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On-line learning practices of millennial students in the flipped classroom

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Abstract

Millennials designate the generation born between 1982 and 2005. The millennials have a unique relationship to information technology which they consider an integral part of life. They tend to be always busy, impatient, and with a short attention span, which leads them to multitask using various forms of electronic communication and devices[1]. Millennial students are team-oriented; they prefer working in cooperative groups and learning experientially through trial-and-error (hacking).

The flipped classroom approach was popularized around 2007 as millennials were in high school. In this approach, short recorded lessons available online for the students to view before coming to class replace traditional classroom lectures. Class time is used for application exercises usually done in groups, experimentation, and other team activities in which student learning takes a central role. The flipped classroom approach appears well-suited to accommodate the unique characteristics of the millennial generation[2].

We investigated the lesson viewing patterns of two cohorts of engineering students enrolled in two college-level junior and senior flipped classroom courses on basic analog electronics and LabVIEW programming. The electronics course is offered in the Spring semester and comprises an even mix of juniors and seniors (~45 students/class). The programming course is offered in the Fall and Spring semesters to seniors (~25 – 40 students/class). Short (< 20 min) narrated PowerPoint lessons were posted on the Learning Management System. The latter kept track of whether the students viewed the lessons entirely (coded 1), in part (coded 0.5), or not at all (coded 0). The sum of the codes expressed as a percentage of the maximum represented the "viewing score" for each student in each course.

The viewing scores of 56 students who enrolled in both courses were highly and positively correlated ($p < 0.01$) suggesting that students tended to watch the lessons with similar assiduity for the two courses. There was no correlation between the viewing score and the final exam score in the analog electronics course ($p = 0.22$) while there was a significant positive correlation ($p < 0.01$) between the viewing score and the final exam score in the programming course. This observation could be linked to the availability of a textbook for the electronics course such that a fraction of students could have learned the course material mostly from the textbook. The video lessons were the main source of learning material for the programming course, such that viewing the lessons diligently would have benefited performance on the final exam. In the programming course, students had a lower viewing score for the Spring semester compared to the Fall (68 ± 28 vs. 85 ± 21, $p = 0.02$), possibly because getting closer to graduation decreased their motivation to study.

These results suggest that millennial engineering students vary in their approach to online learning in the flipped classroom with some students favoring traditional learning sources. Use of online lessons can be used to better understand the students' learning habits.

Introduction and background

The millennial generation designates students born between 1982 and 2005. Several traits have been identified that characterize the millennial students[2,3] including being constantly connected electronically to the internet and to each other, such that finding information online for immediate consumption is natural to them. Being part of a constantly evolving network of classmates and friends leads the millennials to be team-oriented and to find personal validation in the success of the group. Teaching methods that promote active learning in groups fit the team-oriented predisposition of millennial students[4]. The millennials are high achievers and expect immediate feedback for their work.

Several previous studies reported that traditional teaching methods, particularly the lecture, are ill-adapted to the characteristics and learning styles of millennial students[2,4]. In contrast, various reports suggested that the flipped classroom approach which started to be popular when the first groups of millennial students were in high school presents several characteristics that are suitable to the millennial generation[1,5]. Content material is usually delivered electronically through recorded video lessons or screencasts. The video lessons can be curated to focus on the most essential content and limited to 20 min or less which appeals to short attention span of the millennials[3]. The flipped classroom emphasizes learning as opposed to teaching with group problem solving, collaborative activities, and other forms of active learning that keep the students engaged and active. The active learning activities performed in groups in the classroom with instructor guidance represent a distinct difference between the traditional lecture and the flipped classroom that renders the latter mode of instruction better suited to the distinct learning style of the millennial generation[2,3].

The flipped classroom appears well adapted to acquiring procedural knowledge, including engineering problem-solving because the procedural steps can be presented succinctly in the video lessons[5]. The students gain abundant practice applying the procedures in class with guidance from their classmates and from the instructor. The flipped classroom promotes several principles for good practice in undergraduate education[6]. Frequent and informal contacts between students and the instructor take place while the instructor roams the classroom and works with the student groups on their problem-solving activities[7]. Students are engaged in active learning and work in groups. Discussing and explaining to one another their problem-solving strategies strengthens knowledge acquisition[8].

