STUDENT STUDY HABITS AS INFERRED FROM ON-LINE WATCH DATA

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ABSTRACT

This paper examines on-line watch data for three different Mechanical Engineering courses. The results indicate that positive benefits can be derived from flipped delivery if newly available lecture time is used to increase the amount of formative assessment in the course. Students are found to study more often in the afternoon and evening than they are in the morning, a trend that exists for both weekdays as well as weekends. Evidence of prioritization is given where students are able to adjust content viewing and study time in relation to the demands placed on them by all of the courses that they are taking in a given semester.

KEYWORDS

Blended Learning, On-line Delivery, CDIO Standards 10 and 11

INTRODUCTION

The general concept of distance learning and video lectures is not new: for example, the Open University (McAndrew and Scanlon, 2013) has been using this approach for the past 50 years. However, recent advances in video and on-line technology, along with the decreasing cost of this technology, have made this approach much more accessible to teaching faculty. The most well-known contribution to this area in recent years has been the "massive open on-line course" or MOOC (Pappano, 2012), whereby students view relatively traditional lectures by a prestigious professor through an on-line forum (an example of this approach is Harvard's introductory computer science course: CS 50).

Although on-line delivery has generated much interest in higher education, institutions still struggle with its implementation (Bates, 2010). In particular, there is a growing consensus that on-line learning in isolation can be problematic with respect to student completion and student assessment (Dutton et al., 2011). However, when on-line modules are combined with in-class activities, the resulting hybrid approach has been shown to greatly enhance student learning (Peercy and Cramer, 2011; U.S. Department of Education, 2011). As a result, there has been interest in hybrid learning techniques such as "flipped" learning (Al-Zahrani, 2015) where on-line lectures are used to open up time for more meaningful activities during the in-person sessions (e.g., discussions, case studies, projects, problem-solving sessions, etc.). Care must be taken with the flipped approach though, especially when implemented across multiple courses where there is the risk of overloading students with outside-of-class video lectures (Khanova et al., 2015).

The use of on-line delivery for flipped or blended learning offers a number of opportunities to explore student study habits in ways not readily available when using traditional live lecture delivery. Given the nature by which data is recorded, on-line learning platforms provide an ability to collect data that is more objective in comparison to methods such as interviews (Oosterbeek, 1995), personal journals (Juster and Stafford, 1991; Kember et al., 1995), or end-of-semester course evaluations (Zuriff, 2003). The ability to monitor the number of times, duration, and time of day when students view content in relation to the date that homework is due or that exams are held can provide new insight into how students structure their study time. Further insight can be derived from extending this data collection to include the dates of assessment activities in other courses taken by students during a single semester.

This paper will explore student on-line watch data collected during the delivery of three different blended learning courses: Mechanical Engineering Thermodynamics taken by third-year students; Introductory Fluid Mechanics taken by second-year students; and Heat Transfer taken by third-year students. Each course offering involved different assessment schedules, making it possible to examine how student study habits vary in relation to the differing schedules. Both Mechanical Engineering Thermodynamics and Heat Transfer were taught over a 13-week-long semester with most students enrolled in 5 to 6 courses at a time. Introductory Fluid Mechanics was taught over 6 weeks during a Summer session with most students taking only one course during the Summer term. Given the varying lengths of academic semesters, the differences in assessment schedules, and the differing course loads, it becomes possible to examine how student study habits change in response to these parameters. Through an analysis of student watch data, the intent is to also suggest that the process of developing and refining a flipped-delivery course can facilitate the following: increased faculty teaching competence (Standard 10); more diverse assessment of disciplinary knowledge (Standard 11); and increased time for alternative learning methods (Standard 8) and, as a result, improved student learning experiences.

METHODS

This section discusses the nature of the student sample, the instruments and measures used, and the procedures by which the instruments and measures were used to collect the data analyzed in this paper.

Sample:

The first year for students in the Schulich School of Engineering is experienced as a common-core year. At the conclusion of the first year, they select their programs. Placement in programs is highly competitive and based on the students' first-year GPA (Grade Point Average). Mechanical Engineering is a popular program choice for students, and the first-year cut-off GPA for the Mechanical Engineering program has averaged between 2.6 and 2.8 on a 4-point scale.

