RESEARCH

The Effect of Pharmacy Students’ Attendance on Examination Performance in Two Sequential Active-Learning Pharmacotherapy Courses

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Objective. To examine the relationship between class attendance by Doctor of Pharmacy students and their performance on pharmacotherapy examinations within an active-learning classroom model.

Methods. Second-year pharmacy students enrolled in a pharmacotherapy course series were included in the study (N = 160). Class attendance was taken manually by members of the study team over a one-year study period (fall 2017 and spring 2018 semesters). Course attendance was not required and had no direct impact on student grades. Scores from the six competency-based examinations and overall course grades for each semester course, respectively, were then linked to class attendance records. Two additional examination attempts (retake and extended learning experience) were administered to students who did not receive a score of at least 80% on the initial exam or retake exam, respectively.

Results. Class attendance was documented during 48 class sessions. Of the six examinations given each semester, students required an average of 1 retake of the examination during the fall semester and 1.5 retakes in the spring semester. A significant negative correlation was found in both courses between students missing more classes and receiving a lower final course grade. For each missed class session, there was a reduction in overall course grade of 0.18% and 0.14% in the fall and spring courses, respectively.

Conclusion. Regular class attendance by pharmacy students enrolled in an active-learning pharmacotherapy curriculum was associated with higher scores on examinations. The results of this study illustrate the importance of attending active-learning sessions to attain higher examination scores. Further research is needed to determine whether class attendance is associated with students’ improved ability to apply pharmacotherapy concepts.

Keywords: absenteeism, attendance, academic performance, therapeutics

INTRODUCTION

The profession of pharmacy is constantly evolving, and students must be prepared to deal with a variety of clinical scenarios. As a result, teaching methods must be adapted to effectively prepare students to be competent and effective clinicians upon graduation. Various teaching styles can help students develop various aspects of problem-solving, which include understanding the problem, researching information, analyzing relationships, and hypothesizing effective solutions to problems.1 In particular, the “flipped classroom” approach offers a unique teaching style that may help students perform these tasks. Indeed, studies have found that a flipped classroom approach can improve students’ test performance and perceptions of the learning experience.2

The basis of this approach is for students to review the content before attending class so that the time in class can be devoted to active-learning activities. At the Washington State University College of Pharmacy and Pharmaceutical Sciences (WSU CPPS), the Doctor of Pharmacy (PharmD) program uses an active-learning classroom model that employs the “flipped classroom” format for all required didactic courses. Students are provided with pre-lecture materials to review prior to class, which include narrated video lectures and/or required readings, such as textbook chapters or journal articles. While the WSU CPPS has widely adopted an active-learning classroom model within the curriculum, the format and approach taken within each course is at the discretion of the instructor and is not otherwise standardized, including whether class attendance is mandatory and assigned course credit. Once students have
reviewed the pre-lecture materials, they then can attend class to practice and apply the information they learned through review and study of the pre-class materials.

Pharmacotherapy is an integral part of the pharmacy curriculum as it incorporates aspects of other courses, such as pharmacology and other science-based concepts, and applies learned concepts within a clinically oriented framework. Koo and colleagues performed a study that analyzed the impact of a flipped classroom design on student performance in a pharmacotherapy course. The study showed that in comparison to a traditional lecture model, the flipped classroom design improved student performance and perceptions of the learning experience. While benefits of this approach have been reported, provision of material online has the potential to impact class attendance. With the changes of curricula in several colleges of pharmacy, it is important to assess the impact of student attendance on performance in required courses that adopt flipped or active classroom approaches. More broadly, student absenteeism not necessarily tied to flipped classroom (or active learning models) in higher education has been linked with inadequate learning and poorer academic performance. Likewise, negative associations have been reported within pharmacy courses between the number of hours students miss and their course performance. Additional studies are needed to determine how best to implement novel course delivery and its potential impact on class attendance and student performance.