Implementation of the flipped classroom approach in engineering courses increases students' performance on exams in upperclassmen (college juniors and seniors) in comparison with traditional lecture-based teaching[7]. For the present study, we tracked the video lesson watching habits of engineering upperclassmen in two required courses of our curriculum. For the same course, we found differences in the fraction of video lessons watched by students in their last semester of study before graduation when compared to taking the same course the prior semester. Students tended to watch video lessons with similar levels of regularity across courses. Assiduity in tending to the video lessons correlated with exam performance only for one of the two courses examined in the study.

Methods

The "Medical Electronics" ("Med. Elec.") course at our institution is a 4-unit required course in the curriculum of our Biomedical Engineering undergraduate program with an enrollment of about 50 juniors and seniors. The course with laboratory is offered in the Spring semester and it presents the analysis and design of analog electronic functions commonly found in measurement systems and medical instruments, as well as the components used to implement these functions in hardware. The "Measurement and Instrumentation" ("Meas. & Instr.") course is also a 4-unit required course which is offered both in the Fall and in the Spring semester to accommodate the ~ 60 senior students of our undergraduate program. The in-class part of the course presents principles of engineering design and graphical programming in LabVIEW (National Instruments). Students work on their senior design projects in teams of four students in the laboratory portion of the course. They use LabVIEW to develop the software that runs the prototype medical instruments they design and implement for their capstone design project. Students enroll either in the Fall offering or the Spring offering of the course based on their study plan.

Both courses are taught using the flipped classroom approach with narrated video lessons prepared by the instructor using PowerPoint (Microsoft) and Camtasia Studio 8 (Techsmith). The ~15-20 min-long video lessons present the course content and a few application examples. The students are asked to view the video lessons posted on the course Learning Management System (LMS) Blackboard Learn (Blackboard Inc.) before coming the classroom. The LMS is programmed to track whether the students watch the video lessons completely, in part (in progress), or not at all. In the classroom, students work in groups on application exercises which involve circuit analysis and circuit design for the "Med. Elec." course and programming exercises for the LabVIEW portion of the "Meas. & Instr." course. For the latter, the students discuss and help each other while working on the in-class exercises but they work on their individual computers which does not allow for the same level of interaction as the exercises of the "Med. Elec." course. For both courses, the instructor and teaching assistant roam the classroom and answer questions or assist student groups and individual students.

Grading of the students in the "Med. Elec." is based in part on a midterm exam and a final exam which comprise 25 – 40 objective questions that test the students' abilities to analyze electronic circuits. Students in the "Meas. & Instr." course receive a group project score for their senior design project. The students also receive individual scores for in-class exams in which they develop short LabVIEW programming assignments that satisfy specified requirements. The exam scores are assigned using rubrics that compare the students' work with the requirements of the assignments.

For this study, we selected students who enrolled in both courses over two years (2015 – 2016) when the courses used the flipped classroom approach. All these students took the "Meas. & Instr." course as seniors while about half took the "Med. Elec." in the Spring semester of their junior year. Retrospectively, the viewing record of the students was retrieved from the LMS for each video lesson and scored as 1 (completed), 0.5 (in progress), or 0 (not viewed). The "Med. Elec." course content was presented over 12 video lessons while the LabVIEW programming content of the "Meas. & Instr." course was covered in 17 video lessons. The lesson scores were added and the sum divided by the maximum possible score represented the viewing scores of the students on a 0 – 100% scale.

To analyze the data, we compared the viewing scores of the students who took the courses in the Fall semester and in the Spring semester to determine if there was an influence of time of enrollment on the students' assiduity in watching the video lessons. The viewing scores received by the same students in the two courses were compared to determine if their viewing habits in the two courses were correlated. We also examined the relationship between the viewing scores of the students and their marks on the midterm exam and final exam. All analyses were performed using SPSS.

Results

Fifty-six students completed the two courses over the two-year period for which the data is analyzed. Among these students, 19 completed the “Meas. & Instr.” course in the Fall semester and 37 completed the course in the Spring semester.

The average viewing score in the two courses was approximately 68 ± 26 % (Table 1). Viewership was significantly higher for the Fall offering of the Meas. & Instr. course when compared to the Spring offering ($p = 0.02$) while average viewership was equivalent for the two Spring courses.