Data from three Mechanical Engineering courses are examined in this paper: one a second year Fluid Mechanics course (ME341) and the other two third-year courses – Thermodynamics (ME485) and Heat Transfer (ME471). The Fluid Mechanics and Heat Transfer courses were taught only once, whereas the Thermodynamics course was taught twice. Given that the first author had previously taught all three courses in a face-to-face manner, these same courses were selected in order to reduce the time required to develop the on-line content. Data for all four course offerings are presented in Table 1.

Table 1: Course Information

Course Number	Course Title	Semester Taught	# of Students	# of Weeks	# of Term Exams	Final Exam
ME485F	Thermodynamics	Fall ‘13	92	13	2	Yes
ME485W	Thermodynamics	Winter ‘14	94	13	2	Yes
ME341	Fluid Mechanics	Summer ‘15	59	6	4	Yes
ME471	Heat Transfer	Fall ‘15	94	13	6	No

All three of the courses involved lectures and laboratories. The Fluid Mechanics course (ME341) also involved a tutorial. The laboratories in the Thermodynamics and Heat Transfer courses were of the scripted variety, where students followed an explicit procedure from a laboratory manual while performing the experiment. Written laboratory reports were due one week after the conclusion of the experiment, and reports were submitted in groups.

The laboratories in the Fluid Mechanics course were not scripted but rather followed an Inquiry-Based Learning approach where each experiment was described to the students; they were provided with equipment; and then they were told to construct the experiment and formulate a test plan. Four types of group reporting were assessed: a short technical report, a technical poster, a 10-minute video presentation, and an oral presentation.

All four courses had homework assignments; however, only in the Fall 2013 offering of Thermodynamics was the homework graded, as shown in Table 2. The Winter 2014 offering of the same course required that homework be submitted, but it was not graded. Active Tutorials were given in all four courses. Both electronic personal response systems and Mazur’s peer instruction technique (Mazur, 1997) were applied during the active tutorials.

Table 2: Teaching & Learning Activities and Assessment Weight

Course Number	Homework (Assigned / Due)	Homework Qty / %	Lab Reports Qty / %	Active Tutorial Qty / %	Semester Exams Qty / %	Final Exam
ME485F	Yes / Yes	8 / 10%	2 / 10%	10 / 10%	2 / 30%	40%
ME485W	Yes / Yes	8 / 0%	2 / 10%	9 / 10%	2 / 30%	50%
ME341	Yes / No	5 / 0%	5 / 25%	5 / 5%	4 / 40%	30%
ME471	Yes / No	6 / 0%	4 / 20%	6 / 5%	6 / 75%	--

Instruments and Measures:

1) YouTube Analytics Data – Canadian Watch Minutes

With the on-line content delivered through YouTube, it was possible to use the Analytics package within YouTube to examine and compare viewing statistics. It should be mentioned that watch data for Canada is reported in aggregate for the entire country, and consequently it is possible that some of the reported watch data includes students who were not registered in the course, such as students at another university. Electronic communications received by the course instructor from students at other Canadian universities confirmed that this is indeed the case. A second source of ambiguity can be attributed to students downloading the YouTube videos and watching them offline, as reported to the course instructor by a number of registered students. These two sources of ambiguity would tend to cancel one another out, especially in cases where the course was offered for the first time.

It should be mentioned that given that this was the first time that three of the four courses were offered via YouTube (i.e. the availability of these YouTube lectures was in its infancy and potentially not discovered by other Canadian students), it is assumed that the Canadian watch data is primarily attributed to University of Calgary students.

2) YouTube Analytics Data – Real-time Report

Starting in September 2014, YouTube began providing content creators with the ability to monitor their YouTube watch data hourly. As a result, estimated views from the last five published videos can be monitored. Additional videos can be monitored by creating groups of up to five videos per group and then monitoring the hourly watch data for each of these groupings. It is not possible to filter the views by country or region. Real-time data has a lifespan of 48 hours, and consequently if data is not downloaded within 48 hours, it is lost.

