The Relationship Between the Use of Online Resources and Dental Students' Attendance and Performance

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By

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Abstract:

Background: Educational resources for dental students are increasingly being provided through new technologies. Dental faculty members now commonly upload and record their lectures through software systems to maximize student access. These online resources can impact learning behaviors including whether students choose to attend lectures.

Aims: This study was conducted to evaluate the effect of the use of online lecture materials on class attendance and students' performance in basic science and pre-clinical courses. The study also aimed to evaluate the relationship between previous (during undergraduate college) and current usage of online resources.

Methods: The study targeted (190) 2nd year pre-doctoral students at Tufts university school of dental medicine (TUSDM) during the fall semester of 2014. Three basic science and three pre-clinical dental courses were selected. The online access habit for each participant was calculated. A survey containing questions about demographics, attendance and online usage behavior was conducted. The final grade for each participant in each selected course was obtained and matched with their online access and attendance.

Results: Out of a total 190 students, 146 (77%) answered the survey. There was no significant relationship between grade and attendance. There was no significant relationship between grades and online usage. There was no significant relationship between attendance and online usage except for a weak negative relationship for Epidemiology ($p = 0.0002$) and the mean of overall pre-clinical dental courses ($p =$

0.03). There was no significant relationship between previous and current use of either lecture PPT/PDF (p= 0.62) and lecture recording (p= 0.43).

Conclusion: Students who do not attend lectures and subsequently utilize online resources may perform just as well on exams as the students who attend. Students preferred a combination of lecture PPT/PDF and recordings to enhance their learning. The majority of the students thought that the availability of online resources could affect class attendance. Teacher's teaching style and time of the lecture during the day might play a role in student attendance.

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Introduction

The use of technology to support teaching and learning is increasing. Advances in the types of technology and easy access to information have had a tremendous influence on education.[1-3] Students can get information any time they want. Learning through technology tools provide many advantages, for example various media can allow students to watch and listen to a lecture whenever they want. When students lose attention in a lecture or if they do not understand part of it, a lecture recording allows them to stop, replay, and repeat it until they feel they have a good understanding of the material. [4,5] Many dental learning institutions also deliver electronic resources to broaden student knowledge and aid in skills acquisition. Despite the increase in use of technology, the impact on learning is still poorly understood. [1,2,3,5]

In this new environment, one wonders whether the "traditional lecture" still plays a role in how students learn. Traditional lectures are still an important source of information. A lecture allows students to interact and communicate with their faculty. Even poorly structured lectures contain information. [1,2,4] Schreiber et al. compared two groups of students randomly assigning to either attending a regular lecture or watching a recording of the same lecture by the same teacher. Afterward, student knowledge was examined through multiple-choice questions on the same topics. They found no significant difference between the two groups and concluded that traditional lectures were superior in terms of student interaction and concentration. [5]

Lectures can also help students who have little background in a topic and can aid in the comprehension of the subject being taught. Increasingly however, students, professors and institutions are looking for ways to supplement lectures through the use of technology. [5-7]

Although lectures have several benefits for students, there are also some negative aspects. Some students are less adept at learning in lectures, may be unable to attend a lecture, may miss a lecture or may be poor note takers. [8,9] A study by Costa et al. compared students attending traditional lectures and students attended group-discussion classes on the same orthopedic topics. They found that the group discussion attendees scored significantly higher on final exam grades than the traditional lecture attendees. They concluded that the group-discussion classes allowed the students to have deeper understanding and memorize the material. [10] Most students lose focus when a lecture is too long, poorly organized or if the teacher is unable to maintain student attention or convey the information in the lecture in an understandable manner. This generation of students might also be less likely to attend the lecture if it is scheduled too early in the day.[11]

Allen et al. found that many students use more than one lecture resource to help in their studies. Moreover, in their survey, student performance was not associated with a student's preference for utilizing a lecture recording or traditional lecture. However, when haveing missed lectures, students favored a recorded lecture.[12]

Faculty members have tried to find other ways to maximize the benefits of their lectures and improve academic achievement, such as posting a lecture online in a PowerPoint presentation (PPT), through lecture recordings or videotaping.[6, 9,11,13]

Embi et al. sent a survey to medical students asking them about their preferences for watching live lectures or listening to lectures and found that the majority of students preferred to have both.[14] These students can access the lecture through a special software system called a course management system (CMS) whenever and wherever they want. This system facilitates communication between students and faculty members and allows the posting of lecture references, quizzes, and even final exam grades.[8, 9,11] For faculty members, a CMS system allows for delivery of course content that is accessible for all students. This content supplements the lecture, can provide extra resources and can result in overall student satisfaction.[15, 16]

The CMS provides an opportunity for the student to read the subject matter that is covered in the lecture and makes it easy to review the material. The CMS allows students to add their notes, simplifies studying, allows for the reviewing of materials before exams and can improve the student's final grade.[8] Some students also use recorded lectures to increase learning efficiency by watching lectures at higher speed or at times when they can optimize their learning and improve their motivation. [9,17]

Many dental schools offer recorded lectures. This gives students a choice of attending the lecture or listening to the recorded lecture online at the students' convenience. Students with different learning abilities and language skills can listen

to the lecture at different speeds. Online resources and lecture recording are still an area of discussion at the institutional and faculty level.[7] Institutions are concerned about software costs, the need to provide qualified technical support and faculty training.[18, 19] Some faculty members are unfamiliar with technology and have a difficult time using it, or believe that it takes additional time and effort, or are concerned about copyright issues.[20, 21] Faculty members may be concerned about students' attendance and performance if students choose to watch recorded lecture not attend them.[22, 23]

Hammen and Kelland did a study on the effect of attendance on performance in a Physiology class for second year medical science students in which the in-class attendance was recorded. They found a weak negative correlation between absences and students' performance.[24] In another study, Moore compared the student anticipation of their grades in relation to their attendance. The author found that 94% of students believed that missing classes affected their grades. Students who anticipated getting an A grade on the exam had a greater than 81% attendance rate. Students anticipating a C grade had a less than 61% attendance rate. On the other hand, many students believed that if they substituted missed classes by reading the assigned materials and getting the notes from other students, attendance did not affect their performance. The author concluded encouraging students to attend classes.[25]

Gagliardi *et al*. reported that students based their decisions about attending a lecture on several factors, such as the teacher's ability to explain a topic well, how

interesting the topic was, if attending the lecture made it easier to understand the topic and also at what the time of the day the lecture was held. [11]

Bollmeier *et al*. compared the number and duration of times that medical students accessed online resources in a therapeutic course in relation to their final exam grades and attendance as well as in comparison to control group students where the online lectures not recorded. They found no relationship between the number and duration of lecture accessed to class attendance and student performance. However, final exam grades were significantly higher compared to students who did not have access to online lectures. [6]

In other studies, Solomon *et al*. [26] and Davis *et al*. [27] compared two groups of medical students: one group who attended a traditional lecture and a second group who viewed a computer-based lecture. They found no difference between the two groups in terms of knowledge acquired. They concluded that the computer-based lecture could replace or supplement face-to-face lecture. Along similar lines, Cardall *et al*. found that 79% of the students reported that using a video recording made the lecture more useful and they learned more from the lectures. [9]

McCann et al. did a survey targeting dental and hygiene students who use online resources. They found that students preferred to use lecture slides or PDF files over other aids. Students also needed online resources to help them to understand the lectures, and did not substitute the lectures for these materials. [28]

In contrast, Ramlogan *et al*. compared two groups of dental students who either attended a live lecture or saw a video of the same lecture in terms of their exam grades in clinical Periodontology. The authors detected a significant difference

between the two groups, favoring the students who attended the lecture. They concluded that a future combination of the two teaching methods would be most beneficial to students. [8]

Tufts University School of Dental Medicine (TUSDM) began using electronic resources several years ago. The course management system is called TUSK (Tufts University Sciences Knowledgebase). It was built on the LAMP framework that consists of four parts: Linux (operating system), Apache (web server), MysSQL (database system) and Perl (computer language). It has a mobile mediator. TUSK fully supports Tufts' medical, dental and veterinary schools, as well as other health science foundations in many countries including USA, Sweden, Saudi Arabia and India. [29]

TUSK is a content repository and management system using the National Library of Medicine's Unified Medical Language System (UMLS) for easy delivery, indexing, searching, editing, reuse, and management of learning objects across all health science disciplines. TUSK has tools for education including case-based education, self-evaluation, exams, problem-based education, competency-based education and evaluation. [29]

The system allows for curriculum delivering and evaluation for continuous improvement by formative and summative assessments of students, classes and programs. It allows administrative management for assessment and comparison of education programs from any network of clinical sites or institutions, evaluating competency-based learning with collecting data and forming reports for professional health science institutional accreditation guidelines. [29]

TUSK supports both faculty members and students by providing multiple sources of resources and promoting curriculum improvement, enhances the learning process, facilitates communication and easy to use and widely accessible. Each student has his or her own password that allows access to the system. One of the features of the TUSK system is that it allows the student to access lecture outlines, PowerPoint presentations and lecture recordings at any time. The purpose of this study was to evaluate the effect of the use of online lecture materials on class attendance and students' performance in basic science and pre-clinical dental courses.

