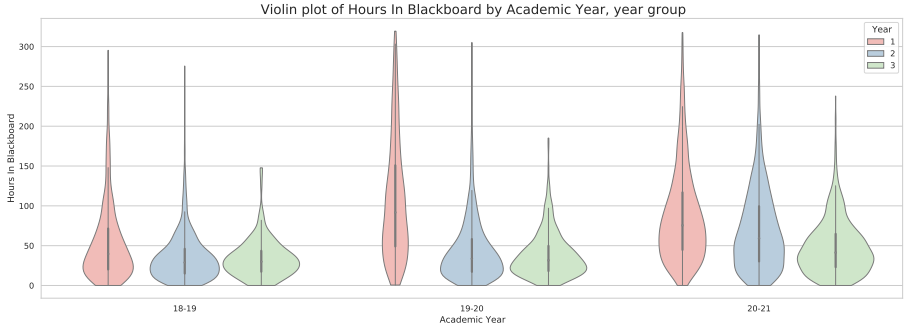

Figure 22: Violin plots of hours spent on Blackboard pages split by academic year and year group

3 students tend to post more than students in either of the other two year groups. This, combined with the third plot, could be an indication that, relative to the other two year groups, the students in year 3 are more interested in the questions that they themselves asked rather than questions asked by other students, perhaps due to the specific and individual nature of questions asked in advanced modules. These four plots collectively show that student engagement with Piazza did not vary significantly between year groups.

Figure 24 shows violin plots of a different four fields of data for Piazza, this time split by elective/compulsory modules. The first plot shows that the number of edits to answers given by students is very similar between compulsory and elective modules. From the second plot, we can see that there are many more edits made to posts in elective modules than compulsory modules, although it is unclear why. The third and fourth plots suggest that the distributions of the number of followups written and the number of 'good question' reactions given, respectively, are very similar between elective and compulsory modules. As a whole, these violin plots suggest that Piazza engagement did not vary significantly between compulsory and elective modules.