3) Instructor Survey

Course instructors teaching the cohort of students who were taking Heat Transfer during the Fall 2015 semester were asked to complete a survey of course assessment activities. Instructors were asked to report, by week, when assignments, quizzes, midterms, laboratories, projects, or other activities were either held or due and the assessed weight of the activity.

Procedures:

Canadian watch minute data was downloaded weekly while each course was being offered. The data was stored but not analyzed until after course grades had been awarded. Real-time data was only collected for courses offered after September 2014 (Fluid Mechanics and Heat Transfer). Data was collected for one or more weeks before examinations were held in order to develop an understanding for when students viewed the content in preparation for an exam.

RESULTS AND DISCUSSION

Data provided by on-line learning platforms is relatively new to the engineering education community and consequently it is important to begin by examining methods for visualizing these data sets. YouTube Analytics provides a variety of data sets that includes watch time, audience retention, demographics, playback locations, traffic sources, devices, and so on. Of interest to this paper is watch time data by video that is restricted to Canada. The watch time data is cumulative, and is reported by video in decreasing number of cumulative views. In order to gain insight into how students watch content over the duration of a course, the daily watch minute reports first need to be extracted from each daily report, then sorted by video, and finally concatenated into a single file that quantifies cumulative watch minutes by video by day. The result of this process, when plotted in the form of a contour plot, is shown on the left in Figure 1. In this figure, the horizontal axis represents time from the start to the end of the course. The vertical axis represents lecture video segment going from the content covered at the start of the course to content covered at the end of the course. Finally, each colour contour denotes the number of cumulative watch minutes. Visually this plot provides an indication of which videos students are watching and when.

A second method of viewing this same data set is to compute the difference in cumulative watch minutes or, more specifically, the total number of minutes watched per video per day. This data set is presented to the right in Figure 1. Viewing the data in this manner reveals a light blue band that tracks student progression through the course, starting on Day 8 and ending on Day 100. Comparing both the cumulative (left) and the daily (right) contours, the daily contour is seen to be the more effective method for highlighting when video segments are being watched. Consequently it was decided to use this form of data representation for the remainder of this paper.

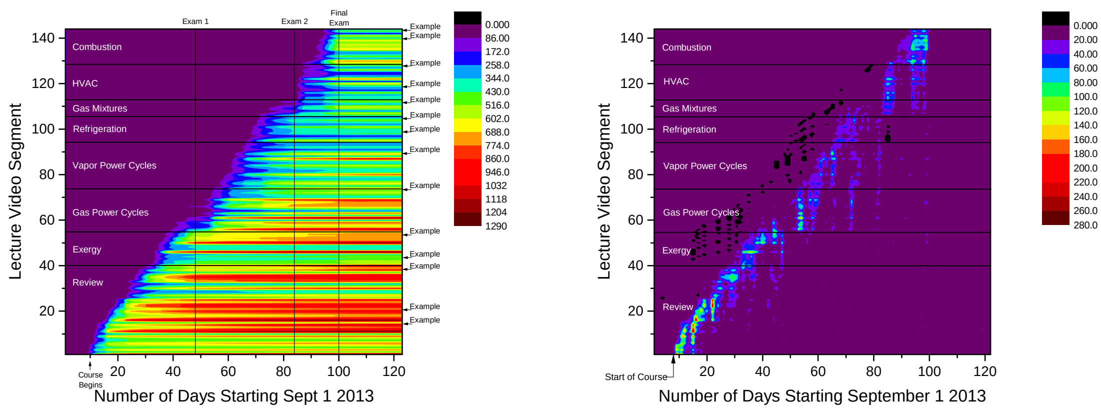


Figure 1: Canadian Watch Minutes – ME485F – Fall 2013 – Cumulative (left); Daily (right)

As shown in Table 1, the Mechanical Engineering Thermodynamics course (ME485) was taught twice, first in Fall 2013 and a second time in Winter 2014. Watch minute data collected from both of these courses was compiled and the resulting contour plots are compared in Figure 2. Visual inspection of both contour plots reveals a light blue band that runs from the lower left (start of the course) to the upper right (end of the course). The data set on the right in Figure 2 includes a feature not observed in the plot on the left, specifically a band of light blue that extends horizontally across the bottom of the contour plot. This horizontal band covers video segments from the first four lectures of the course. It also covers introductory course material that reviews topics normally found in an Introductory Thermodynamics course. It is believed that this content was being watched throughout the duration of Winter 2014 by other Canadian students who were not registered in the course. Thus given that these views negatively impact the quality of data collected during the Winter 2014 semester, it was decided not to examine this data further in this investigation.