Hypotheses and Specific Aims

We hypothesized that:

- There is a positive relationship between students' attendance and students' grades in basic science and pre-clinical dental courses.
- There is an inverse relationship between students' attendance and the usage of online resources in basic science and pre-clinical dental courses.
- There is a positive relationship between the use of online resources and students' grades in basic science and pre-clinical dental courses.
- Students who came from an undergraduate environment that provided online resources currently use more online resources than students who did not.

The specific aims are:

1) To evaluate the relationship between students' attendance and students' grades in dental school courses.

2) To evaluate the relationship between students' attendance and students' usage of online resources in dental school courses.

3) To evaluate the relationship between the use of online resources and students' grades in dental school courses.

4) To survey key characteristics of students attendance, online behaviors and to evaluate the relationship between prior exposure to online resources and current use of online resources.

Research Design and Methods:

This is a prospective observational study composed of extraction of data from the TUSK system, and the collection of information using a survey.

Materials and Methods

This study involved second-year pre-doctoral students at Tufts University School of Dental Medicine (TUSDM) during the academic year 2014-2015. Tufts University Institutional Review Board approved the study protocol.

The class of 2017 had 190 students that were eligible to participate in the study. All eligible students were invited to participate. Students were informed that participation or the refusal to participate would have no effect on their academic standing. Students who participated were asked to provide their student ID numbers to match-up survey results with grades and TUSK usage data. After the data was combined in one spreadsheet and ready for analysis, all identifying information was deleted to ensure student confidentiality.

Both basic science and pre-clinical dental courses on TUSK were evaluated to identify which courses had most of their course materials recorded and which were taken in the fall semester due to project time constraints. Based on that review, three basic science (Infectious Diseases, Epidemiology, and Medicine II) and three pre-clinical dental courses (Anesthesiology, Oral and Maxillofacial Radiology, and Fixed Prosthodontics), were included in the study.

The Infectious Disease course had eleven lectures during the fall semester from September through October. Two hours long lectures were held twice a week. This

course offered lecture slides, PDF files, and lecture recordings. There were two exams during the course. One exam was on Tuesday Sept. 17/2014 and the second on Wednesday Oct. 23/2014. The Epidemiology course had six lectures during the fall semester from September to December. Each lecture was one-and-a-half hours long and held once a week. This course offered lecture slides, PDF files, and lecture recordings. There was one exam held at the end of the course on Friday Dec. 13/2014. The Medicine II course was started in September and ended in April. There were 22 lectures during the fall semester from September to December. Each lecture was three-and-a-half hours long, held once a week. This course offered lecture slides, PDF files, and lecture recordings. There were two exams during the fall. One was on Monday Oct. 21/2014 and another on Monday Dec. 9/2014.

The Anesthesiology course had 12 lectures during the fall semester from September to December. Each lecture was one hour long, and was held once a week. This course offered lecture slides, PDF files, and lecture recordings. There were two exams during the course. One exam was on Oct. 22/2014 and the second on Friday Dec. 23/2014. The Oral and Maxillofacial Radiology course was started in September and ended in April. There were 10 lectures during the fall semester from September to December. Each lecture was one hour long, and held once a week. This course offered lecture slides, PDF files, and lecture recordings. There was one exam held at the end of the fall semester on Thursday Dec. 13/2014. The Fixed Prosthodontics course started in September and ended in April. There were 22 lectures during the fall semester from September to December. Each lecture was one

hour long, and held twice a week. This course offered lecture slides, PDF files, and lecture recordings. There was one exam during the fall on Wednesday Nov. 9/2014.

Materials and Methods of aim 1: evaluate the relationship between students' attendance and students' grades in dental school courses. Attendance was collected as part of the study survey. The students were asked: How many lectures did they miss in each selected course? Then the percentages of attendance in each course for each student were calculated (Appendix A). The problem of this method is the response rate from students, as some students may not have responded. To address this problem we encouraged students to respond back by using various sorts of rewards, such as a gift cards. Students' final grades or fall semester exam scores for the selected courses in the semester were obtained from the Office of Academic Affairs and then matched and compared to their attendance.

For the statistical analysis, relationships between attendance and grades were assessed using the Pearson correlation test. All analyses were performed using SPSS, Version 19 (IBM Corporation). Any p-values less than 0.05 were considered statistically significant.

Materials and Methods of aim 2: evaluate the relationship between students' attendance and students' usage of online resources in dental school courses. Attendance was collected as part of the survey questions given at the end of semester and students were asked: How many lectures did they miss in each selected course? Then, the percentages of attendance in each course for each student were calculated (Appendix A). TUSK administrators provided information about the access pattern of online resource usage for each selected course for each

student (Appendix B). The ID of each student was used to count the student access. After that, each student's total number of instances of online access for each selected course was calculated and then matched and compared with their attendance.

For the statistical analysis, relationships between attendance and online usage were assessed using the Pearson correlation test. All analyses will be performed using SPSS, Version 19 (IBM Corporation). Any p-values less than 0.05 were considered statistically significant.

Materials and Methods of aim 3: evaluate the relationship between the use of online resources and students' grades in dental school courses. TUSK administrators provided information about access of online resources for each selected course for each student (Appendix B). The ID of each student was used to count the student access. After that, the student's total number of instances of online access for each selected course was calculated and then matched and compared with their attendance. Students' final grades for the selected courses in the semester were obtained from the Office of Academic Affairs and then matched and compared to their total number of instances of access to online resources.

For the statistical analysis relationships between grades and online usage were assessed using the Pearson correlation test. All analyses were performed using SPSS, Version 19 (IBM Corporation). Any p-values less than 0.05 were considered statistically significant.

Materials and Methods of aim 4: to survey key characteristics of students' attendance, online behaviors and to evaluate the relationship between prior exposure to online resources and current use of online resources. By the end of

the fall semester, participant students received an email with the survey. The survey was administered using Qualtrics and designed to take approximately 10 minutes to complete. There were twenty-one questions with multiple choice and open-ended answers. The students were first asked to enter their student ID number to match the results with their grade and attendance. The subjects were surveyed on demographic information and information on online behavior. There were questions about age, gender, undergraduate major, previous exposure to online resources before attending dental school, frequency of use of online resources, when they used the online resources (before the lectures, after the lectures, or just before the exams) and how they used them, reasons for not attending lectures, student preferences for lecture PPT/PDF or lecture recordings, student opinions about how the availability of online resources may have affected class attendance and how many lectures did they miss in each of the selected courses (Appendix A). Four reminder emails were sent and the survey remained open for approximately two weeks. Students were given $10 gift cards to Starbucks for completing the survey.

For the statistical analysis, bivariate tests were used to evaluate confounders individually with the outcomes of grades, online usage, and attendance. Pearson correlation test was used to evaluate the relationship of age with grades, online usage, and attendance. An Independent t-test assuming equal variances was used to evaluate the relationship of major (science and non-science) with grades, online usage, and attendance. Also, an Independent t-test was used to evaluate the relationship of gender with grades, online usage, and attendance. The analyses were

accomplished using SPSS, Version 19 (IBM Corporation). Any p-values less than 0.05 were considered statistically significant. The sample was a convenience sample. Even if only 30% of the class agreed to participate, the study had 80% power to detect a positive correlation of 0.6 between student attendance and grade and online usage (our primary hypothesis), setting $\alpha=0.05$ (nQuery Advisor, 7.0).

Results

Out of 190 second-year dental students, 146 students completed the survey, (77% of the class). Eighty-six respondents were female (59%) and sixty respondents were male (41%). The mean and standard deviation (SD) of the students' age was 24 years (2.34). Of the respondents, 126 (86%) had a science as their undergraduate major (Biochemistry, Biology, Chemistry, Health Science, Microbiology, Neuroscience, Nutrition, Physiology and Psychology) and 20 (14%) students had a non-science major (Building Construction, Business Management, History of Art and Architecture, Linguistics and Music) (Table1).

Aim 1: Relationship between students' grades and attendance in basic science and pre-clinical dental courses.

Basic science courses.

For the *Infectious Disease* course, the mean grade was 83.12% (SD= 8.72), while mean attendance was 77.64% (SD= 11.9). Using the Pearson correlation test, no significant relationship was found between grades and attendance in the *Infectious Disease* course, (r= -0.015, p= 0.86). For the *Medicine II* course, the mean grade was 88.22% (SD= 6.5), while mean attendance was 57.78% (SD= 36.38). Using the Pearson correlation test, no significant relationship was found between grades and attendance in the *Medicine II* course, (r= -0.055, p= 0.51). For the *Epidemiology* course, the mean grade was 88.11% (SD= 8.1), while mean attendance was 95.21% (SD= 11.9). Using the Pearson correlation test, no significant relationship was found

between grades and attendance in the *Epidemiology* course, (r= -0.070, p= 0.39) (Table 2).

Pre-clinical dental courses.

For the *Anesthesiology* course, the mean grade was 90.2% (SD= 6.3), while mean attendance was 77.9% (SD= 31.48). Using the Pearson correlation test, no significant relationship was found between grades and attendance in the *Anesthesiology* course, (r = -0.041, p = 0.62). For the *Fixed Prosthodontics* course, the mean grade was 83.43% (SD = 6.8), while mean attendance was 95.02% (SD= 31.48). Using the Pearson correlation test, no significant relationship was found between grades and attendance in the *Fixed Prosthodontics* course, (r= -0.022, p= 0.79). For the *Oral and Maxillofacial Radiology* course, the mean grade was 94.84% (SD = 5.1), while mean attendance was 65.82% (SD= 32.48). Using the Pearson correlation test, no significant relationship was found between grades and attendance in the *Oral and Maxillofacial Radiology* course, (r= -0.033, p= 0.7) (Table 2).