In addition to using an active-learning model, the WSU CPPS employs a competency-based grading model where students demonstrate achievement of clearly defined learning objectives and curriculum outcomes by achieving a score of 80% or above on all course examinations. Briefly, the competency-based examination model uses a three-tier (ie, honors/satisfactory/fail or H/S/F) grading scheme. Within didactic courses, such as the pharmacotherapy sequence, students are allowed three attempts to achieve the 80% required competency on each given examination. If a student does not achieve 80% competency on the initial examination attempt, they complete a repeat examination within one week. If competency is not achieved on the repeat examination, students are required to complete the examination a third time at the end of the semester during what is known as an extended learning experience (ELE). Each of the three examinations on a given block of material contain unique questions; however, they assess the same learning objectives. The purpose of providing students with a retest and ELE if needed is to allow them the opportunity to demonstrate competency after failing the initial examination. For students who demonstrate competency on a repeat examination or ELE, the maximum score they can achieve on either is 80%. While this scoring paradigm is used for the gradebook within the courses, for the purpose of this analysis, their actual score on each examination was used (eg, if a student scored above 80%, their actual percentage score was used in the analysis). The combination of having an active-learning model and frequently administering examinations allows us to study the impact of class attendance on student performance in this setting.

For this study, student attendance and subsequent performance on pharmacotherapy examinations in two courses are reviewed to see if the active-learning model employed within the courses proved to be effective for students who participated in the active-learning portion of the class versus those who relied solely on review of the pre-lecture materials provided prior to class. In examining the relationship between participation in the active-learning component of the pharmacotherapy course and examination performance, we predicted that participation in the active-learning component of the courses would correlate with better performance on examinations.

METHODS

The Washington State University Institutional Review Board determined the study was exempt and therefore did not require students to submit informed consent as all students were assigned a study identification number and all study data were deidentified. A total of 160 second professional year (P2) students enrolled in the WSU Doctor of Pharmacy program were included in this study. Students were excluded from the analysis if they were repeating either course (ie, they had previously taken the course and received a failing grade). All other enrolled students were included in the analyses.

Examination was conducted via a proprietary computer-based testing platform, ExamSoft (ExamSoft Worldwide, Inc., Boca Raton, FL). Question formats used within the examinations included multiple-choice, true/false, select all that apply, and fill-in-the-blank. A mixture of knowledge-, application-, and synthesis-level questions that tested students on concepts from both pre-class and in-class materials were included on all examinations. Each of the courses assessed student mastery of the content through six examinations (not counting any repeat examinations and ELEs).

The two pharmacotherapy courses included in this study were part of the WSU CPPS pharmacotherapy sequence. The first course was completed during the fall 2017 semester and covered pharmacotherapy topics primarily spanning the gastrointestinal and neurological systems. The second course was completed during the spring 2018 semester and covered topics primarily spanning the cardiovascular, respiratory, and renal systems. The courses, as is
standard within the overall WSU CPPS curriculum, use an active-learning approach to content delivery where students are asked to review pre-class materials covering key concepts for each lesson followed by an in-person active-learning session. The pharmacotherapy courses were taught by a wide range of instructors, which included pharmacy residents and clinical pharmacists. The pre-class materials included prerecorded videos and assigned readings. The two courses were administered by different instructors of record and were analyzed separately because of differences in subject matter and course management.

The active-learning sessions were approximately one to two hours in duration, depending on the topic, and used a mixture of audience-polling techniques, presentation and review of case studies, and games (ie, Jeopardy) to facilitate learning. Class attendance was not required for these pharmacotherapy classes, which is similar to other courses within WSU’s PharmD program. Furthermore, class attendance was not measured as a component of the courses (ie, no participation points were given nor did the class have required quizzes or other activities).

Data gathered for this study were related to examination performance and student attendance of active-learning sessions to determine if a link existed between participation in active-learning sessions and examination/course performance. Examination performance data were extracted from ExamSoft. Class attendance was taken manually by members of the study team for each active-learning session over the year-long study period. Class attendance was defined as arriving within 20 minutes of the start of the class session. Because of the structure of the class, students’ level of participation in the active-learning activities was not measured or considered in the current analysis.

