Experiences in Teaching and Learning

Use of condensed videos in a flipped classroom for pharmaceutical calculations: Student perceptions and academic performance☆

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ABSTRACT

Background and purpose: The flipped teaching method was implemented through a series of multiple condensed videos for pharmaceutical calculations with student perceptions and academic performance assessed post-intervention.

Educational activity and setting: Student perceptions from the intervention group were assessed via an online survey. Pharmaceutical exam scores of the intervention group were compared to the control group. The intervention group spent a greater amount of class time on active learning.

Findings: The majority of students (68.2%) thought that the flipped teaching method was more effective to learn pharmaceutical calculations than the traditional method. The mean exam scores of the intervention group were not significantly different than the control group (80.5 ± 15.8% vs 77.8 ± 16.8%; p = 0.253).

Discussion: Previous studies on the flipped teaching method have shown mixed results in regards to student perceptions and exam scores, where either student satisfaction increased or exam scores improved, but rarely both.

Summary: The flipped teaching method was rated favorably by a majority of students. The flipped teaching method resulted in similar outcomes in pharmaceutical calculations exam scores, and it appears to be an acceptable and effective option to deliver pharmaceutical calculations in a Doctor of Pharmacy program.

Background and purpose

According to the Accreditation Council for Pharmacy Education (ACPE) Standards 2016 Key Element 10.12, the didactic curriculum should be “delivered via teaching and learning methods that: (1) facilitate achievement of learning outcomes, (2) actively engage learners, (3) promote student responsibility for self-directed learning, (4) foster collaborative learning, and (5) are appropriate for the student population (i.e., campus-based vs. distance-based).” At Touro University California College of Pharmacy (TUCOP), active learning continues to be integrated into the pharmacy curriculum and certain didactic topics are delivered in the flipped format to further increase active learning. In a typical non-flipped lecture, TUCOP students would spend approximately half their time taking part in a “traditional” didactic learning environment where the professor lectures on a topic, with the second half of

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the class time incorporating the use of Small Group Discussion sections involving case-based problems and activities.

Several pharmacy schools have also incorporated the flipped teaching method in their curriculum. For example, Wong et al.\textsuperscript{2} reported using pre-recorded lectures in teaching cardiac arrhythmias for the basic science, pharmacoeconomics, and therapeutics courses. Pierce and Fox\textsuperscript{2} utilized four one-hour pre-recorded lectures on renal therapeutics. McLaughlin et al.\textsuperscript{4,5} utilized 25 condensed lectures, each 35 min in length, to present material in a pharmaceutics course. Recently, Cotta et al.\textsuperscript{6} reported on the use of the flipped in a course on pharmaceutical calculations using pre-recorded lectures of 40–60 min in length, demonstrating improved student performance and satisfaction. While the flipped teaching method has been shown to improve academic performance in some instances, student perceptions have been mixed.\textsuperscript{1,2,6,7} Recently, interest has been growing in using "TED (Technology, Entertainment and Design, LLC) Talks" type presentations typically limited to under 18 min in length as an effective means of disseminating information. TED Talks have become a popular means of disseminating information in short, targeted videos.\textsuperscript{8} In the current study, basic pharmaceutical calculations were delivered in three class periods using the flipped teaching method in a manner similar to the TED Talks format with multiple videos of 7–15 min in length. Learning advanced mathematics can be a challenge for some students, often requiring a high degree of structure and repetition. In fact, according to DC Geary,\textsuperscript{9} "for most people the mastery of secondary quantitative abilities appears to require highly organized, focused, and repetitive instructional practices." Today's students tend to avoid reading long texts and learn better from material presented on short segments. According to Tvenge,\textsuperscript{10} "...when they must hear a lecture, these students respond to pictures, graphics and short video segments like those found on YouTube." Increasing student acceptance of active learning can help overcome barriers to acceptance of active learning strategies.\textsuperscript{11} The flipped teaching method has been used successfully in a drug literature evaluation course using short videos.\textsuperscript{12}

In order to incorporate more active learning during the class period, the flipped teaching method using TED Talks format videos was implemented for first year pharmacy students on the topic of pharmaceutical calculations. The topic of pharmaceutical calculations was chosen for the current study for multiple reasons. The mathematics involved remain relatively constant over time, and would likely require minimal revision from year to year. Also, students who struggle with math would be able to review the recorded material repeatedly at their own pace if needed. The flipped method was initially implemented in an arrhythmias series a few years prior with positive results.\textsuperscript{2} The topic of arrhythmias was chosen because it has been a challenging topic for students within our institution. This was the impetus for trying the flipped method for pharmaceutical calculations. In the study's flipped teaching method, lecture material that previously would have been presented in the classroom was recorded prior to the class period. Various media were used as learning methods, including audiovisual recordings, reading assignments, and practice problems. The majority of the class period was then used to apply the material through group participation in activities such as problem solving exercises and small group discussion.