Overall Basic science and pre-clinical dental courses

When we compared the mean of overall grade 86.48% (5.73) with the mean of overall attendance 76.88% (20.73) in the basic science courses; there was no significant correlation (r= -0.05, p= 0.524) (Figure 1A). Also, there was no significant correlation (r= -0.03, p= 0.733) between the mean of overall grade 89.50% (4.32) and the mean of overall attendance 79.58 %(20.29)(Figure 1B) (Table 3).

Aim 2: Relationship between student attendance and student usage of online resources in basic science and pre-clinical courses.

Basic science courses.

For the *Infectious Disease* course, mean online usage was 18.66 (SD = 7.69), while mean attendance was 77.64% (SD= 11.9). Using the Pearson correlation test, no significant relationship was found between online usage and attendance in the *Infectious Disease* course, (r= 0.074, p= 0.37). For the *Medicine II* course, mean online usage was 54.46 (SD= 15.59), while mean attendance was 57.78% (SD = 36.38). Using the Pearson correlation test, no significant relationship was found between online usage and attendance in the *Medicine II* course, (r= 0.10, p= 0.22). For the *Epidemiology* course, the mean online usage was 14.5 (SD= 14.53), while mean attendance was 95.21% (SD= 11.9). Using the Pearson correlation test, a weak to moderate negative correlation was found between online usage and attendance in the *Epidemiology* course, (r= -0.30, p= 0.0002)(Table 4).

Pre-clinical dental courses.

For the *Anesthesiology* course, the mean online usage was 39.19 (SD = 19.6), while the mean attendance was 77.9% (SD= 31.48). Using the Pearson correlation test, no significant relationship was found between online usage and attendance in the *Anesthesiology* course, (r= -0.12, p= 0.14). For the *Fixed Prosthodontics* course, mean online usage was 27.58 (SD= 12.9), while mean attendance was 95.02% (SD= 31.48). Using the Pearson correlation test, no significant relationship was found between online usage and attendance in the *Fixed Prosthodontics* course, (r= -0.115, p= 0.17). For the *Oral and Maxillofacial Radiology* course, mean online usage was

27.12 (SD= 14.96), while mean attendance was 65.82% (SD= 32.48). Using the Pearson correlation test, no significant relationship was found between online usage and attendance in the *Oral and Maxillofacial Radiology* course, (r=-0.15, p= 0068)(Table 4).

To calculate the number of times each lecture in each course was accessed, we divided the total number of accesses for each course by the number of lectures. For the basic science courses: Infectious Disease 18.66/11= 1.6), Epidemiology (14.51/6 = 2.4), and Medicine II (54.46/22 = 2.5). For the pre-clinical dental courses: Anesthesiology (39.28 /12 = 3.3), Fixed Prosthodontics (27.58/22 = 1.25) and Radiology (27.12/10 = 2.7). From these calculations, the Fixed Prosthodontics had the lowest online usage (one access for each lecture), while Medicine II, Anesthesiology and Radiology had the highest online usage (almost three access times for each lecture in each course).

Overall Basic science and pre-clinical dental courses

When we compared the mean of overall attendance 76.88% (20.73) with the mean of overall online usage 29.21 (7.89) in basic science courses; there was no significant correlation (r=-0.02, p=0.83) (Figure 2A). However, there was a significant weak negative correlation (r=-0.17, p=0.039) between the mean of overall attendance 79.58% (20.29) and the mean of overall online usage 31.29 (9.33) in pre-clinical dental courses (Figure 2B)(Table 3).

Aim 3: Relationship between students' grades and online usage in basic science and pre-clinical courses.

Basic science courses.

For the *Infectious Disease* course, the mean grade was 83.12% (SD= 8.72), while mean online usage was 18.66 (SD= 7.69). Using the Pearson correlation test, no significant relationship was found between grades and online usage in the *Infectious Disease* course, (r= 0.14, p= 0.09). For the *Medicine II* course, the mean grade was 88.22% (SD = 6.5), while the mean online usage was 54.46 (SD= 15.6). Using the Pearson correlation test, no significant relationship was found between grades and online usage in the *Medicine II* course, (r= 0.006, p= 0.94). For the *Epidemiology* course, the mean grade was 88.11% (SD = 8.1), while mean online usage was 14.5 (SD= 14.53). Using the Pearson correlation test, no significant relationship was found between grades and online usage in the *Epidemiology* course, (r= -0.06, p= 0.49) (Table 5).

Pre-clinical dental courses.

For the *Anesthesiology* course, the mean grade was 90.2% (SD= 6.3), while mean online usage was 39.18 (SD= 19.6). Using the Pearson correlation test, no significant relationship was found between grades and online usage in the *Anesthesiology* course, (r = -0.03, p = 0.73). For the *Fixed Prosthodontics* course, the mean grade was 83.43% (SD = 6.8), while mean online usage was 27.6 (SD = 12.9). Using the Pearson correlation test, no significant relationship was found between grades and online usage in the *Fixed Prosthodontics course*, (r = -0.019, p = 0.82). For the *Oral and Maxillofacial Radiology* course, the mean grade was 94.84% (SD = 5.1), while the mean online usage was 27.12 (SD =14.96). Using the Pearson correlation

test, no significant relationship was found between grades and online usage in the *Oral and Maxillofacial Radiology* course, (r= -0.037, p= 0.65) (Table 5).

Overall Basic science and pre-clinical dental courses

When we compared the mean of overall grade 86.48% (5.73) with the mean of overall online usage 29.21 (7.89) in basic science courses; there was no significant correlation (r=0.01, p= 0.903)(Figure 3A). Also, there was no significant correlation (r = -0.01, p = 0.936) between the mean of overall grade 89.50% (4.32) and the mean of overall online usage 31.29 (9.33) in pre-clinical dental courses (Figure 3B) (Table 3).

Aim 4: To survey key characteristics of students attendance, online behaviors and to evaluate the relationship between prior exposure to online resources and current use of online resources.

Students' behavior during undergraduate college compared to TUSDM regarding online usage and attendance

Out of 146 respondents, 114 (78%) had experience with online resources when they were undergraduates and 32 (22%) did not. Out of those who had experience, (56.85%) students reported lectures in a PPT/PDF were the most used, and a combination of both PPT/PDF and recording (19.86%) came next, while the least used were lectures recording only (1.37%).

Out of 114 students (78%), 89 (60.96%) students reported using online lecture resources more at TUSDM, 20 (13.7%) used these resources in undergraduate college at a similar level as at TUSDM, and five (3.42%) used the resources more at

their undergraduate college. Regarding attendance, 58 (38.4%) students reported the same attendance rates in their undergraduate college as at TUSDM, 37 (25.3%) reported more attendance during undergraduate compared to TUSDM, and 19 (12.6%) reported less attendance than at TUSDM (Table 6).

Students' online usage behavior at TUSDM.

Half of the respondents, 73 (50%), reported using both lecture PowerPoint presentations (PPT)/PDF and recordings. 57 (39.04%) used PPT/PDF only, and 16 (10.9%) used recording only. Regarding the use of lecture PPT/PDF, half of the students, 73 (50%), used PPT/PDF whenever they needed. The others reported using this resource in the following manner: 25 (17.12%) before the exam, 19 (13.01%) after the lecture during the same week, 4 (2.74%) after the lecture at the same day, 23 (15.76%) during the lecture, and 2 (1.37%) before the lecture (Figure 4).

Regarding use of lecture recordings, 52 (35.62%) students used it before the exam, 23 (15.8%) used it instead of attending the lecture, 22 (15.1%) used it in addition to attending the lecture, and 21 (14.49%) used it whenever needed. Nineteen (13.62%) used the lecture recordings after the lecture during the same week, 1 (0.68%) after the lecture at the same day, and 5 (3.42%) did not use it (Figure 5).

The responses regarding the main reason for using online resources were as follows: 56 (38.4%) of the students reported using these resources to help in understanding the lecture, 51 (35%) as guides while studying, 35 (24%) to review a

missed lecture, and 4 (2.7%) reported other reasons, such as to pause, replay and speed up the lecture, skip classes and a combination of the previous reasons (Table 7).

Students' attendance behavior at TUSDM.

The students were asked about main reasons for not attending a lecture, and they responded as following: poorly organized lecture 26 (17.8%), lecture time was too early in the day (12.3%), and teacher's teaching style 13 (9%). Most of the students, 64 (43.8%), chose a combination of the previous reasons. Some students, 25 (17%), mentioned other reasons for skipping class, such as: the teacher speaks quickly and they could not keep up, studying for an upcoming exam, too many lectures, online reviewing is more efficient, learning better at home with online resources by listening more than once and gathering information, sick/medical appointments and traveling.

115 (78.8%) students believed that the availability of the lecture online resources could affect attendance, while 31 (21%) students did not. The types of courses that the most students missed were basic science courses, with 111 (76.03%) students missing these courses, while 8 (5.3%) missed more pre-clinical dental courses (Table 8).