	“Med. Elec.” (Spring)	“Meas. & Instr.” (Spring)	“Meas. & Instr.” (Fall)
Viewing score	63 ± 27	68 ± 28	$85 \pm 21^{*}$

Table 1: Percentage of online lessons viewed (viewing score) for the two courses

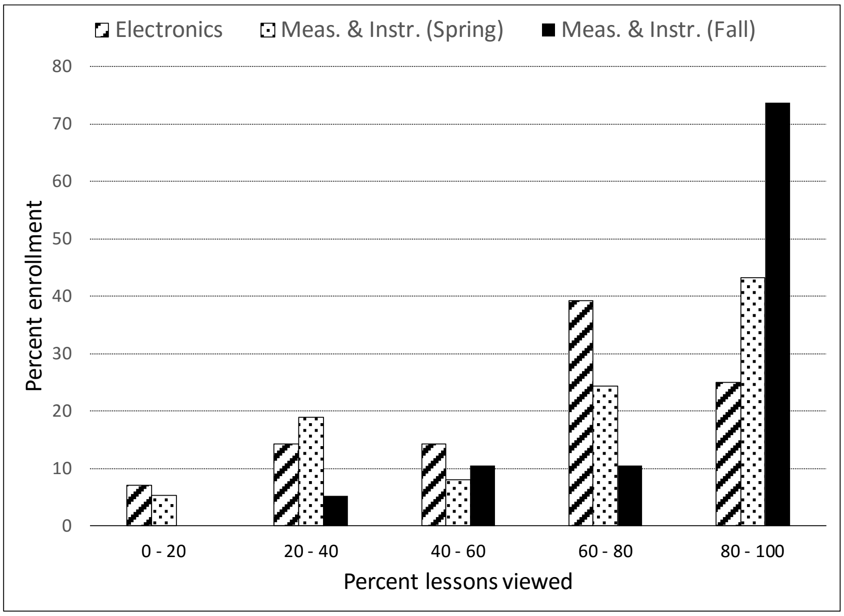

Figure 1: Viewership level for the two courses and semesters

In the Fall semester offering of the “Meas. & Instr.” course, nearly 75% of students watched 80% - 100% of the online lessons (Figure 1). For the Spring offerings, slightly more than 40% of students from the “Meas. & Instr.” course and 25% of students from the Electronics course had an equivalent level of assiduity in watching the online lessons.

The viewing scores of the students in one course were significantly correlated with their viewing scores in the other course. The coefficient of correlation (r) was 0.51 ($p < 0.01$) when considering only the Spring semester enrollees and 0.41 ($p < 0.01$) when considering all the students.

Scores on the midterm exam and final exam in the “Med. Elec.” course were not correlated with the viewing scores of the students (midterm: $r = 0.13$, $p = 0.33$; final: $r = 0.17$, $p = 0.22$).

In contrast, the midterm exam and final exam scores in the “Meas. & Instr.” course were significantly correlated with the students’ viewing scores (midterm: $r = 0.34$, $p = 0.01$; final: $r = 0.37$, $p < 0.01$)

Discussion

The flipped classroom model has been presented as well-suited to the study habits of the millennial generation who is comfortable with acquiring information through visual media, has a short attention span that is mismatched with hour-long classroom lectures, and who appreciates learning by doing and cooperative group work in the classroom[2].

The flipped classroom model assumes that the students learn fundamentals of the subject matter before coming to class, sometimes through readings[9] but much more commonly by watching pre-recorded online video lessons selected by the instructor as preparation for the in-class activities[1,10]. Class-time is used for practice exercises, applications, and explorations done in small groups[9,10].

Our study was conducted on a homogeneous cohort of engineering college students enrolled in the same degree program and for whom the two flipped classes are degree requirements. The students take these courses during the last 3 semesters of their B.S. degree program. In our study, students watched on average 68% of the course content available through online video screencasts. Few studies have examined the extent to which students access the preparatory material in flipped classroom settings, but related issues have been investigated. Kay and Kletskin[11] tracked access to short video demonstrations developed to teach problem-solving procedures for a pre-calculus class and found that about 66% of students used the video podcasts. The fraction of students who find the flipped classroom approach to be beneficial to their instruction has been reported[9] to vary between 60% and 80%.