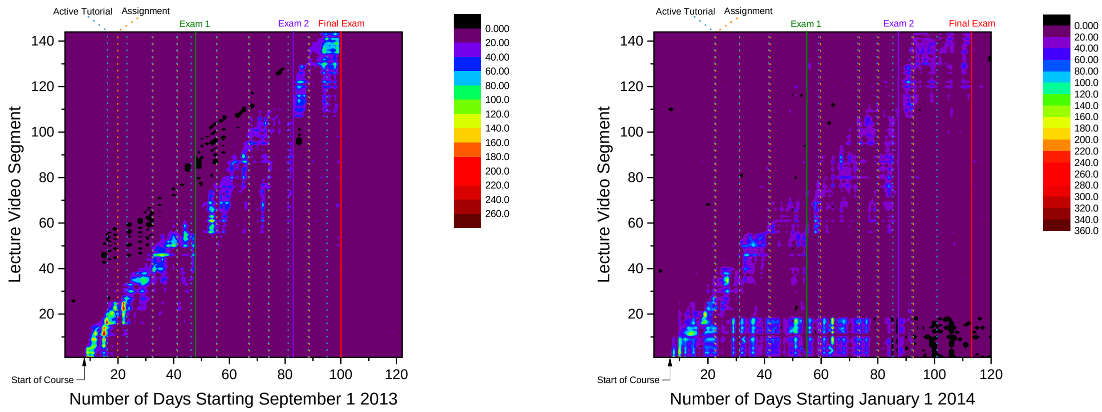


Figure 2: Canadian Daily Watch Minutes - ME485 - Fall 2013 (left); Winter 2014 (right)

Daily Watch Minutes

Daily watch minute data for ME485F, ME341, and ME471 are presented in Figure 3 through to Figure 5. Vertical lines superimposed on each contour plot denote teaching and learning activities within each course that include active tutorials, assignments, and exams. In examining the watch minutes both before and after Exam 1 (green vertical line on Day 48) for Figure 3 for ME485 more closely, it is noted that students watch little content after that content has been assessed. Of particular note is the void in watch data to the right of the green vertical line and below Lecture Segment 55. A similar pattern is observed to the right of Exam 2 (purple vertical line on Day 83) and between Lecture Segments 55 and 108. The only exception to this is the viewing which occurs immediately prior (to the left of) the Final Exam, as indicated by the red vertical line on Day 100. Figure 3 also reveals some evidence of increased viewing prior to when either an active tutorial is held or when an assignment is due, as reflected by vertical bands of watch data to the left of a dashed vertical line (prior to Day 55, for example).

Figure 4 shows the contour plot for watch minutes during the Summer 2015 offering of Fluid Mechanics (ME341). At a little over six weeks, the duration of this course was roughly half that of either the Fall or Winter semester courses. Although students were given assignments in this course, they were not required to be submitted. Instead students were given weekly exams, and an active tutorial preceded each exam and served the purpose of motivating students to study material (and do homework assignments) prior to each exam. Comparing the data in Figure 3 with that in Figure 4, it immediately becomes apparent that weekly exams result in more concentrated student watch minutes. Again, as observed in Figure 3, it is evident that students review content from different sections of the course in preparation for the final exam. In the case of ME341 in Figure 3, lecture segments 30 and 50 were reviewed by students prior to the final exam, indicating that students believed this material would be covered in the final exam. Given that not all lecture content was reviewed prior to the final exam, it can be surmised that students *gamble* in deciding what course material to study in advance of the final exam. In the case of ME341, it was noted that students focused on course content that had not been asked in previous examinations.