Relationship between prior exposure to online resources and current use of online resources.

There were 114 (79%) students that reported use of either lecture PPT/PDF or lecture recording while undergraduates, while 32 (21%) did not use any of these resources as undergraduates. There was no significant relationship found when

comparing previous use to current use of both PPT/PDF and recording, (p = 0.73). Moreover, there was no significant relationship found when comparing previous use with either current use of PPT/PDF (p = 0.62) or lecture recording (p = 0.43).

Relationship between age, gender and undergraduate major to grade, attendance and online usage

Students' ages ranged between (23–34 years old). Pearson correlation test was used to assess the relationship between age and grade, online usage, and attendance. No significant relationships were found between age and grade r= (-0.002 – 0.71) (p > 0.05), age and online usage r= (-0.01–0.002) (p > 0.05) and age and attendance r= (-0.12 – 0.03) (p > 0.05).

An independent t-test was used to determine the relationship between gender and grade, attendance and online usage. No significant relationship was found between gender and grade t = (-1.76 – 0.55) (p > 0.05), gender and attendance t = (-0.84 – 1.77) (p > 0.05), or gender and online usage t = (-0.77 – 1.84) (p> 0.05); except for *Fixed Prosthodontics,* where the female students used more online resources than males, (t = 2.18) (p = 0.031).

Undergraduate major (science and non science), had no significant relationship with grade t = (-1.73 – 0.97) (p > 0.05), or with attendance t = (-0.65 – 0.25) (p > 0.05). Also, there was no significant relationship between undergraduate major and online usage t = (-0.76 – 0.91) (p > 0.05) except for *Medicine II*, where non-science major students used more online resources (t = 2.0, p = 0.043).

Discussion

This study aimed to evaluate the effect of the use of online lecture materials on class attendance and students' performance in basic science and pre-clinical dental courses. We looked at six second-year courses at TUSDM taken by the class of 2017. Courses were selected based on ample online resources and then we divided the courses into two groups, basic science (Infectious Disease, Medicine II, Epidemiology) and pre-clinical dental courses (Anesthesiology, Radiology, Fixed Prosthodontics). 146 out of 190 (77%) students completed the survey and participated in the study.

Our first hypothesis was that there is a positive relationship between students' attendance and their grades in basic science and pre-clinical dental courses. Attendance was measured through a survey that asked participants: How many lectures did you miss in each selected course? Attendance percentage was calculated from this data. Final semester grades, along with exam grades from the time period of this study, in the selected courses were obtained from the academic office and then compared with attendance. There are many ways to collect lecture attendance. One is by passing an attendance sheet before the lecture ends. In our case, we had up to 190 students that were expected to attend the lecture and collecting attendance in this way is difficult and time consuming. Therefore, we decided to collect attendance information as part of survey questions asking the students how many lectures they missed for each chosen course. One of the limitations of using a survey to collect attendance is the accuracy of the information, as we rely on the student's response.

Our findings did not support the hypothesis and no significant relationship was found between attendance and grade in the in basic science (r= -0.05, p=0.52) or pre-clinical dental courses (r= -0.03, p= 0.73) (Table 3). This means that students who did not attend lectures performed as well as students who attended. In contrast to our finding, a previous study by Hammen and Kelland found a weak negative correlation (r= -0.33) between absence and grade in a physiology class.[24]

In this study, the mean attendance was high for Epidemiology (95.21%) and Fixed Prosthodontics (95.02%). The mean grade for Epidemiology was (88.11%) and for Fixed Prosthodontics (83.43%). In comparison, attendance was lower for Medicine II (57.78%), and the grade (88.22%) was comparable to Epidemiology and slightly better than Fixed Prosthodontics (Table 2). One of explanations for this high attendance in the previous two classes is that faculty members provided in-class assignments that encouraged the students to attend. This finding is supported by a Moore study, which found a positive relationship between attendance and grade if the students did not get credits for attendance.[25] The Medicine II class had the lowest attendance and this class had two separate lectures, where the second lecture was taken right after the first one on the same day with a total duration of three and half hours long. In addition, the second lecture was held late in the afternoon so many students did not attend the second lecture.

Secondly, we hypothesized an inverse relationship between online usage and attendance in basic science and pre-clinical dental courses. Online usage was measured as the total number of online accesses of resources in selected basic and pre-clinical dental courses for each participant. In general, we found no relationship

between online usage and attendance in basic science courses (r= -0.02, p= 0.83). However, Epidemiology had a weak to moderate negative correlation (r= -0.3, p= 0.0002) and pre-clinical courses overall had a weak negative correlation (r=-0.17, p=0.039) (Figure 2B). Having a weak negative correlation means that posting online lecture resources might not affect student attendance. This was supported by two previous studies, Bollmeier et al. study found no correlation between online usage and attendance.[6] Also Gagliardi et al. study, found that the availability of online resources did not affect attendance.[11] Although a correlation was not found or it was weak, most of the students, 111 (76.03%), thought that the availability of online resources could affect class attendance.

The third hypothesis was that there is a positive relationship between the use of online resources and student grades in basic science and pre-clinical dental courses. However, we found no correlation between these outcomes in basic science courses (r= 0.01, p= 0.903) or pre-clinical dental courses (r= -0.01, p= 0.936), which was similar to Bollmeier et al. finding.[6] The mean grades were similar for Fixed Prosthodontics and Infectious Disease (83%) however, online usage in Infectious Disease (18.66) was lower than the Fixed Prosthodontics course (27.58). Thus, the posting of online resources had no effect on grade. This finding was supported by a Schreiber et al. study, which found no significant different between students who used online resource and students who attended the same lecture in terms of student performance on questions distributed right after the lecture.[5]

Most of the students 112 (76%) had used online resources before they came to dental school. We hypothesized that students who had used online resources before

would use them more often than students who did not. However, our findings did not support this hypothesis.

Based on our survey, some students reported they could be more efficient with their time by using online resources. For instance, students can pause, replay and speed up a lecture. This finding was similar to two previous studies, Cardall et al.[9] and Allen et al. [12] With advances in technology and a reported increase in learning through online resources, there might be increases in student absences.[6, 13] The faculty members find other ways to attract students to attend lecture, such as through student motivation, in-class assignments, in-class interaction, extra points for attendance and participation, delay posting to encourage attendance, and to stop posting if attendance decreases. [6,13]

Students reported many reasons for missing lectures, such as teacher's teaching style (27%) and time of the lecture (12.3%). Our finding supported that the teacher plays a role in whether students attend or not. Additionally, students sometimes miss lectures if they are too early or late in the day. These findings were supported by a previous study, which found (40%) of students made their decision of attendance based on the teacher's ability to deliver the information in a manner that was easy to comprehend and (10%) of students missed lectures scheduled early in the morning. [11]

Many students (76.03%) reported that they were more likely to miss basic science classes. This was confirmed mainly through the Medicine II class, where the mean attendance was the lowest (57.78%). Also, the overall attendance in basic science courses (76.88%) was slightly lower than the overall attendance in pre-

clinical dental courses (79.58%) but was not statistically significant (Table 3). Moreover, non-science major students used more online resources in basic science courses especially in Medicine II, which is not surprising due to the level of difficultly of this subject.

Only 16 (10.9%) students preferred using lecture recording only over lecture PPT/PDF or a combination. This finding is supported by the research of Grabe et al., which found only (3%) of the class preferred to use the recording.[1] Therefore, the sole use of a lecture recording was not popular among the students, and they preferred a combination of lecture PPT/PDF and the recording.

The study had some limitations. The small sample size may not adequately represent the whole school or other dental schools. Attendance was collected based on recall information provided by the students, which might not be accurate. For Fixed Prosthodontics course, students might watch different content (simulation laboratory) that was not counted in this study. Online usage was counted as the total number of accesses by each student; however, we were not able to count the actual time spent by each student on watching or downloading the online resources. Some of the selected courses also continued until after the fall semester, which might influence final grades. Future research is needed to evaluate this relationship by observing the actual time each student spends watching or downloading online resources and by utilizing more accurate measures for attendance.

Conclusions

Students who do not attend lectures and subsequently utilize online resources may perform just as well on exams as the students who attend. There was no significant relationship between grade and attendance in basic and pre-clinical dental courses. Use of online resources did not affect final grades but may affect attendance. Previous use of online resources before attending dental school was not related to current use. Students preferred a combination of lecture PPT/PDF and recordings to enhance their learning. The majority of the students thought that the availability of online resources could affect class attendance. Teacher's teaching style and time of the lecture during the day might play a role in student attendance.

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Tables

Table 1. Descriptive analysis for demographic data

Variable	**Mean (SD)**
Age	24.83 (2.34)
	Number (%)
Gender	
Male	60 (41)
Female	86 (59)
Undergraduate Major	
Sciences	126(86)
Non-sciences	20(14)
Undergraduate online resources availability	
Yes	114 (78)
No	32 (22)

Table 2. The relationship between grade and attendance in basic science and pre-clinical dentsl courses.