This study had two objectives: (1) determine the effectiveness of the flipped teaching method on learning pharmaceutical calculations by comparing the exam scores of students receiving the flipped teaching method (Spring 2015) to exam scores of students receiving the traditional teaching method (Spring 2014), and (2) determine the student perceptions of the flipped teaching method via survey.

### Educational activity and setting

The pharmaceutical calculations series consists of three class periods, spaced out over a period of six weeks. This study utilized the existing course structure that had been previously built into the schedule. This structure was used for both the intervention and control groups. All three classes in both groups were taught by the same faculty member. The calculations were primarily algebraic in nature. Some calculations were more complex in their structure requiring multiple steps. The outline of topics is listed in Table 1.

In the flipped group, students were instructed to view five pre-recorded video modules before each class (each video

### Table 1
Outline of pharmaceutical calculations topics.

<table>
<thead>
<tr>
<th>Calculations I</th>
<th>Calculations II</th>
<th>Calculations III</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Introduction to Concepts: Units, Error, Percent Strength, Ratio Strength</td>
<td>I Introduction to Concepts: Dilution, Concentration</td>
<td></td>
</tr>
<tr>
<td>II Minimum Weighable Quantity (MWQ), Error, Sensitivity Requirement</td>
<td>II Algebraic Method for Concentration</td>
<td></td>
</tr>
<tr>
<td>III Aliquots with solid measures</td>
<td>III Algebraic Method for Dilution</td>
<td></td>
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<tr>
<td>IV Aliquots with liquid measures</td>
<td>IV Mass Balance Method for Dilution</td>
<td></td>
</tr>
<tr>
<td>V Trituration with multiple steps</td>
<td>V Alligation Method for Dilution</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>I Introduction to Concepts: Diffusion, Osmosis, Osmolarity, and Osmotic Pressure, Tonicity</td>
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<td>II Sodium Chloride Equivalent Method with NaCl</td>
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<td>III Sodium Chloride Equivalent Method with NaCl more than one ingredient</td>
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<tr>
<td></td>
<td></td>
<td>IV Sodium Chloride Equivalent Method with boric acid</td>
</tr>
<tr>
<td></td>
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<td>V Freezing Point Depression Method</td>
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</tbody>
</table>
approximately 7–15 min in length) for a total of 15 video modules. Prior to each of the three classes, the links to each video module were posted on the Blackboard Learn (Blackboard Inc., Washington, D.C.) pharmaceutics course homepage along with learning objectives, 10 practice problems, and equation flowsheets with step-by-step explanations of the problem-solving process. With the exception of the videos, the control group received the same learning materials in advance. Table 2 shows an outline of the flipped and traditional class layouts. At the start of each three-hour class period in the intervention group, students were given 15 min to complete an announced graded quiz. The quizzes were used to incentivize pre-class preparedness. After the quiz the students were allotted another 15 min to ask questions about the recorded material. The remaining 150 min were spent on active learning where the students applied the material to class problems. Students took formative pharmaceutics exams that included questions on pharmaceutical calculations. To determine the effectiveness of the flipped teaching method, 13 pharmaceutical calculation exam questions were compared in the intervention group (first year students who received the flipped teaching method in Spring 2015) and the control group (first year students who received the traditional teaching method in Spring 2014). The test questions for both groups were of the same level of difficulty.

An anonymous electronic survey was administered via Qualtrics (Provo, UT) to the intervention group receiving the flipped teaching method at the end of the three-class pharmaceutical calculations series. Items assessed included: amount of time students spent preparing for each class period, student perceptions of the pre-recorded material, assignments, learning objectives, and perceived value of the flipped teaching method. Students were allowed to add free format responses on the survey. Student survey participation was voluntary.

Inclusion into the study consisted of first year pharmacy students (Class of 2018) enrolled at Touro University California College of Pharmacy during the Spring 2015 semester who participated in all three pharmaceutical calculations classes, and first year pharmacy students (Class of 2017) who took part in the traditional teaching method. The quizzes were used to verify attendance. Students who dropped out of the Spring 2015 pharmaceutics course as well as students who failed the Spring 2014 course and were retaking the Spring 2015 pharmaceutics course were excluded from the study.

