Research Article

Student use of flipped classroom videos in a therapeutics course

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ABSTRACT

Purpose: To evaluate the extent of student use of flipped classroom videos. Methods: This was a cross-sectional study conducted in a college of pharmacy therapeutics course in the Unites States. In one section of the course (four sessions) all content was provided in the form of lecture videos that students had to watch prior to class. Class time was spent discussing patient cases. For half of the sessions, there was an electronic quiz due prior to class. The outcome measure was video view time in minutes. Adequate video view time was defined as viewing ≥75% of total video duration. Video view time was compared with or without quizzes using the Wilcoxon signed-rank test. Results: There were 100 students in the class and all were included in the study. Overall, 74 students had adequate video view time prior to session 1, which decreased to 53 students for session 2, 53 students for session 3, and 36 students for session 4. Median video view time was greater when a quiz was required [80 minutes (IQR: 38–114) versus 69 minutes (IQR: 3–105), p < 0.001]. The mean score on the exam was 84 ± 8 points (out of 100). There was a significant association between video view time (per 50% increment) and score on the exam (coefficient 2.52; 95% CI: 0.79–4.26; p = 0.005; model $R^2$ = 7.8%). Conclusion: Student preparation prior to the flipped classroom is low and decreases with time. Preparation is higher when there is a quiz required.

Introduction

Teaching methods in higher education are evolving to include active learning that incorporates student interaction and problem solving. Active learning has been shown to be more effective than traditional lecture in terms of student performance.1 The use of the “flipped” classroom is one method that can be used to create time for active learning, and the method is gaining momentum in both K-12 and higher education.2 In health sciences education, the flipped classroom has been shown to be more conducive to learning than traditional methods and is increasingly being incorporated into courses.3 Flipping involves preparation by students ahead of time so that class time can be spent on interactive exercises. Content is first provided to students in the form of video or audio lectures or readings. The students are to review this material ahead of class time so that the time spent with the instructor can be optimized to focus on content application. Effectiveness of this “flipped” classroom requires students to prepare adequately prior to class. Literature regarding the extent of student preparation prior to the flipped classroom is limited, particularly in the health sciences literature.

In one college of pharmacy, an introductory pharmaceutics course was modified from traditional lecture to the flipped classroom.4 Faculty created video lectures for each class session, and class time was used for interactive activities. In general, the

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students considered this method more effective for learning, and students rated the course significantly higher (p < 0.05) on an end-of-course survey. However, the faculty time commitment required to prepare the course increased three-fold, and managing the class required an additional 20 hours per week of teaching assistant time annually. The new approach only resulted in a 2.5% increase in exam scores. Unfortunately, the proportion of students that viewed the videos and prepared prior to class was not reported.

The primary objective of this study was to determine the extent to which students viewed prepared lecture videos before class after a flipped classroom format was instituted. The secondary objectives were to determine if student viewing of videos was higher with the use of quizzes on the material and if lecture video viewing prior to class was associated with quiz and exam scores.

**Methods**

**Study design and setting**

This was a cross-sectional study conducted at the University of Arizona College of Pharmacy. The study was determined to be exempt by the Institutional Review Board.

**Subjects**

The study included all students (n = 100) enrolled in a six-credit-hour therapeutics course. The course was offered to students in the second year of the professional program.

**Intervention**

The flipped classroom format was used for the first module of the therapeutics course, which covered critical care therapeutics over four two-hour class sessions. Lecture content was pre-recorded in short videos and made available to students via the course website using Desire2Learn course management software. Students were able to view the videos asynchronously 24 hours per day. The lecture videos were created using Explain Everything™ (Version 2.60) Interactive Whiteboard software on an iPad (Apple, Inc.) by the course coordinator. Lectures were divided into seven to ten video segments of approximately five minutes each. The videos were created using an upbeat tempo and were kept short in duration in hopes of achieving better student engagement. The videos contained content similar to what would have been provided during an in-class lecture of the same topics. Students were expected to view the lecture videos prior to attending class. No other preparation or reading materials were required. Class time was spent discussing patient cases so that students could apply content covered in the videos. Quality of participation in analysis of patient cases during class was not graded.

The two-hour flipped class sessions included session 1 (pain, agitation, and delirium); session 2 (sepsis); session 3 (cardiac dysrhythmias); and session 4 (advanced cardiac life support). Before sessions 1 and 3, students were required complete an online open book quiz before arriving to class (ten points each). The students were notified of quiz dates at the start of the course and were told that the quiz questions were based on the lecture videos. The quizzes were open book so that students would have access to the videos in order to clarify concepts while they were taking the quiz. There was no required quiz prior to sessions 2 and 4. At the end of the module, a multiple choice closed book exam was administered to the students (100 points total). The flow of the module in this course is depicted in the Figure.