Course	Grade	Attendance	Pearson correlation coefficient	P-value
Infectious Disease	83.12	77.65	-0.015	0.86
Epidemiology	88.11	95.21	-0.070	0.39
Medicine II	88.22	57.78	-0.055	0.51
Anesthesiology	90.28	77.91	-0.041	0.62
Fixed Prosthodontics	83.43	95.02	-0.022	0.79
Radiology	94.84	65.82	-0.033	0.7

* Statistical significant at p-value < 0.05

Table 3. Overall basic science and pre-clinical dental courses relationship with grade and attendance, attendance and online usage, grade and online usage.

	Courses	Mean Attendance	Mean Online usage	Mean Grade	Overall mean of grade (SD)	Overall mean of attendance (SD)	Overall mean of online usage (SD)	Relationship between attendance and grade r (p-value)	Relationship between attendance and online usage r (p-value)	Relationship between online usage and grade r (p-value)
Basic science courses	Infectious Disease	77.65	18.66	83.12	86.48 (5.73)	76.88 (20.37)	29.21 (7.89)	-0.05 (0.524)	-0.02 (0.830)	0.01 (0.903)
	Medicine II	57.78	54.46	88.22						
	Epidemiology	95.21	14.51	88.11						
Pre-clinical dental courses	Anesthesiology	77.91	39.28	90.28	89.52 (4.32)	79.58 (20.29)	31.33 (9.33)	-0.03 (0.733)	-0.17 (0.039)*	-0.01 (0.936)
	Fixed Prosthodontics	95.02	27.58	83.43						
	Radiology	65.82	27.12	94.84						

* Statistical significant at p-value < 0.05

Table 4. The relationship between online usage and attendance in basic science and pre-clinical dental courses.

Course	Online Usage	Attendance	Pearson correlation coefficient	P-value
Infectious Disease	18.66	77.65	0.074	0.37
Medicine II	54.46	57.78	0.10	0.22
Epidemiology	14.51	95.21	-0.30	0.0002*
Anesthesiology	39.28	77.91	-0.12	0.14
Fixed Prosthodontics	27.58	95.02	-0.115	0.17
Radiology	27.12	65.82	-0.15	0.068

* Statistical significant at p-value < 0.05

Table 5. The relationship between grade and online usage in basic science and pre-clinical dental courses.

Course	Grade	Online Usage	Pearson correlation coefficient	P-value
Infectious Disease	83.12	18.66	0.14	0.09
Medicine II	88.22	54.46	0.006	0.94
Epidemiology	88.11	14.51	-0.06	0.49
Anesthesiology	90.28	39.28	-0.03	0.73
Fixed Prosthodontics	83.43	27.58	-0.019	0.82
Radiology	94.84	27.12	-0.037	0.65

* Statistical significant at p-value < 0.05

Table 6. Students' attendance and online usage at undergraduate college versus at TUSDM.

Variable	Number	%
Type of online resources provided at undergraduate college		
Lecture PPT/PDF	83	56.85
Lecture Recording	2	1.37
Both	29	19.87
None	32	21.9
Uses of online resources undergraduate vs. at TUSDM		
More than at TUSDM	5	3.42
Same as at TUSDM	20	13.7
Less than at TUSDM	89	60.96
None	32	21.9
Attendance at Undergraduate college vs. TUSDM		
More than at TUSDM	37	25.3
Same as at TUSDM	58	39.7
Less than at TUSDM	19	12.6
None	32	21.9

Table 7. Students' online usage behavior at TUSDM.

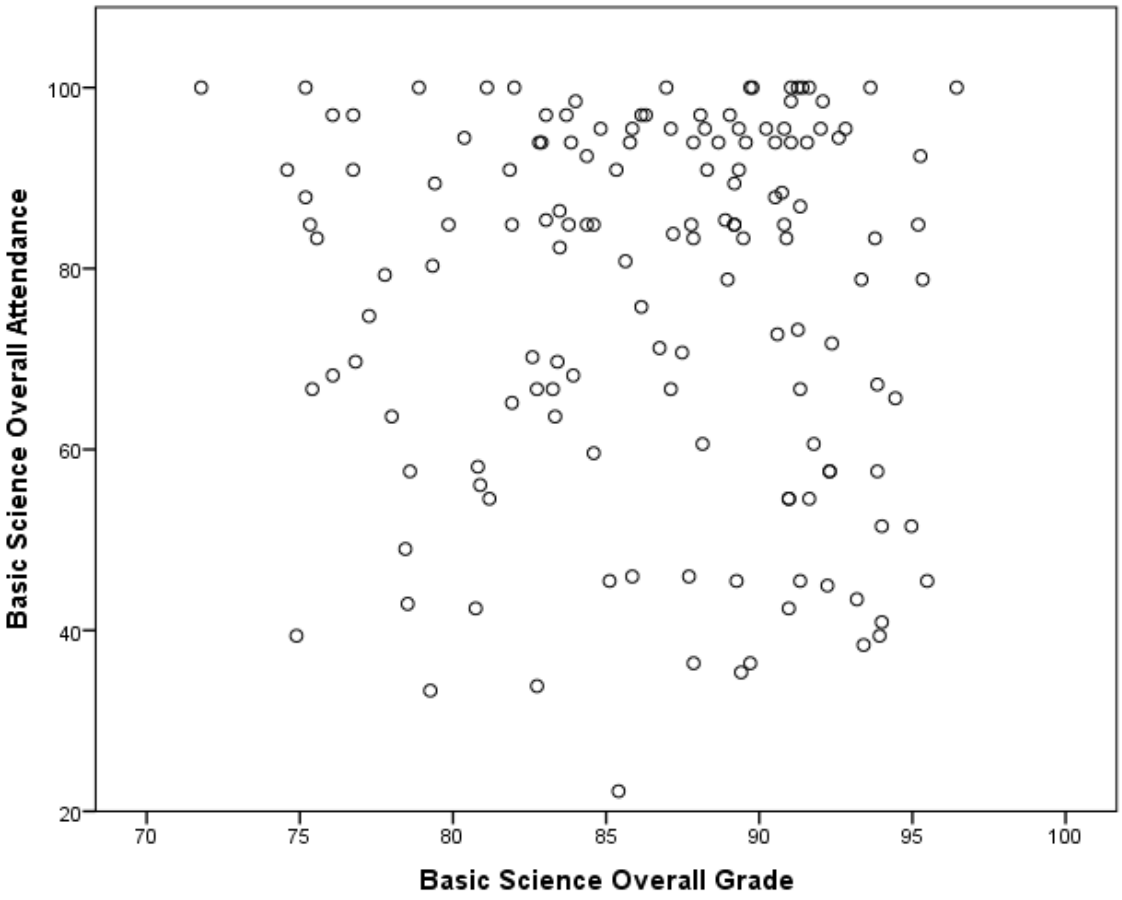
Variable	Number	%
The most used online resources		
Lecture PPT/PDF	57	39.04
Lecture Recording	16	10.9
Both	73	50
How do you use lecture PPT/PDF?		
Before the lecture time	2	1.37
During the lecture time	23	15.76
After the lecture in the same day	4	2.74
After the lecture in the same week	19	13.01
Before the exam	25	17.12
Whenever needed	73	50
How do you use lecture recording?		
Instead of attendance	23	15.8
In addition to attendance	22	15.1
After the lecture in the same day	1	0.68
After the lecture in the same week	19	13.10
Before the exam	52	35.62
Whenever needed	21	14.39
I do not use it	5	3.42
Main reason to use online resources		
Help to understand Lecture	56	38.4
Guide in studying	51	35
Review missed lecture	35	24
Other reason	4	2.7

Table 8. Students' attendance behavior at TUSDM.

Variable	Number	%
Main reason to not attend lecture		
Poorly organized	26	17.81
Teacher's teaching style	13	8.9
Time of the lecture	18	12.33
Combination	64	43.8
Other academic reason	11	7.5
Other personal reason	14	9.6
Does the availability of online resource affect class attendance?		
Yes	115	78.8
No	31	21.2
Type of course that was likely to be missed.		
Basic science courses	111	76.03
Pre-clinical courses	8	5.3
Not applicable	27	18.5