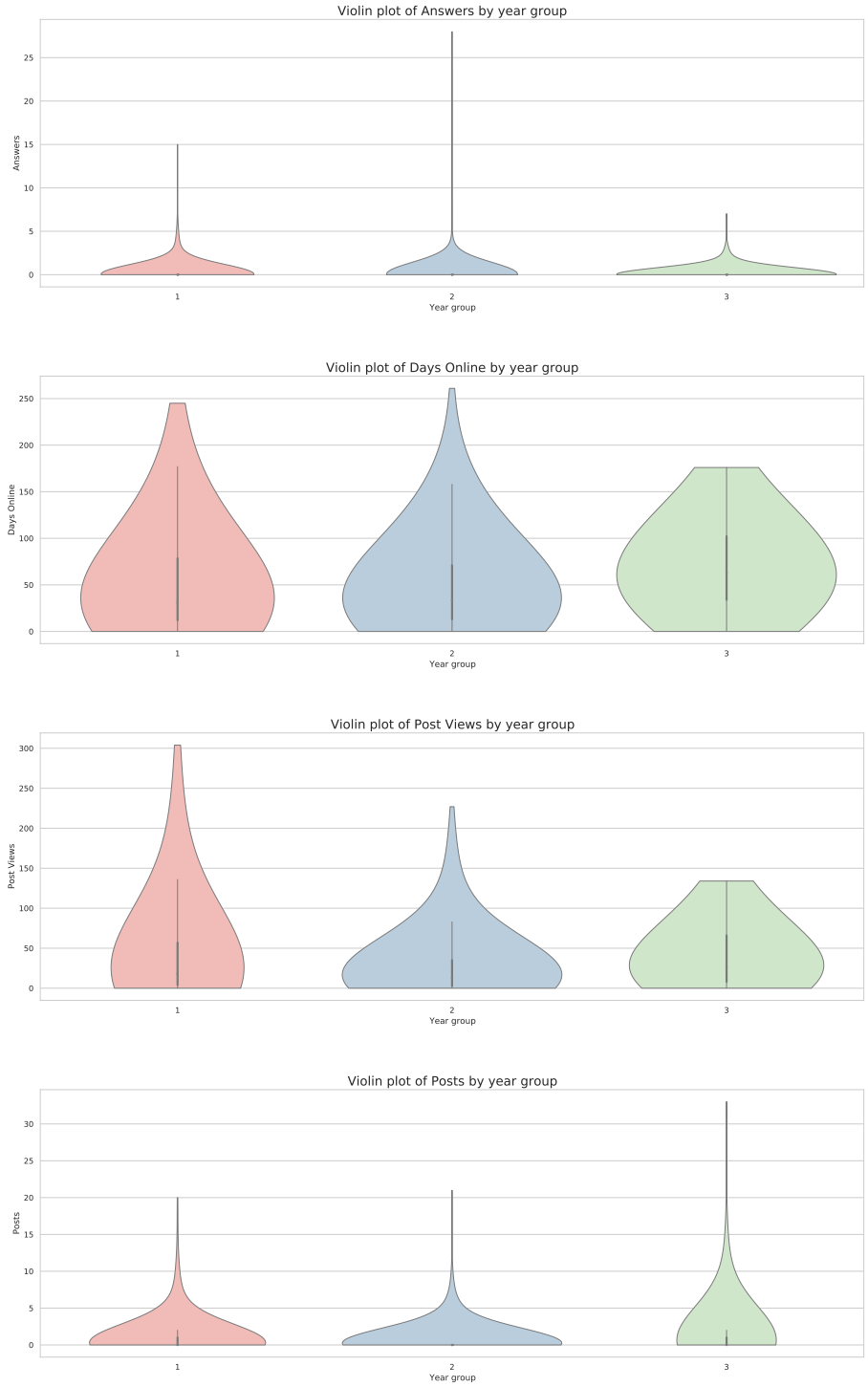

Figure 23: Violin plots of Piazza data split by year group

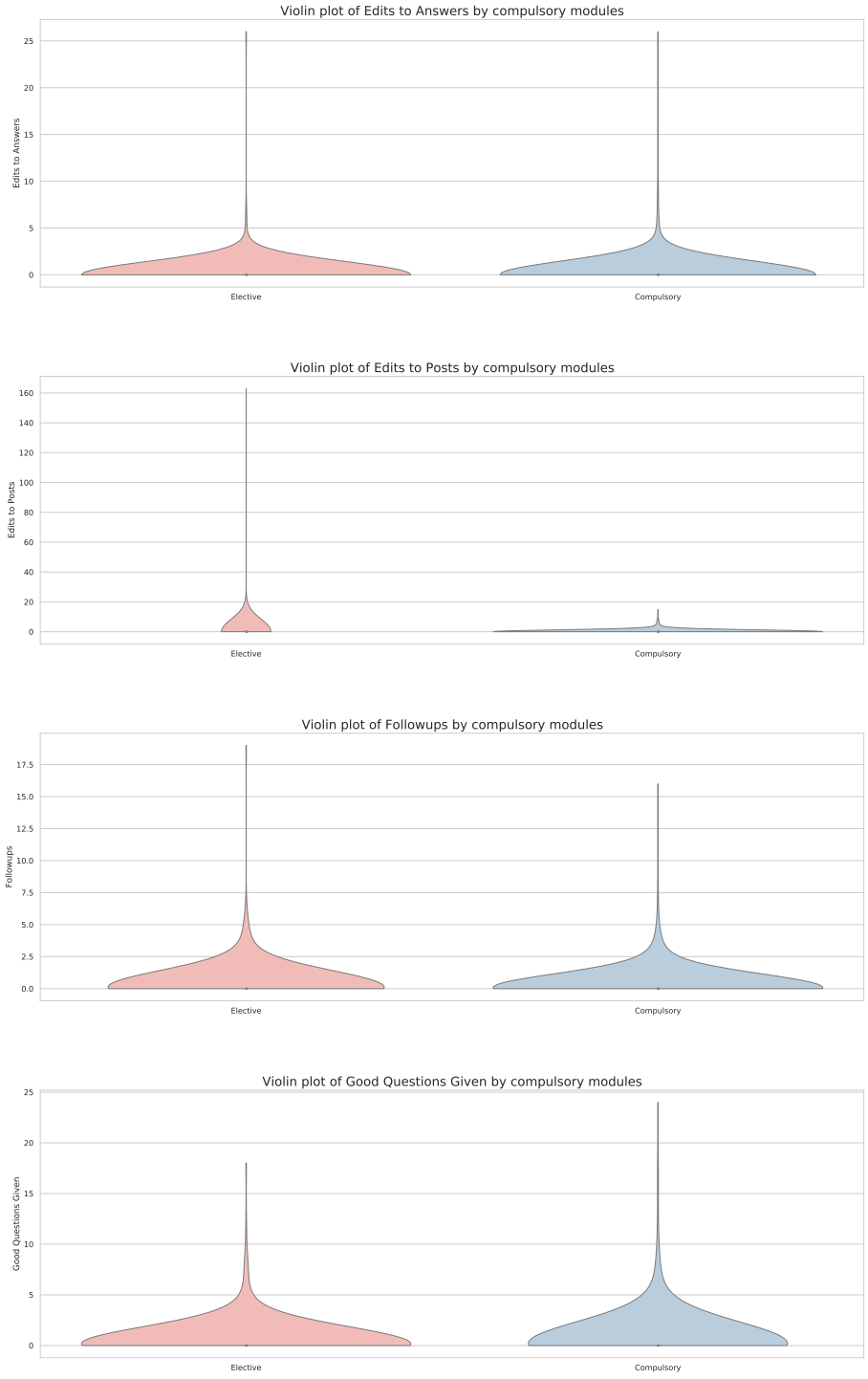

Figure 24: Violin plots of Piazza data split by elective/compulsory modules

7 Conclusion

7.1 Panopto

Despite the shift towards blended learning, the distribution of average views appear similar through academic years 18-19 to 20-21. As expected, looking at the 20-21

academic year, many more students are watching videos to completion. Overall, students are also watching more minutes of Panopto for each module, compared to the previous two years. Furthermore, a larger proportion of lecture videos were watched during the 'term period' rather than the 'revision period' during 20-21. This is not surprising since in academic year 20-21 there is no direct alternative (in person lectures) to watching lectures on Panopto. The influence of the year the student is in and whether a module is elective or compulsory on the distribution seem to decrease on the covariate 'percent completed', but increase for the covariates 'minutes delivered' and 'proportion of videos last viewed in term time' in 20-21.