Data for this prospective observational cohort study were imported into SPSS, version 24.0 (IBM, Armonk, NY) and summarized separately by course strata. The descriptive summaries used in the statistical analysis included overall grade point averages, standard deviations, and minimum and maximum values between class attendance and grades. The relationship between attended classes and overall course grade for each of the two classes was assessed via Pearson correlation coefficient. Because the correlation coefficient measures linear association, a least-squares regression was then determined. The more immediate relationship between class attendance and grade was determined using ordinal categorizations of the number of class periods missed within a content block and the student’s subsequent examination grade. For the fall 2017 semester, all content blocks were composed of four content sessions. Accordingly, attendance categorizations for the fall 2017 semester included four, three, two, one, and zero classes missed within the content block, respectively. In the spring 2018 semester, the number of content sessions composing each content block varied, ranging from four to six sessions. Because of this, attendance categorizations for the spring 2018 semester were defined differently to accommodate for the variability in content sessions constituting each content block. For spring 2018, attendance categorizations included four out of four or greater than or equal to five out of six; three out of four or four out of six; two out of four or two to three out of six; one and zero classes missed within the content block, respectively. For each course an ANOVA F test was determined with a post-hoc Tukey test to determine mean homogeneous attendance subgroups. Effect sizes were reported as $\eta^2$ values, where values of 0.01, 0.06, and 0.14 were considered thresholds for small, medial, and large effect size, respectively. The relationship between categorical attendance and the nominal variables for examination score below 80% (signaling the need for the examination to be retaken) and ELE remediation was assessed via linear associations chi-square tests. Post-hoc Bonferroni adjusted z tests were performed in the presence of overall significance ($p<.05$ via two-sided testing). Effect sizes were also determined using the Cramer V test, where values of 0.1, 0.3, and 0.5 are considered thresholds for small, medium, and large effect size, respectively.

**RESULTS**

Attendance data were collected for 24 class sessions during fall 2017 and 26 class sessions during spring 2018 for the 160 students enrolled in these pharmacotherapy courses. There were two fewer class sessions for the fall course because of the Point of Care and Clinical Services course which was offered and had to be completed within the first week of the fall semester of the second professional year. As shown in Table 1, students on average missed 11 classes during both the fall 2017 and spring 2018 courses. Table 1 also reports the mean final course grades, mean number of retakes where students required a second attempt, and the mean number of ELEs where students required a third attempt. Of the six examinations given during each semester, students in the fall semester course were required to retake an average of 1.0 examination, and students in the spring semester course were required to retake an average of 1.5 examinations. Only a small portion of the students required one or more ELEs.

A significant negative correlation was found for both the Fall ($r = -0.31, p < .001$) and Spring ($r = -0.29, p < .001$) semesters between the total number of classes missed and the final course grade, indicating that missing more classes was related to a lower final course grade. Further regression analysis predicted a final course grade of 91%
in the fall course and 88% in the spring course if no classes had been missed (Table 2). For each missed class session, the regression predicts a reduction in overall course grade of 0.18% in the fall and 0.14% in the spring courses.

The impact of the number of class sessions attended on subsequent examination performance is reported in Table 3 for the fall 2017 course and Table 4 for the spring 2018 course. For the fall 2017 course, each of the six examinations in the course had four class sessions where examination content was covered. This allowed analysis by five different attendance categories as determined by the number of classes missed: four classes missed; three classes missed; two classes missed; one class missed; and zero classes missed. The spring 2018 course had between four and six class sessions prior to each examination because of course scheduling around holidays and breaks. Attendance again was divided into five categories based on the number of classes missed and in consideration of the number of class sessions composing each block of testable material: four out of four or at least five out of six classes missed; three out of four or four out of six classes missed; two out of four or two to three out of six classes missed; one class missed; and zero classes missed.

For the fall 2017 course, a one-way ANOVA yielded significant differences in mean examination scores between the five attendance categories ($p < .001$) (Table 3). Additionally, linear association chi-squares tests showed significant differences between the attendance categories when evaluating the number of retakes required ($p < .001$) but not for the number of ELEs required. Further post-hoc analysis identified three statistically distinct subgroups that had either a negative, neutral, or positive effect on mean examination scores and the number of retakes required (Table 3). Missing all four class sessions prior to an examination had a negative impact on both mean examination scores and the number of examination retakes. In contrast, perfect attendance at all class sessions resulted in significantly higher examination scores and decreased the possibility of a student being required to retake an examination. Students who missed one, two, or three of the four total class sessions were part of the neutral subgroup. Overall, missing at least one of four class sessions was associated with a non-significant trend toward being required to retake an examination ($p = .066$; 95% CI = 0.82-19.46), with each class missed increasing the odds of needing to retake an examination by 6.7% ($p < .001$).