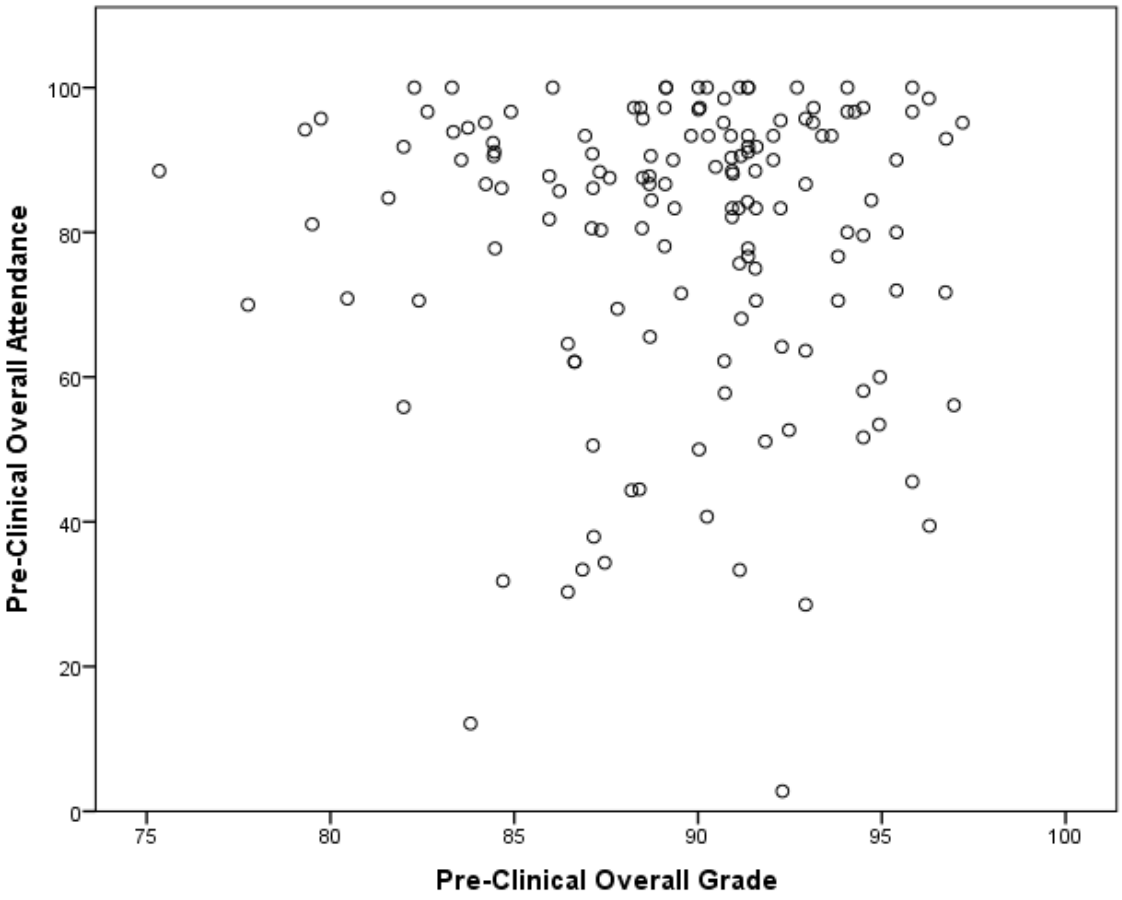
Figures

Figure 1A. The relationship between the mean of overall grade and the mean of overall attendance in basic science courses.



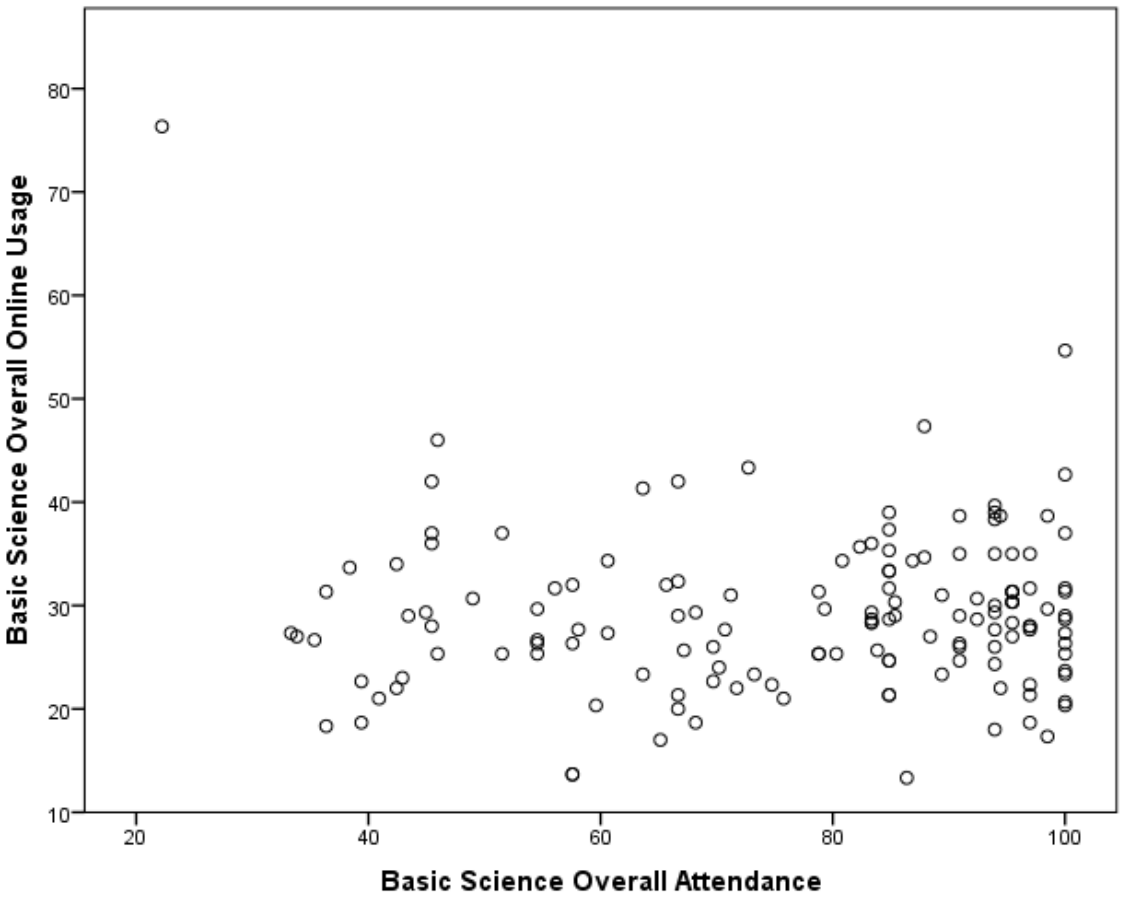
There was no significant correlation (r=-0.05, p= 0.524) between the mean overall grade and the mean overall attendance in basic science courses.

Figure 1B. The relationship between the mean of overall grade and the mean of overall attendance in pre- clinical dental courses.



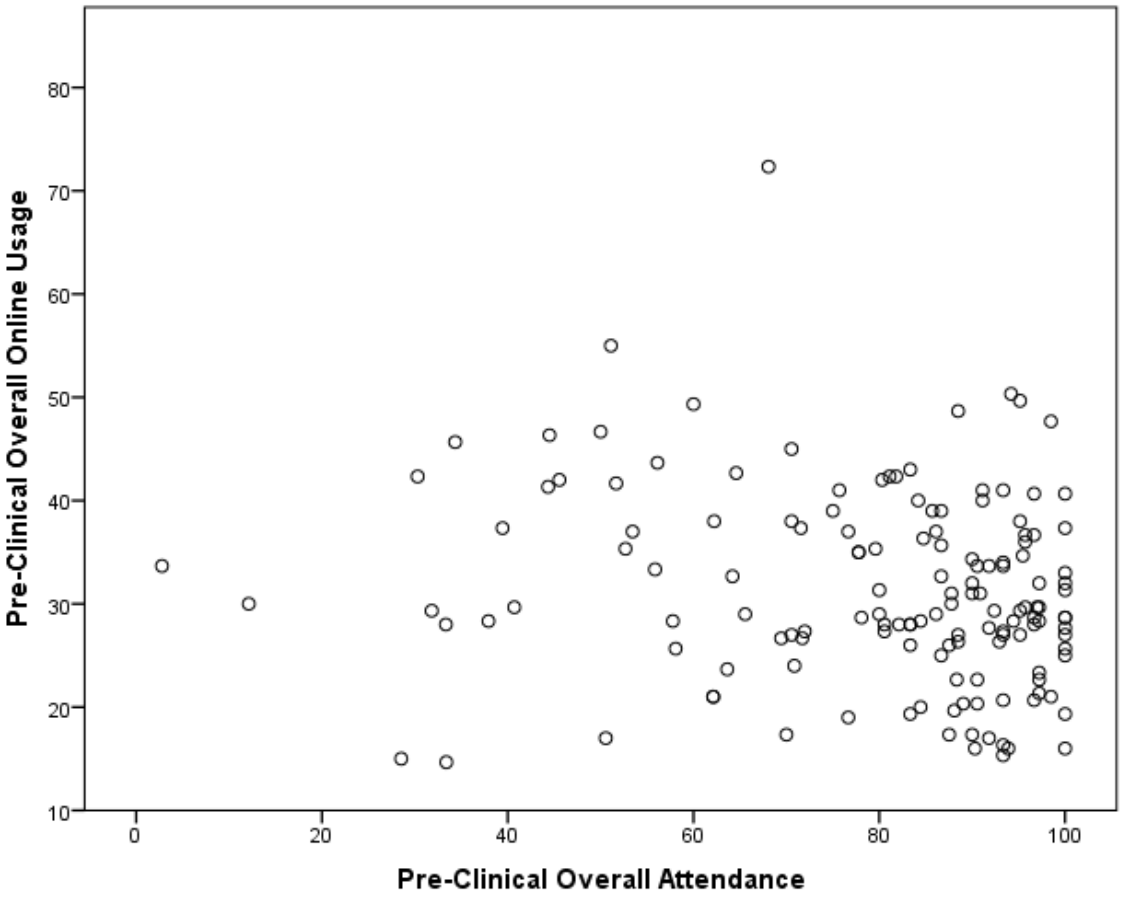
There was no significant correlation (r=-0.03, p= 0.733) between the mean overall grade and the mean overall attendance in pre- clinical dental courses.

Figure 2A. The relationship between the mean of overall attendance and the mean of overall online usage in basic science courses.