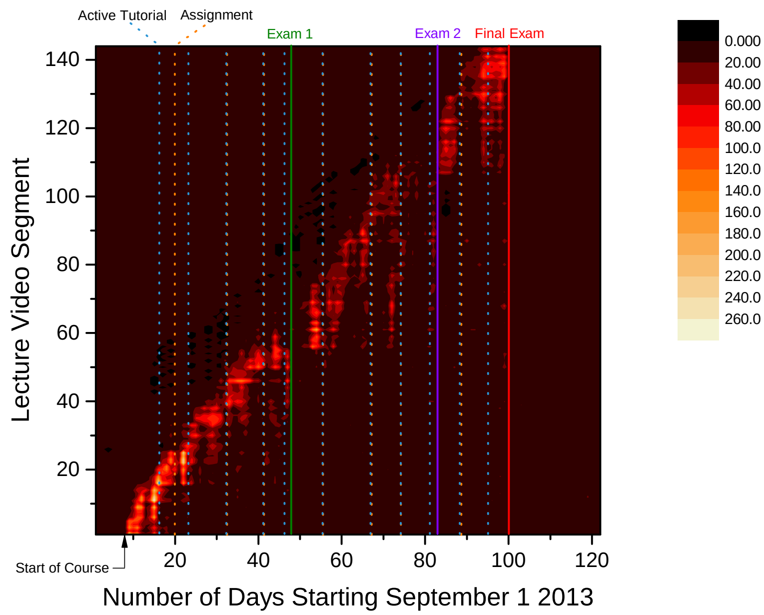


Figure 3: Canadian Daily Watch Minutes – ME485 – Fall 2013

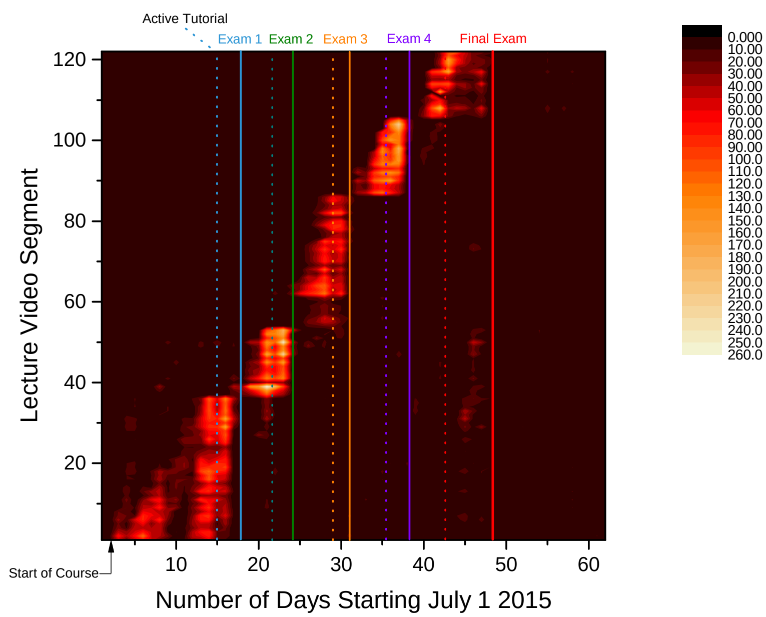


Figure 4: Canadian Daily Watch Minutes – ME341 – Summer 2015

Figure 5 illustrates the watch minute data for Heat Transfer (ME471) which was offered during Fall 2015. This course was structured with six semester exams and no final exam. Each semester exam was preceded by an active tutorial held during the lecture period prior to the exam. In Figure 5, active tutorials are denoted by dashed lines, and exams are denoted by solid lines. Again, as with ME341 shown in Figure 4, content was viewed both before and after each active tutorial and the watch minutes were found to be tightly clustered in advance of each semester exam.