One-way ANOVA and linear association chi-square tests indicated significant differences in the attendance categories for the spring 2018 course for mean examination scores ($p < .001$), number of retakes required ($p < .001$), and number of ELEs required ($p = .001$) (Table 4). Through further post-hoc analysis, statistically distinct subgroups were identified from the five attendance categories that had either a negative, neutral, or positive effect on performance indicators. When looking at mean examination scores, two subgroups were identified: students that missed less than or equal to two out of four or two to three out of six classes had significantly higher examination scores while missing greater than or equal to three out of four or four out of six classes negatively impacted

| Table 1. Descriptive Summary of a Study of Doctor of Pharmacy Students’ Attendance and Grades in Two Pharmacotherapy Courses in Which an Active-Learning Teaching Format Was Used (N=160) |
|-----------------|-----------------|-----------------|-----------------|-----------------|
| Variables       | Fall 2017       | Spring 2018     |
| Total missed classes | Mean (SD) | Mean (SD)       |
| Total examination retakes | 1 (1.2) | 1.5 (1.5)       |
| Total ELEs | 0.1 (0.4) | 0.3 (0.7)       |

Abbreviations: ELEs = extended learning experiences (third examination attempt)

- Students who scored below 80% on any of the six examinations administered during each semester were required to retake a different version of the examination that covered the same content.
- Students who scored below 80% on the second examination attempt (the retake) were required to complete an ELE.

| Table 2. Regression Analysis Between Attendance and Final Course Grade in a Study of Doctor of Pharmacy Students Completing Pharmacotherapy Courses in Which an Active-Learning Teaching Format Was Used |
|-----------------|-----------------|-----------------|-----------------|-----------------|
| Variables       | Fall 2017       | Spring 2018     |
| Constant (SE)   | 91 (0.6)        | 88 (0.5)        |
| Unstandardized Beta (SE) | -0.18 (0.045) | -0.14 (0.038) |
| $R^2$           | 0.093           | 0.081           | 0.01           | 0.01           |

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examination scores. Similarly, students missing greater than or equal to three out of four or four out of six classes were more likely to require both a retake and an ELE. Overall, missing at least one class session within a testing block of material increased the odds of a student being required to retake an examination by more than fivefold \((p = .025; 95\% \text{ CI: } 1.06-30.11)\), with each class missed significantly increasing the odds of requiring a retake by 7.4\% \((p < .001)\).

Overall, there was a positive relationship between class attendance and examination scores for the fall 2017 pharmacotherapy course and the spring 2018 pharmacotherapy course (Tables 3 and 4). For the fall 2017 cohort, students who attended all classes in which a block of material was discussed and applied achieved a mean score of 90\% on the examination covering that material and those who missed all classes (four out of four) for a block of material achieved a mean score of 83\% on the examination, a difference of 7\%. For the spring 2018 cohort, students who attended all classes in which a block of material was covered achieved a mean score of 86\%. For those who attended zero of four or less than or equal to one out of six classes in spring 2018, the mean score was 80\%, a difference of 6\% from the group with 100\% class attendance. Because of the 80\% standard for showing competency, a tight range of performance scores was expected and observed. Thus, the absolute percentage differences in mean scores between the 100\% and 0\% attendance groups illustrate how important attending active-learning classes are in attaining higher examination scores.