**Data collection and measures**

Video viewing times by student, quiz scores, and exam score were collected. The course website automatically maintains video viewing statistics for each student that can be accessed by the course coordinator. Video viewing statistics were downloaded prior to each class session to determine the view time for each student. Percent lecture video view time (defined as time online divided by total length of video) of ≥75% was considered to be adequate viewing. Quizzes were automatically graded by the D2L course management software. The exam was taken in-class by the students on Scantron® forms and graded by the college’s grading machine.

**Data analyses**

The primary outcome of interest was the number of students with a lecture video view time percent of ≥75%. Though there is no well-accepted breakpoint for this measurement, the upper quartile was selected and considered to be a reasonable breakpoint. View-time percentage was gathered for each of the four in-class sessions as a dichotomous variable and reported descriptively. The secondary objective was to compare video view time between quiz and no quiz sessions. Thus video view time was also totaled for sessions 1 and 3 (quiz required) and sessions 2 and 4 (no quiz required). Median video view time was compared between the quiz and no quiz periods using the Wilcoxon signed-rank test. Video view time for the quiz and no quiz periods were standardized to 100 minutes each to enable comparisons of medians.

Another objective was to evaluate if video view time was associated with improved student performance as defined by quiz scores and exam score. The association between quiz view time and quiz score was evaluated using logistic regression analyses. The quizzes were dichotomized as full points versus less than full points. A linear regression analysis was used to evaluate the relationship between total video view time and exam score. The coefficient was reported per 50% increment in view time. An α = 0.05
was used for all analyses. All analyses were conducted in STATA 13 (College Station, TX).

## Results

The study cohort included 100 students, which included all the students registered for the class. Seventy-four students had \( \geq 75\% \) video view time prior to session 1, and this decreased to 53 students for session 2, 53 students for session 3, and 36 students for session 4. The Table contains data for each 25% increment in video view time. Fourteen students did not watch any video prior to session 1, and this increased to 30 students for session 2, 43 students for session 3, and 59 students for session 4. The majority of students who watched any video (\( > 0\% \)) maintained their video view time to greater than 75%. Median video viewing time (out of 100 minutes) was greater when a quiz was required prior to class [80 minutes (IQR: 38–14) versus 69 minutes (IQR: 3–105), \( p < 0.001 \)].

The scores (0–10 points) on quiz 1 for the student cohort were as follows: 48 students received 10 points; 11 students received nine points; four students received six points; and one student received five points. Adequate video view time (\( \geq 75\% \)) prior to quiz 1 was associated with increased odds of responding correctly to all quiz questions (OR = 2.25; 95% CI: 1.28–3.94; \( p = 0.005 \)). The scores (0–10 points) on quiz 2 were as follows: 80 students received 10 points; 11 students received nine points; seven students received eight points; and two students received seven points. Adequate video view time (\( \geq 75\% \)) prior to quiz 2 was not significantly associated with an achieving full points (OR = 1.49; 95% CI: 0.56–4.00; \( p = 0.424 \)). The mean score on the module exam was 84 ± 8 points (out of 100), and there was a significant association between video view time (per 50% increment) and score on this exam (coefficient 2.52; 95% CI = 0.79–4.26; \( p = 0.005 \); model \( R^2 = 7.8\% \)).

## Discussion

The key finding of this study was that preparation prior to a flipped classroom was low and occurred in only 36% of students by the fourth session. It is interesting that prior to the first session, close to three-fourths of students prepared. This decreased with

### Table

<table>
<thead>
<tr>
<th>Proportion of total video viewed by students (%)</th>
<th>Session 1 [quiz] Number of students</th>
<th>Session 2 [no quiz] Number of students</th>
<th>Session 3 [quiz] Number of students</th>
<th>Session 4 [no quiz] Number of students</th>
</tr>
</thead>
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<td>&gt;0</td>
<td>86</td>
<td>70</td>
<td>57</td>
<td>41</td>
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<td>38</td>
</tr>
<tr>
<td>≥50</td>
<td>77</td>
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<td>≥75</td>
<td>74</td>
<td>53</td>
<td>53</td>
<td>36</td>
</tr>
</tbody>
</table>

* Values reported are number of students (N = % because there were 100 students).
each subsequent session. It is possible that students were uncertain about what to expect prior to the first session, and this lead to greater preparation initially with levels decreasing as students became more familiar with the course format. It is also surprising that only half of the students prepared prior to the third session even though a quiz was required. One possible explanation for this finding is that students found that they were able to answer the questions using other resources (i.e., internet) during the first quiz rather than spending time viewing the videos ahead of time. The course coordinator developed the quizzes primarily as an incentive to view the videos. In retrospect, more challenging questions, a closed book quiz in class, shorter time allocation for the quiz, or higher stakes for poor performance during application of material presented on videos during class case discussions might have led to greater video viewing. It was anticipated that greater preparation prior to class would have a positive association with quiz and exam scores. This was true only for some of the assessments, showing an inconsistent effect.