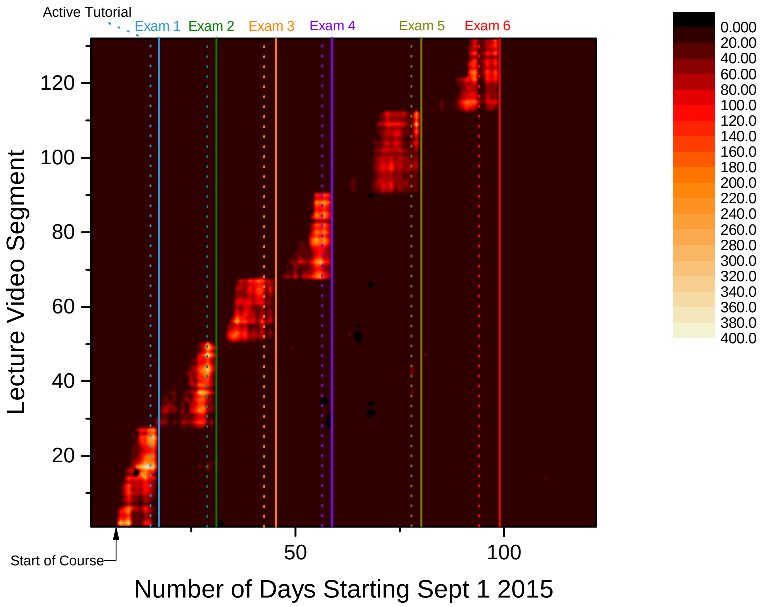


Figure 5: Canadian Daily Watch Minutes – ME471– Fall 2015

Weekly Viewing Patterns

Real-time watch data was used to examine how students would watch content on an hour-by-hour basis. Figure 6 shows data that was collected for more than one week prior to Exam 5 (held on a Thursday) and Exam 6 (held on a Tuesday). Overlaid on the contour plot are yellow boxes indicating scheduled lectures for the five courses taken by the cohort of students taking ME471 during the Fall 2015 semester. These students had three scheduled courses held on Monday, Wednesday, and Friday along with two scheduled courses held on Tuesday and Thursday. The yellow box with yellow crosshatching denotes the time that the ME471 lectures were scheduled. The data indicates that students tend not to watch the on-line content during the time allocated for ME471 traditional lectures (Tuesday and Thursday, 8:00-9:15AM), but rather they watch content starting at around noon and extending into late night. Content viewing is greatest on days preceding exams (Monday and Wednesday) and lowest on Thursday and Friday. Some content viewing is noted at times when other lectures are being held. It is also noted that on weekends the students do not start viewing content until the afternoon, and on Saturdays content viewing is greater in the afternoon than in the evening while on Sundays content viewing is greater in the evening than in the afternoon.

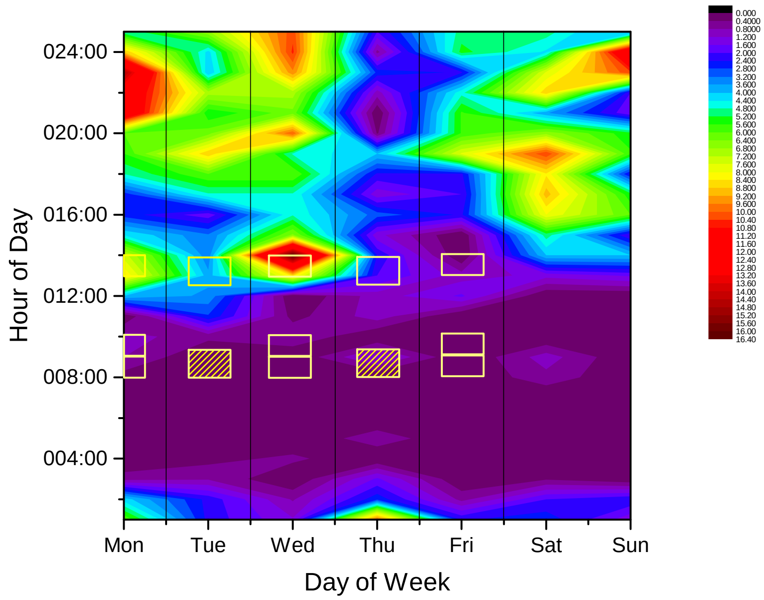


Figure 6: Real-time Watch Data by Day of Week - ME471 - Fall 2015
[yellow boxes represent lecture times; cross-hatched box denotes ME471]