7.2 Blackboard

As we might expect, student engagement with Blackboard has widely increased as a result of the shift towards blended learning since 18-19. All three year groups exhibited greater use of the platform during the fully online learning of 20-21 than in previous academic years for both compulsory and elective modules.

7.3 Piazza

Since Piazza was only introduced in the 20-21 academic year, we cannot compare student engagement to previous years. Our analysis showed that students from all year groups engaged with Piazza to a similar extent, and students engaged with compulsory and elective modules to a similar extent on Piazza. However, the data indicates that third year students perhaps use Piazza slightly more than first or second year students (seen by considering the modes in Figure 23).

7.4 Further exploration

Due to the time constraints imposed by this project we were unable to explore all aspects regarding blending learning.

If we could explore this project further, it would be useful to consider holistic effects on blended learning. For example, how it affects the social experience of students, and whether certain groups of students are more negatively affected by blended learning. The majority of higher education institutions offering blended learning is in direct response to COVID-19. According to Quach [16], it is expected that "the social isolation caused by the pandemic will have a disproportionate impact on women and racial minorities". Surveying students on their access to appropriate equipment and study space could lead to some insightful findings.

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A Appendix

Tables 1 to 4 contain summary statistics pertaining to the data.

	Id	Module Title	Academic Year	Average views	Minutes Delivered	Percent Watched	Proportion of last views during term time	Module Code	Hours on Blackboard	Year group	Compulsory (binary)
count	10556.0	10556	10556.0	8958.0	8958.0	8958.0	8958.0	10482	10067.0	10556.0	10556.0
unique	1076.0	35	3.0					37		3.0	2.0
top	11609.0	Analysis 1	2020.0					MATH40007		1.0	1.0
freq	19.0	680	4166.0					497		4608.0	7802.0
mean				1.693	601.969	61.683	0.783		65.47		
std				0.588	581.856	29.714	0.29		56.774		
min				1.0	0.018	1.0	0.0		0.0		
25%				1.25	116.567	38.089	0.636		24.825		
50%				1.569	436.56	66.824	0.933		48.88		
75%				2.0	931.534	88.742	1.0		88.881		
max				4.067	5400.696	100.0	1.0		319.369		

Table 1: Summary Statistics All Data (after pre-processing)

	Average views	Average Minutes Delivered Per Person	Average Percent Watched	Proportion of last views during term time	Average Hours on Blackboard
count	1903.0	1903.0	1903.0	1903.0	1957.0
mean	1.688	571.637	60.498	0.763	61.591
std	0.448	477.707	26.657	0.225	45.577
min	1.0	0.103	1.0	0.0	0.0
25%	1.375	159.929	39.775	0.653	28.64
50%	1.595	448.668	60.097	0.812	49.372
75%	1.948	895.745	84.398	0.951	82.975
max	3.889	3035.6	100.0	1.0	317.561

Table 2: Summary Statistics grouped by Individual

	Average views	Average Minutes Delivered Per Person	Average Percent Watched	Proportion of last views during term time	Average Hours on Blackboard	Class size
count	62.0	62.0	62.0	62.0	64.0	66.0
mean	1.694	554.283	59.646	0.738	58.27	165.53
std	0.2	304.363	19.565	0.198	28.632	80.78
min	1.302	18.415	13.991	0.074	25.016	8.0
25%	1.577	389.197	46.581	0.598	38.068	92.0
50%	1.703	479.802	53.596	0.802	48.884	204.0
75%	1.806	669.285	80.804	0.886	65.585	230.75
max	2.389	1404.682	89.012	0.998	148.362	267.0

Table 3: Summary Statistics grouped by Module

	Average views	Average Minutes Delivered Per Person	Average Percent Watched	Proportion of last views during term time	Average Hours on Blackboard
count	3.0	3.0	3.0	3.0	3.0
mean	1.7	559.674	58.543	0.767	63.29
std	0.036	275.027	20.498	0.114	16.304
min	1.671	383.231	45.528	0.696	44.487
25%	1.68	401.227	46.729	0.701	58.192
50%	1.688	419.223	47.929	0.706	71.897
75%	1.714	647.895	65.05	0.802	72.692
max	1.74	876.567	82.171	0.899	73.486

Table 4: Summary Statistics grouped by Academic Year

The code used to analyse the data can be found at: https://colab.research.google.com/drive/1zkH0cojRs3fLXCqM9N7f7MkVzLHgXpwC?usp=sharing (last updated 01/08/2020).