Subjects were provided informed consent containing additional information regarding the study and assuring confidentiality and anonymity. No individually identifiable data were collected. Only researchers identified in the research proposal had access to the data and all researchers have completed a National Institutes of Health human subjects training program. The study was determined to be exempt from review by the Touro University California Institutional Review Board (TUCA IRB).

Statistical analysis was conducted using STATAv13 (StataCorp LP, College Station, TX). The chi-square test and student’s t-test were used for comparisons of categorical data and continuous data, respectively. A p-value of less than 0.05 was defined as statistically significant.

Findings

As shown in Table 3, mean pharmaceutical calculation examination scores for the intervention and control groups were 80.5 ± 15.8% versus 77.8 ± 16.8% (p = 0.253) respectively. Sixty-seven out of 102 students in the intervention group completed the flipped teaching survey at the end of the three-class series, a response rate of 65.7%. Student perceptions regarding the flipped teaching method are summarized in Table 4. The majority of students (78.5%) spent two or more hours in pre-class preparation

Table 2
Comparison of control and intervention class design.

<table>
<thead>
<tr>
<th></th>
<th>Control Traditional Class (n = 104)</th>
<th>Intervention Flipped Class (n = 102)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before Class</td>
<td>Lecture slides posted</td>
<td>Videos posted 1 introductory module (15 min)</td>
</tr>
<tr>
<td></td>
<td>Reading materials posted</td>
<td>Slides from modules posted</td>
</tr>
<tr>
<td></td>
<td>Class problems posted</td>
<td>Reading materials posted</td>
</tr>
<tr>
<td></td>
<td>Review of materials prior to class advised</td>
<td>Class problems posted</td>
</tr>
<tr>
<td>Scheduled Class</td>
<td>Lecture - live (60 min)</td>
<td>Review of materials prior to class required</td>
</tr>
<tr>
<td></td>
<td>Active learning activity (120 min)</td>
<td>Announced quiz (10 min)</td>
</tr>
<tr>
<td></td>
<td>Solutions posted at the end of class</td>
<td>Introduction, Answer Questions (20 min)</td>
</tr>
<tr>
<td>Block Exams</td>
<td>Five questions from each of the three classes</td>
<td>Active learning activity (150 min)</td>
</tr>
</tbody>
</table>

Table 3
Academic performance measures.

<table>
<thead>
<tr>
<th></th>
<th>Control Group (n = 104)</th>
<th>Intervention Group (n = 102)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pharmacy Calculations</td>
<td>77.8 ± 16.8</td>
<td>80.5 ± 15.8</td>
<td>0.253</td>
</tr>
</tbody>
</table>
before each class session, with a mean of 3.2 hours of preparation time. A small minority of students (1.5%) reported spending less than one hour of time to prepare before class. Answers of strongly agree/agree were combined for the analysis of the Likert scale questions. The majority (73.8%) of students strongly agreed/agreed that reviewing the material prior to class helped improve understanding of pharmaceutical calculations and a majority (68.2%) also felt the flipped teaching method was a more effective way to learn pharmaceutical calculations than the traditional teaching method. However, less than half of students (47.7%) would like to have more lecture topics taught in the flipped teaching method instead of the traditional lecture format. Free format responses were centered mostly on likes and dislikes of the flipped method. Most comments were favorable toward the flipped method for pharmaceutical calculations. Common themes in the student comments included: “allow[ed] us to learn the material on our own,” and “helpful for students to go over at their own pace.” Reasons for preferring the traditional format varied, though one common theme was the additional time needed prior to class for preparation: “Overall I think the method is good but just time consuming outside of class.”

Discussion

The current study demonstrated similar outcomes in mean pharmaceutical calculations exam scores when using the flipped method compared to the traditional method. In addition, the majority of students rated the flipped teaching method favorably as they felt it improved their understanding of pharmaceutical calculations and viewed it as more effective than the traditional lecture-based teaching method.

Despite no significant improvement in exam scores, there are advantages to utilizing the flipped method (and in particular with multiple condensed videos) for pharmaceutical calculations for both the student and faculty. First, the pre-recorded material is available for the students to review on their own time. Second, students who are less proficient can review the videos multiple times, allowing them to prepare for class at their own pace independent of the classroom. Third, the use of shorter-length videos, similar to TED Talk videos’ duration has been shown to enhance viewer engagement and attention span over longer videos. Student buy-in is needed for the flipped method to be successful, so student perception and acceptance of the teaching method is an important consideration when designing a teaching format. According to Twenge, one step to better teach the current generation of students is “…to meet its members on their own ground by breaking lectures into short chunks, using video and promoting hands-on learning.” The brief, targeted approach of the videos may be a potential reason why the majority of students rated the flipped teaching method for pharmaceutical calculations favorably. One area where student feedback was less favorable in regards to the additional time spent prior to class to prepare. However, the balance here is that additional class time was available using the flipped method, allowing for more in-depth discussion of the approaches used to solve the calculations (e.g. algebraic versus alligation). Producing the videos did require initial investment in time. However, the videos can be used repeatedly each year, and the short format allows for flexibility if a section of material needs to be modified in future years. As such, the flipped model can be beneficial for both students and faculty.