Student Prioritization

The instructors of all five courses taken by the cohort of students during the Fall 2015 semester were surveyed and asked to specify when students were assessed and to specify the weight of that assessment. Figure 7 shows the daily watch minutes for ME471 during Fall 2015, and inset in the contour plot is a bar graph showing the total assessment by week for all five courses. With this information it is possible to examine how students choose to adjust their content viewing in relation to assessment activities in their courses. Comparing Weeks 4 and 5, it is noted that more content is viewed during Week 4 when the total assessment is 7.5% as compared to Week 5 when the total assessment is 50%. Week 8 offers another example where the total assessment was 27.8%, and consequently students opted to defer their viewing until Week 9. Weeks 11 and 12 again offer another example: with the total assessment in Week 11 being 43.3%, students elected to defer their viewing until Week 12 when the total assessment was much lower at 11%.

It is important to note that students *do* prioritize their watch time (and consequently study time) in relation to when assessment activities are taking place in all of the courses that they are taking in a given semester. The results in Figure 7 clearly indicate that students do not watch content consistently on a week-to-week basis but rather adjust according to the amount of work that they have in all of their courses. This indicates that one advantage to the flipped delivery model is that it enables students to adjust their viewing schedules in response to the overall demands that are being placed on them.

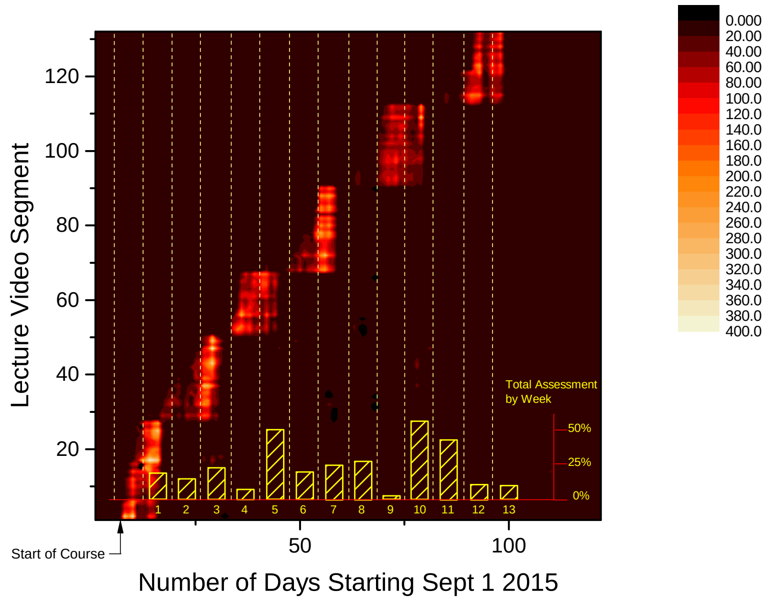


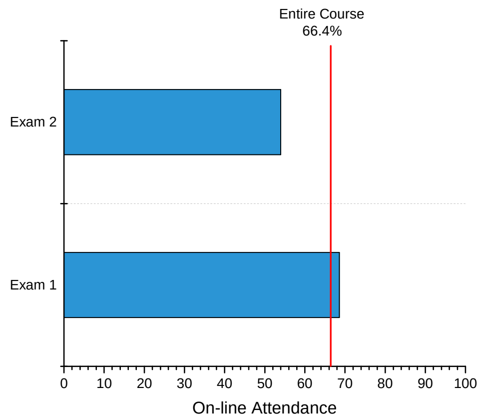
Figure 7: ME471 – Fall 2015 - Total Assessment for All Courses (inset) by Week