As instructors in the health professions adapt their courses to include greater interactive learning and application, there are a few important caveats to consider. Based on our findings related to the approaches we used to stimulate viewing, instructors should anticipate that less than half the class might prepare by reviewing assigned course content ahead of time. However, those students who initiate video viewing may also sustain their viewing. This suggests that the most important challenge may be to get students to start viewing in order to sustain their attention. Limited preparation has the potential to affect in-class participation in various group activities and exercises. Anecdotally, it was observed that a considerable number of students relied on their group members or watched videos during class time to get caught up on the content in order to answer the cases.

Another important factor to consider is the resources involved in flipping the classroom. All lecture content must be prepared ahead of time, and additional cases and exercises must be developed for the in-class sessions. The recording of content and preparation of cases greatly increased the workload of the course coordinator (who was also the instructor) compared to prior semesters. A three-fold increase in initial workload as consistent with a prior study is a reasonable estimate, though it is anticipated that some content may last more than one year and the ease of preparation with more advanced understanding of recording and preparation techniques will reduce preparation time. According to one estimate, the financial cost of conversion to a flipped classroom for medical students was $8763 initially and then $2657 annually. It would be interesting to know how institutions might plan to cover extra costs incurred if instructors are encouraged to modify their courses to this format. It is also important to consider the cost to students. Piling on additional homework in the guise of videos to be watched can add to the time spent working on a course. Clearly, the in-class exercises must also be designed well and used to advance learning.

Educational experts generally agree that engaging students via active participation and application of content adds more value to class time. This has been shown to improve student perceived retention of material and overall satisfaction with courses. This is true in the health professions, where instructors are able to share their insight and approach to problem solving with regard to patient care scenarios. Unfortunately, it is common for even highly experienced instructors to feel obligated to cover all possible content, minimizing the potential practical value they bring to the classroom.

Evidence supporting the effectiveness of flipped classrooms has been mixed, with little high-quality evidence available. Some studies have shown a lack of effect on grades. Also, the inclusion of active learning in a non-flipped classroom yielded equivalent conceptual learning compared to a flipped classroom in one study. This suggests that as long as some active learning is incorporated, flipping the classroom may not be necessary. Flipping via videos should also be compared to other approaches such as required completion of readings and homework cases or problems in advance of class. It is still unknown if the flipped classroom leads to improved overall educational outcomes, pass rates on licensure examinations, success on clinical clerkships, or job placement into post-graduate training such as residency. More studies are needed to justify the additional resources that may be needed to incorporate active learning, especially if student preparation remains low prior to class. In this study very few students had a score less than 70% on the module exam, even though video viewing was lower than expected. One interpretation of this finding is that students gained from the in-class cases and exercises independently of preparation prior to class. We believe that the flipped classroom format was beneficial to gain additional time in class for active learning, and the somewhat limited extent of student preparation should not be used as rationale for continued use of traditional lecture techniques.

This study had important limitations. It is possible that the incentives in place for viewing the videos were insufficient, therefore leading to lower preparation. Additionally, students may have avoided the extra work if the active learning exercises did not challenge them in a way that having the knowledge from the videos was necessary or deemed valuable. We cannot exclude the possibility that the low rate of video viewing was due to quizzes that were not challenging enough and/or that in-class active learning did not require the advanced knowledge of content provided in the videos. Although video view time was higher when a quiz was required, it is possible this was due to the sequence in which the quizzes were administered since preparation decreased with each subsequent session. Anecdotally, we are aware that a few students watched the videos together, thus their view-time was not reflected in the data downloaded. However, this occurred with very few (fewer than five) students based on an informal solicitation for comments by the course coordinator. Nonetheless, there is likely to be measurement bias given that all data were captured automatically from the course website. Another potential limitation is the inability to know definitively whether students actually view the videos while they are running. Students could leave the video running while multitasking or may not watch at all. We assumed there would be a reasonable amount of viewing while videos were running. However, the time online should be considered as the maximum time a student may have watched the video, not necessarily the actual time spent viewing. In this study we equated lecture video viewing time with preparation. In theory, students can prepare by reading primary literature. However, in these circumstances, students were specifically instructed that only video viewing was required and no other materials were provided. Thus we can be fairly certain that little other preparation occurred.
Conclusion

Student lecture video viewing preparation prior to a flipped classroom was low, and using the approaches taken in this course only occurred in less than half of students. The use of quizzes prior to class may improve student preparation. Greater video viewing preparation was associated with slightly better performance on one quiz and the module exam. Future studies need to address the effect of a variety of methods to improve student preparation prior to the flipped classroom.

Conflicts of interest

None.

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References