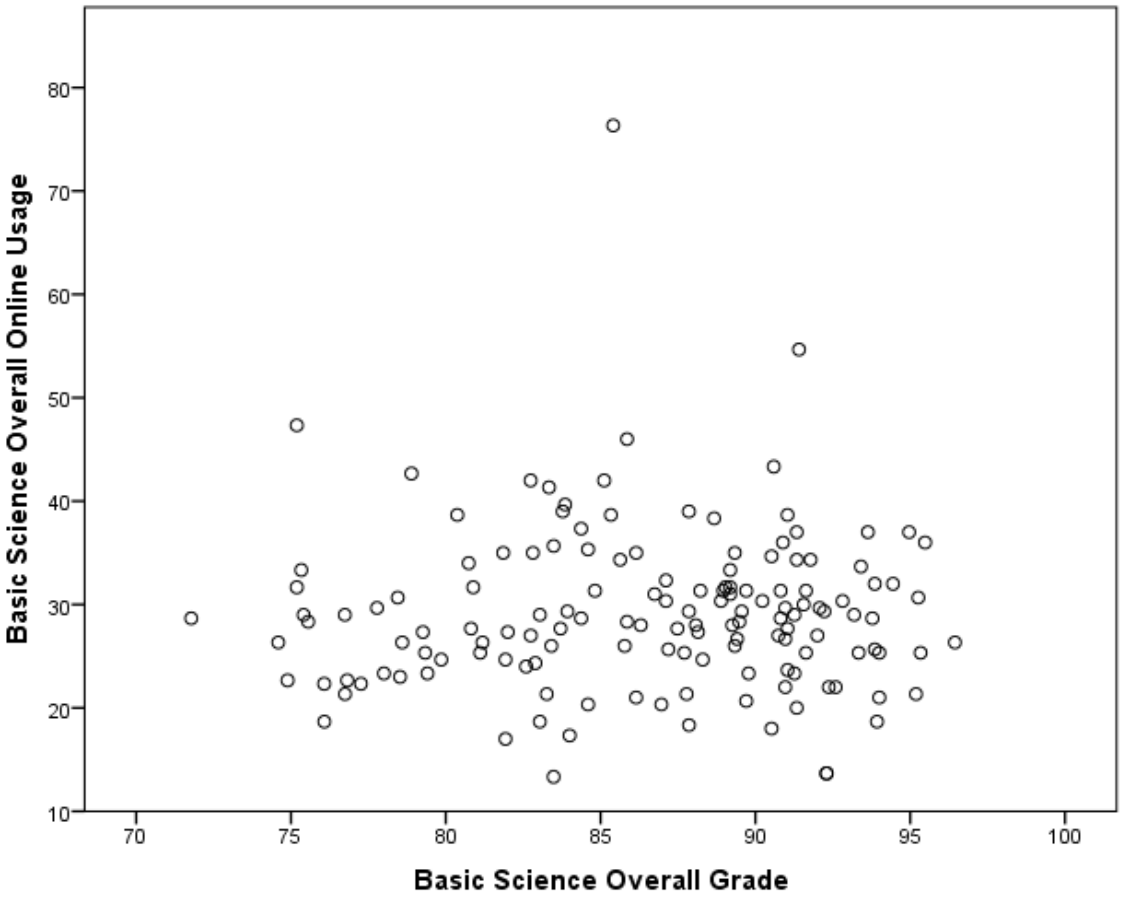
There was no significant correlation (r=-0.02, p= 0.83) between the mean overall attendance and the mean overall online usage in basic science courses.

Figure 2B. The relationship between the mean of overall attendance and the mean of overall online usage in pre-clinical courses.



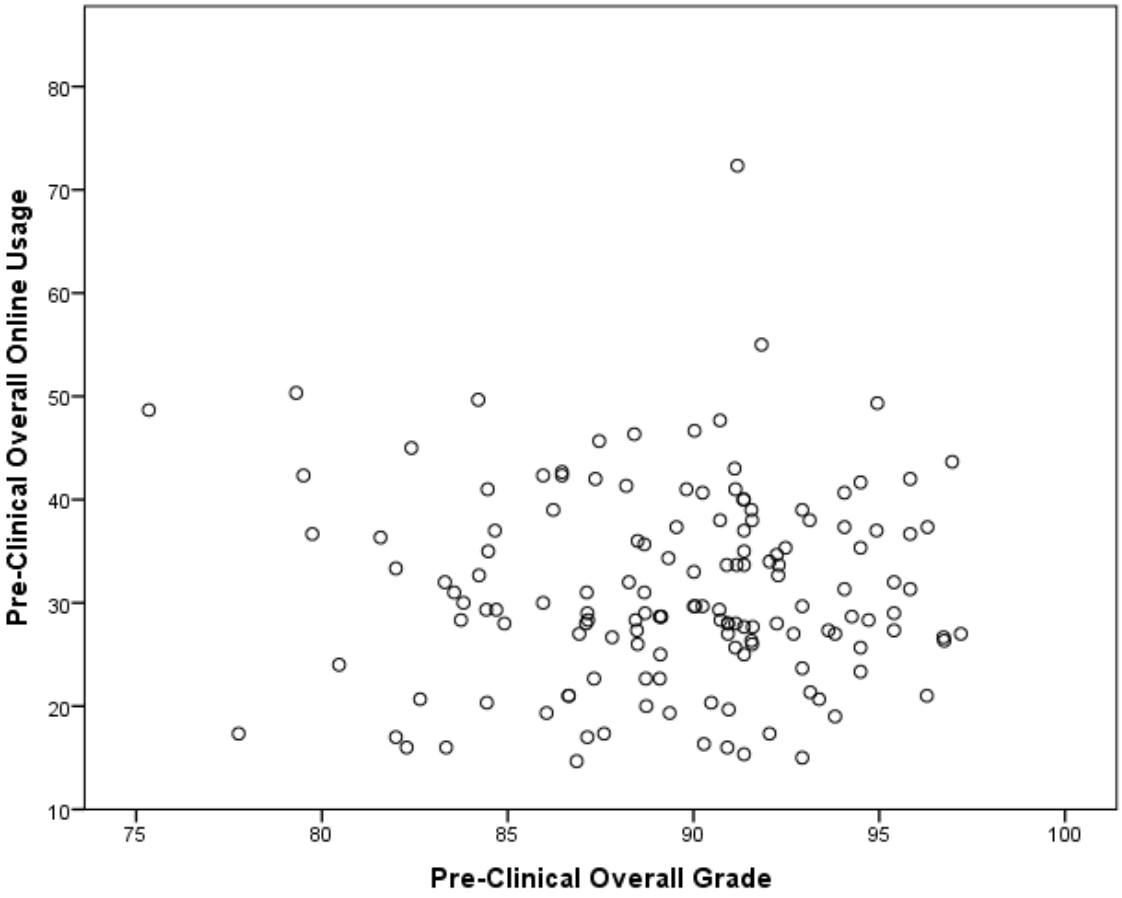
There was a significant weak negative correlation (r=-0.17, p= 0.039) between the mean overall attendance and the mean overall online usage pre-clinical dental courses.

Figure 3A. The relationship between the mean of overall grade and the mean of overall online usage in basic science courses.



There was no significant correlation (r=0.01, p= 0.903) between the mean overall grade and the mean overall online usage in basic science courses.

Figure 3B. The relationship between the mean of overall grade and the mean of overall online usage in pre-clinical courses.



There was no significant correlation ($r = -0.01$, $p = 0.936$) between the mean overall grade and the mean overall online usage in pre-clinical dental courses.

Figure 4. Students' online usage behavior for PPT/PDF.