Previous studies employing the flipped method have demonstrated mixed results, both in exam scores and in student satisfaction/acceptance. For example, McLaughlin utilized 35 min online presentations twice weekly for a core pharmaceutics course. There was no improvement in exam scores compared to the control group, but student perceptions regarding the flipped method were favorable. Pierce et al. utilized audio/visual podcasts for four out of 23 lectures in a pharmacotherapy course. Both exam scores and student perceptions improved over the control group. Ferreri et al. compared a reformatted curriculum utilizing small group discussion in a flipped format to the traditional lecture format. Student exam grades improved, but student feedback was negative. Missildine et al. compared the use of lecture capture to traditional lecture format for teaching Adult Health to nursing students. The authors concluded that the flipped method improved learning as demonstrated by improved exam scores, but that students were less satisfied. Wong et al. utilized pre-recorded lectures for three arrhythmia courses (basic sciences, pharmacology, and therapeutics) compared to the traditional lecture format. Exam scores improved in the pharmacology and therapeutics courses with the flipped method, though student satisfaction varied and was influenced by the quality of the learning objectives, pre-recorded lectures, and in-class
active learning activities. Giuliano and Moser\(^{12}\) used a series of short videos, each an average 13 min in length, in a flipped drug literature evaluation course. Both test scores and student acceptance improved. Cotta et al.\(^{6}\) reported improvements in exam scores and student acceptance using the flipped method in a pharmaceutical calculations course. However, in the current study, no significant differences were noted in mean exam scores while most students perceived the flipped teaching model with use of multiple condensed videos favorably.

While several the teaching methods were similar between the Cotta study and the current study, there were notable differences. Cotta utilized a 40–60 min pre-recorded lecture prior to each class, while the current study utilized a series five short videos ranging from seven to 15 min long prior to each of the three classes to enhance student engagement. Additionally, Cotta et al. administered a quiz at the end of each class session, while the current study administered a quiz at the start of each of the three class session to encourage students to fully take part in the flipped experience prior to class. The quizzes in the Cotta study counted toward 12% of the course grade, while the quizzes in the current study counted only 1% of the course grade. In the current study, the timing of the quizzes at the beginning of class, and the lower grade weighting of may have been factors in student performance. Lastly, the control group in the current study still received 120 min per 180-min. class session of active learning, likely a higher proportion than traditional lecture formats. Perhaps comparing the flipped teaching intervention group to a control group with much less active learning would have resulted in a difference in exam scores.

There are limitations to this study of note. First, this study focused on a single topic, so the results may not be extrapolated to other pharmacy school didactic topics. However, this is just the second study in the literature to analyze the effectiveness of the flipped teaching method on pharmaceutical calculations. Second, the current study did not assess long-term retention of the material. It would be interesting to see if differences in pharmaceutical calculation mastery occur years later in the flipped teaching group versus the traditional teaching group (i.e., calculations performance on the Pharmacy Curriculum Outcomes Assessment [PCOA] or the North American Pharmacist Licensure Examination [NAPLEX]). Third, due to the anonymous nature of the survey, student survey responses could not be linked to calculation exam scores. Thus, we were not able to determine if students who spent more time preparing before class had higher exam scores and vice versa. However, only a small minority of students (1.5%) reported spending less than one hour of time to prepare before class; thus, the majority of the class sufficiently participated in the flipped teaching model.

**Summary**

The flipped teaching method employed in this study resulted in similar outcomes in student pharmaceutical calculations exam scores compared to the traditional teaching method. Additionally, the majority of students rated the flipped method with multiple condensed TED Talk-style videos favorably. Pharmacy education can and should continue to adapt to the learning needs of students. Thus, the flipped teaching method appears to be an effective and acceptable option to deliver pharmaceutical calculations in a Doctor of Pharmacy program.

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13. Ferreri SP, O’Connor SK. Redesign of a large lecture course into a small-group learning course. *Am J Pharm Educ.* 2013;77(1) [Article 13].