Our results revealed three trends:

1. Students were more assiduous in watching the video lessons for the Fall offering of the “Meas. & Instr.” course in comparison with their preparation habits for the Spring semester offerings of “Meas. & Instr.” and “Med. Elec.”.
2. The fraction of video lessons the students watched in one course was correlated with the fraction of video lessons the same students watched in the other course.
3. Students performance as measured by exam scores was only correlated with the percentage of video lessons watched for the “Meas. & Instr.” course and not for the “Med. Elec.” course.

Students enrolled in the “Meas. & Instr.” course during the Fall semester of their senior year likely still feel fully engaged in their course work. In contrast, students who take the course in the Spring semester approach graduation from college. The search for a job or a graduate degree program accompanied by visits and interviews brings distractions to school work. Students who have been offered a job or have been accepted in graduate or professional school may be less motivated to study during their last semester of college studies. These factors could decrease the available time and the motivation for preparing for class by watching the video lessons.

Viewership of the “Meas. & Instr.” video lessons for the Spring offering of that course was higher than the viewership of the lessons of the “Med. Elec.” course, particularly with respect to viewing 80% of more of the online course content. Two factors could have contributed to this difference.

First, engineering students consider their senior design project an important component of their education which they list and describe in their resume when looking for employment or graduate schoolwork. Because the content of the video lessons in the “Meas. & Instr.” course is fundamental to the computer programming aspects of the senior design projects the students complete as part of the course, the students could have been incentivized to watch the video lessons and acquire the programming skills necessary to their senior design project. In contrast, the “Med. Elec.” course is essentially self-contained such that not knowing the course material well only affects the students’ performance in that specific course, with a small related effect to their overall grade point average.

Second, the “Med. Elec.” course uses a textbook such that some students could have preferred studying the course material from the textbook as opposed to the video lessons. Modern electronics textbooks present numerous illustrations and solved sample problems which facilitate learning and which could have appealed to these students. In contrast, the video lessons are the primary source for learning visual programming in LabVIEW for the “Meas. & Instr.” course which does not use a textbook for lack of an available suitable text.

The percentage of lessons viewed by a student in one course was highly correlated with the percentage of lessons viewed by that student in the other course. This observation could reflect differences in motivation among students, with the more studious students studying with similar levels of assiduity in different courses. In addition, and as mentioned above, different students favor the flipped classroom format to different extents[9]. The students more comfortable with the approach likely tended to prepare for class by watching the video lessons to a similar extent across courses.

Student performance on exams was not correlated with viewership of the video lessons for the “Med. Elec.” course but was correlated with the percentage of lessons viewed for the “Meas. & Instr.” course. Learning in the flipped classroom takes place essentially during the group activities and practice exercises done in the classroom[1,10]. Students who did not view the video lessons assiduously for the “Med. Elec.” course could have developed sufficient problem-solving skills from the class activities to succeed on the exams which were focused on circuit analysis and problem-solving. Other students may have viewed the lessons but not benefit as much from the in-class group activities. Students in the “Meas. & Instr.” course view the lessons to prepare for programming exercises in class. They discuss the exercises and receive guidance from the instructor but have less interactions with each other because each student works at his or her own computer. In addition, the programming exercises assigned for the exams relate more tightly to the course content in the video lessons such the viewership of the lessons could have conditioned performance on the exams.

Among the limitations of the study, information on the amount of video lesson material the students viewed was collected after the courses were completed such that we could not determine if the students had watched the lessons as intended in time to prepare for the flipped classroom exercises or if they watched the lessons later to prepare for exams. We did not have the exact fraction for each lesson watched and resorted to an ordinal coding (1, 0.5. 0) dependent on whether the students had watched the lessons entirely, in part, or not at all. Partial viewing could have ranged from viewing almost all the lesson to viewing only a small fraction. More importantly, we had no means of knowing if the students were viewing and studying from the lessons or if the videos were just being played.

Conclusions

We examined the video-lesson viewing habits of a homogeneous cohort of millennial engineering students enrolled in two upper-level undergraduate courses structured according to the flipped classroom approach. We found that on average, students watched about 2/3 of the video lessons with differences that could be attributed to the semester during which the students took the course within their college training and to the course topic. Presently, we have started to embed short electronically-scored quizzes in the video lessons of the Electronics course[10]. The embedded quizzes present short problems to solve and provide immediate feedback to the students and the instructor to let them know how well the course content is understood from watching the video lessons[2]. The quizzes have a token value toward the final course score. We will examine if adding these quizzes increases the percentage of lessons viewed by the students.

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