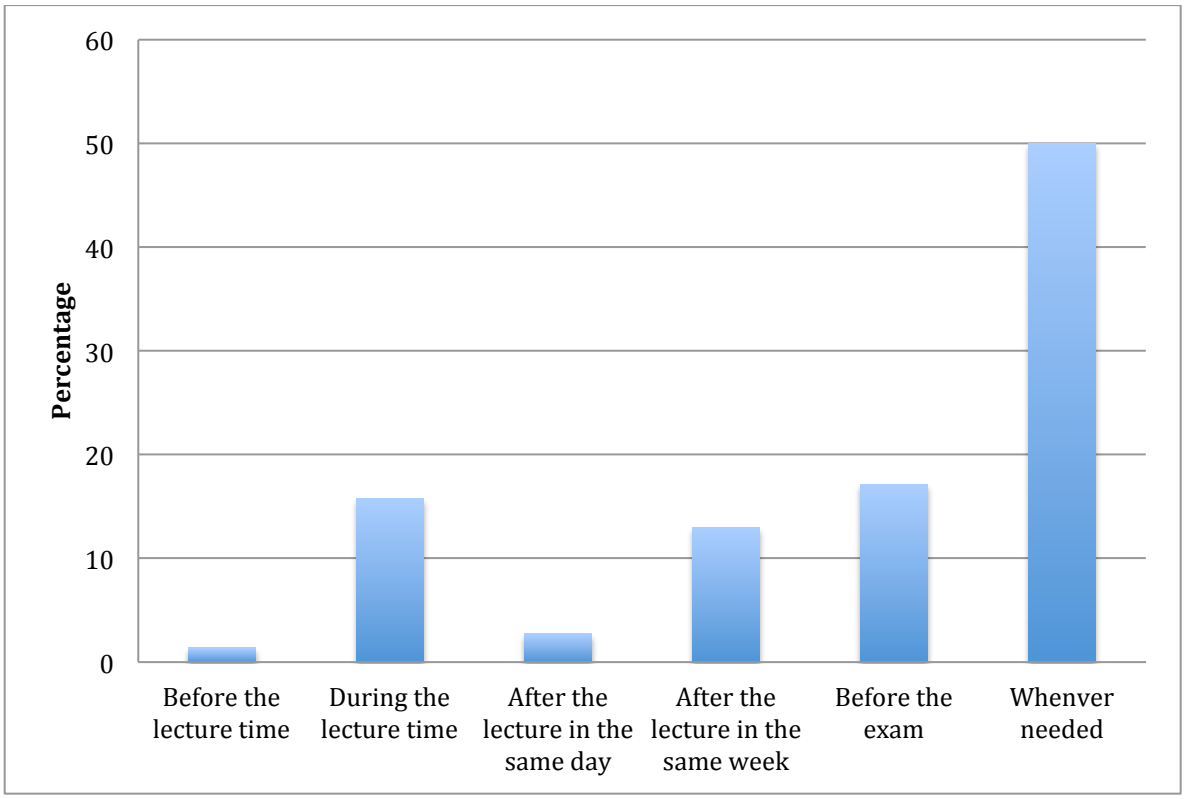
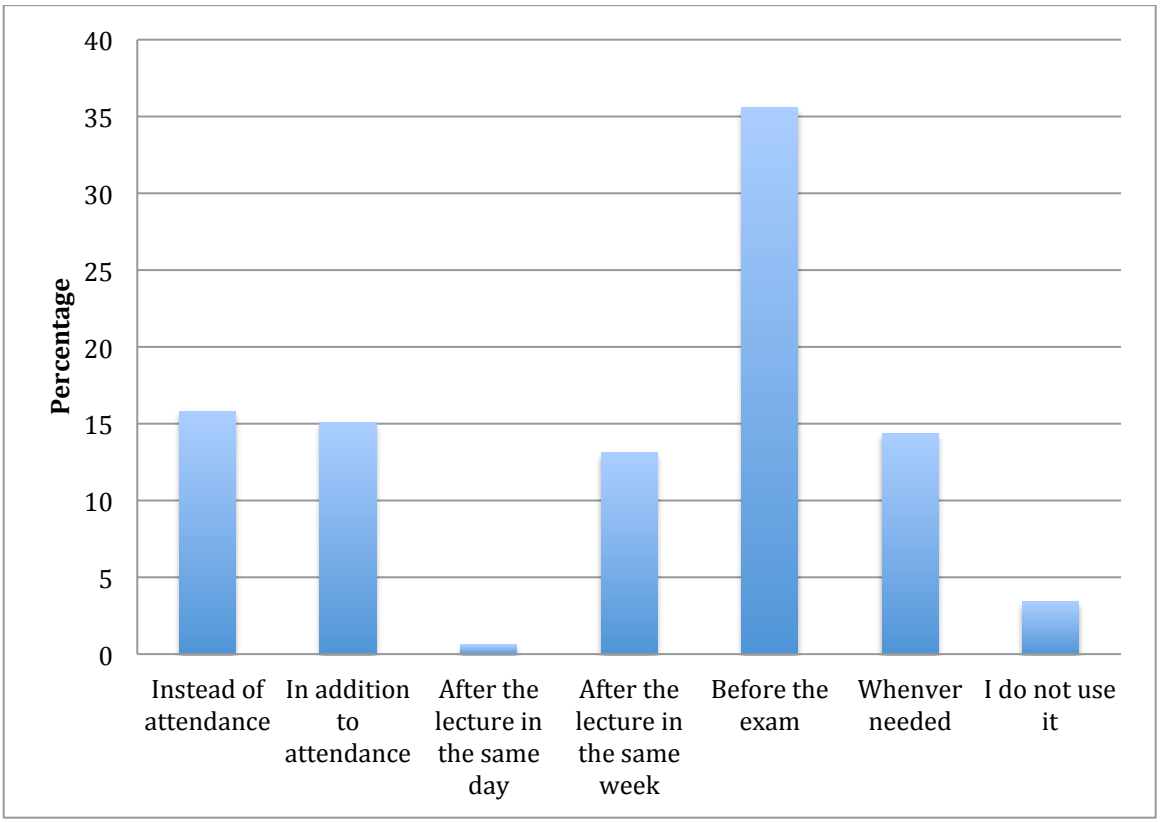


Figure 5. Students' online usage behavior for lecture recordings.



Appendix A. Survey

1) What is your Tufts ID# _____

2) What was your major? _____

3) What is your age? _____

4) What is your gender?

a) Male

b) Female

5) Did your undergraduate (Before dental school) college provide online resources? Example (lecture PowerPoint presentations, lecture recordings)

a) Yes

b) No

6) Type of online resources provided in undergraduate college:

a) Lecture PowerPoint Presentations (PPP)/PDF

b) Lecture Recordings

c) Both

7) As an undergraduate, I used _____ online lecture resources than/as at TUSDM

a) More

b) About the same

c) Less

8) As an undergraduate, I attended _____ lectures than/as at TUSDM

a) More

b) About the same

c) Less

9) Currently, which online resource do you use the most?
(Choose one)

a) Lecture PPT (PowerPoint) or PDF

b) Lecture recordings

c) Both equally

d) None

10) Please indicate how you use the following online resource (Lecture PowerPoint Presentation / PDF) (Circle one)

a) Before the lecture

b) During the lecture

c) After the lecture in the same day

d) After the lecture in the same week

e) Before the exam

f) I used more than once, whenever needed

g) I do not use PPP/PDF

11) Please indicate how you use the following online resource (Lecture recording) (Circle one)

a) I use the lecture recording instead of attending

b) I use the lecture recording in addition of attending

c) After the lecture in the same day

d) After the lecture in the same week

f) I used more than once, whenever needed

g) I do not use lecture recording

12) What do you think is the most important reason to use online lecture resources? (Circle one)

a) Help to understand the subject

b) Guide you during studying

c) Review the missed lecture

d) Other _____

13) What is the main reason you would not/do not attend a lecture?

a) Poorly organized or boring lecture

b) Time of lecture

c) Teacher's teaching style

d) Other academic reasons _____

e) Other personal reasons _____

14) Do you think availability of online resources affects class attendance?

a) Yes

b) No

15) If you do not attend lectures, are you more likely to miss?

a) Basic science courses lectures

b) Pre-clinical dental courses lectures

c) Not applicable.

16) Approximately, how many lecture did you miss in the Infectious disease course? (Out of 11)

a) 0

b) 1

C) 2

d) 3

e) 4

f) 5

g) 6

h) 7

i) 8

j) 9

k) 10

l) 11

17) Approximately, how many lectures did you miss in the Epidemiology course? (Out of 6)

a) 0

b) 1

C) 2

d) 3

e) 4

f) 5

g) 6

18) Approximately, how many lecture did you miss in Medicine II course? (Out of 22)

a) 0

b) 1

C) 2

d) 3

e) 4

f) 5

g) 6

h) 7

i) 8

j) 9

k) 10

l) 11

m) 12

n) 13

o) 14

p) 15

q) 16

r) 17

s) 18

t) 19

u) 20

v) 21

w) 22

19) Approximately, how many lecture did you miss in Anesthesiology course? (Out of 12)

a) 0

b) 1

C) 2

d) 3

e) 4

f) 5

g) 6

h) 7

i) 8

j) 9

k) 10

l) 11

m) 12

20) Approximately, how many lecture did you miss in the Radiology course? (Out of 10)

a) 0

b) 1

C) 2

d) 3

e) 4

f) 5

g) 6

h) 7

i) 8

j) 9

k) 10

21) Approximately, how many lecture did you miss in Fixed Prosthodontics course? (Out of 22)

a) 0

b) 1

C) 2

d) 3

e) 4

f) 5

g) 6

h) 7

i) 8

j) 9

k) 10

l) 11

m) 12

n) 13

o) 14

p) 15

q) 16

r) 17

s) 18

t) 19

u) 20

v) 21

w) 22

Appendix B. Data from TUSK

Log item id	User id	Date/Time	Course id	Content id
114207353	user01	2013-09-14 16:10:26	871	1641748
114208091	user02	2013-09-14 16:38:59	871	1641748
114209375	user03	2013-09-14 17:35:06	871	1641748
114216143	user01	2013-09-14 22:32:57	871	1641748
114216144	user04	2013-09-14 22:32:57	871	1641748
114216177	user04	2013-09-14 22:34:37	871	1641748
114217542	user02	2013-09-14 23:50:34	871	1641748

Alternatively, for a given user, we can query the database to see what items they viewed in a course over a certain timeframe. For example, display all pieces of content user06 has viewed in the Infectious Disease course:

Log item id	User id	Date/time	Course id	Content id
117546918	user06	2013-09-14 22:32:57	871	1641733
123179079	user06	2013-09-14 22:32:57	871	1641748
123179081	user06	2013-09-14 22:34:37	871	1641748
123195161	user06	2013-09-14 23:50:34	871	1641733
123195326	user06	2013-09-14 23:51:00	871	1641748