**DISCUSSION**

In the traditional lecture-style classroom, students are expected to gain knowledge by listening in class and study and/or apply the material outside of the classroom. For the most part, questions asked in a traditional classroom setting are related to clarifying knowledge-based information (e.g., vocabulary, jargon) or gathering the information (e.g., requests for explaining what was just said or repeating what was not heard). In contrast to the traditional lecture-style classroom setting, an active-learning classroom allows students to prepare for class by listening to prerecorded videos or by reading assigned articles or guidelines, for example, to obtain the foundational knowledge needed to delve deeper into any given topic during class. Students obtain the knowledge prior to class and then apply it in critical-thinking activities where the instructor is present. By having an instructor readily accessible during class, the instructor can help guide students through difficult concepts and target higher levels of Bloom’s taxonomy. In addition, potential questions and misunderstanding can be resolved immediately by the instructor.
Theoretically, attending class as part of an active-learning curriculum is even more essential for students to succeed in learning, developing, and applying the knowledge gained from pre-class material than attending a traditional lecture-based class. Thus, the focus of our study was to address the research question of how attendance impacts examination performance in a series of pharmacotherapy courses using an active-learning model. Our results show that there is an inverse relationship between missing class and examination performance, indicating that missing fewer classes was associated with higher examination scores (ie, attending class results in higher examination scores).

Class attendance was also associated with required examination retakes. Students with poor attendance were significantly more likely to require one or more examination retakes. Interestingly, there was no clear ranking relationship between class attendance and number of students having to take an ELE for both semester cohorts (Tables 3 and 4). Overall, fewer students who attended class 100% of the time had to sit for an ELE to show competency compared to the number of students who did not attend class at all (four vs eight for fall 2017 and 10 vs 21 for spring 2018). By identifying similar outcomes in the analysis of two unique academic courses, these findings appear generalizable within pharmacotherapy courses employing an active-learning model.

The primary objective of this study was to examine the relationship between student attendance and an active-learning model to determine if this was correlated with improved examination performance. Student absenteeism and flipped classroom models are important topics of discussion in improving student performance. Student absenteeism has increasingly become a concern in education as it poses a negative impact on student learning.3-10

Hidayat and colleagues concluded that the most common reason of absenteeism was because of the availability of course content and studying for other courses.11 Therefore, it is imperative that educators seek different ways to improve student attendance through creating a community in the classroom, which is often shown through active-learning models. Our study showed that attending class was associated with higher examination scores and less need to retake examinations. Our findings are consistent with existing pharmacy education literature.1,11 Hidayat and colleagues showed a difference in lecture attendance of therapeutic courses between high- and low-performing students with low-performing students missing significantly more hours of class.11 Similarly, Landin and colleagues...
found a positive relationship between a history of pharmacy course attendance and final examination score and final overall course grade. However, only one previous study by White and colleagues evaluated attendance in an active-learning environment. They showed that attendance in active-learning classes was strongly correlated with examination performance on novel questions.1

While absenteeism appears to impact class performance, reasons for missing class are multifactorial.13-15 While an active-learning environment provides an opportunity for students to be more interactive with course materials and unique scenarios, which allows them to learn valuable problem-solving strategies that are applicable to pharmacy practice, participation is necessary for them to realize the potential benefits of this model.

Our study has several limitations. One limitation is that this study did not take into account potential confounders, such as variability in topic content or level of difficulty, the active-learning strategies employed within a given block of material, or variability in guest instructor teaching styles, which may have influenced the results. Like many other programs, the pharmacotherapy courses at WSU use a wide range of instructors, including pharmacy residents who have varied amounts of experience with an active-learning model. Similarly, previous academic performance of students within the curriculum or in their prerequisite courses was not considered in the present analysis. The students who attended class regularly may have been high achievers academically in all classes, which led to self-selection within our study. Another limitation is that this study only looked at attendance and not at the level of student engagement during active-learning sessions. Some students who attended class may have had limited participation and engagement during the in-class activities. The exclusion of students who were repeating the course may be considered a limitation, but the number of students excluded (two) was small and likely did not impact the results.

CONCLUSION

Because absenteeism has become an increasing concern in academic settings and has negative implications for student performance and growth, educators have sought out other strategies to enhance student participation and attendance. Flipped and active classroom models have shown promise in providing stimulating activities with which students may engage in the classroom. Because the study primarily evaluated attendance and did not assess student engagement during the class session, further studies should be considered to assess this variable. Ultimately, students need to perceive value in attending class to participate in active-learning activities. Additional insight into student perceptions and reasons for absenteeism within this active-learning model is needed to devise strategies that maximize student learning and performance.

REFERENCES