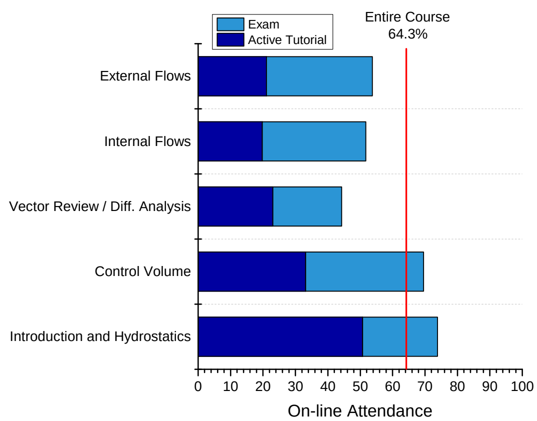
On-line Attendance

An on-line version of “attendance” is presented in Figure 8 where, for each course, the Canadian view minutes over a certain period are divided by the number of content minutes posted for that same period multiplied by the number of students in the course. If all students watched all of the content provided, this number would be 100%. When the course instructor taught face-to-face lecture-based courses from 2000 to 2005, the average class attendance was 65.8% as indicated by student participation in the USRI. In Figure 8, it is interesting to note that for ME485F the on-line attendance for the entire course was 66.4%; for ME341 it was 64.3%; and for ME471 it was 78.7%.

These results indicate that the lecture content viewing for the on-line courses examined in this investigation is similar to lecture attendance in face-to-face courses. The results also indicate that on-line attendance (or content viewing) is seen to increase by administering more and frequently scheduled exams. Although ME341 also had regularly scheduled semester exams, the shortened summer session and the increased load due to the Inquiry-Based Learning laboratories made it more challenging for the students to view the content as compared to the watch patterns observed with ME471 where the semester was longer and the laboratories were of the more traditional scripted variety.

The increased on-line attendance in ME471 with an increased number of term exams implies an increase in student motivation. This result is in agreement with Wankat & Oreovicz (1992) who indicate that an increased number of tests have positive benefit on student learning. One of the drawbacks that they identify, however, is that an increased number of tests will reduce the amount of lecture time that can used to cover content. One advantage of the flipped-delivery model is that this drawback is eliminated, thereby enabling the benefit of increased testing to be realized, as found in this investigation.





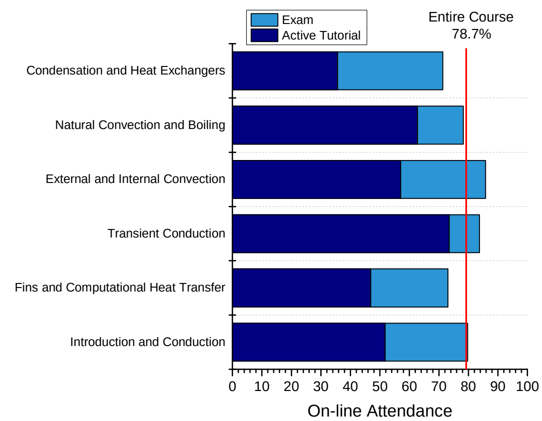


Figure 8: On-line Attendance by Course
[ME485F upper middle;
ME341 lower left; ME471 lower right]

CONCLUSIONS

This paper has examined student watch data from three different on-line courses taught over the span of two years. Daily watch data was found to be an effective method of conceptualizing and visually representing when students watch content and what content they are watching. It was also found that students studied more in the afternoon and evenings than they did in the morning. Students were noted to study less on Thursday and Friday than they did on other days of the week. Evidence of time prioritization in response to the amount of assessment (and hence workload) in all of the courses taken by a single cohort of students was also examined.

From an analysis of the data, it was found that administering a larger number of examinations with smaller assessed value was more effective at motivating students to study than offering fewer exams with greater assessed value. Therefore, future flipped-delivery course offerings will be taught using more frequent assessment. Given that the flipped-delivery format frees up lecture time, this newly available free time can be used to increase the amount of formative assessment and/or to introduce other CDIO-related activities (e.g. active learning). These changes would impact course design and the ways in which students engage in learning.

Overall, the paper offers a glimpse into the type of information that can be derived from the use of on-line watch data. While many of the results obtained in this paper are somewhat intuitive, the significance is in having access to quantitative data that confirms this intuition.

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BIOGRAPHICAL INFORMATION

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